SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

Supplement to the online
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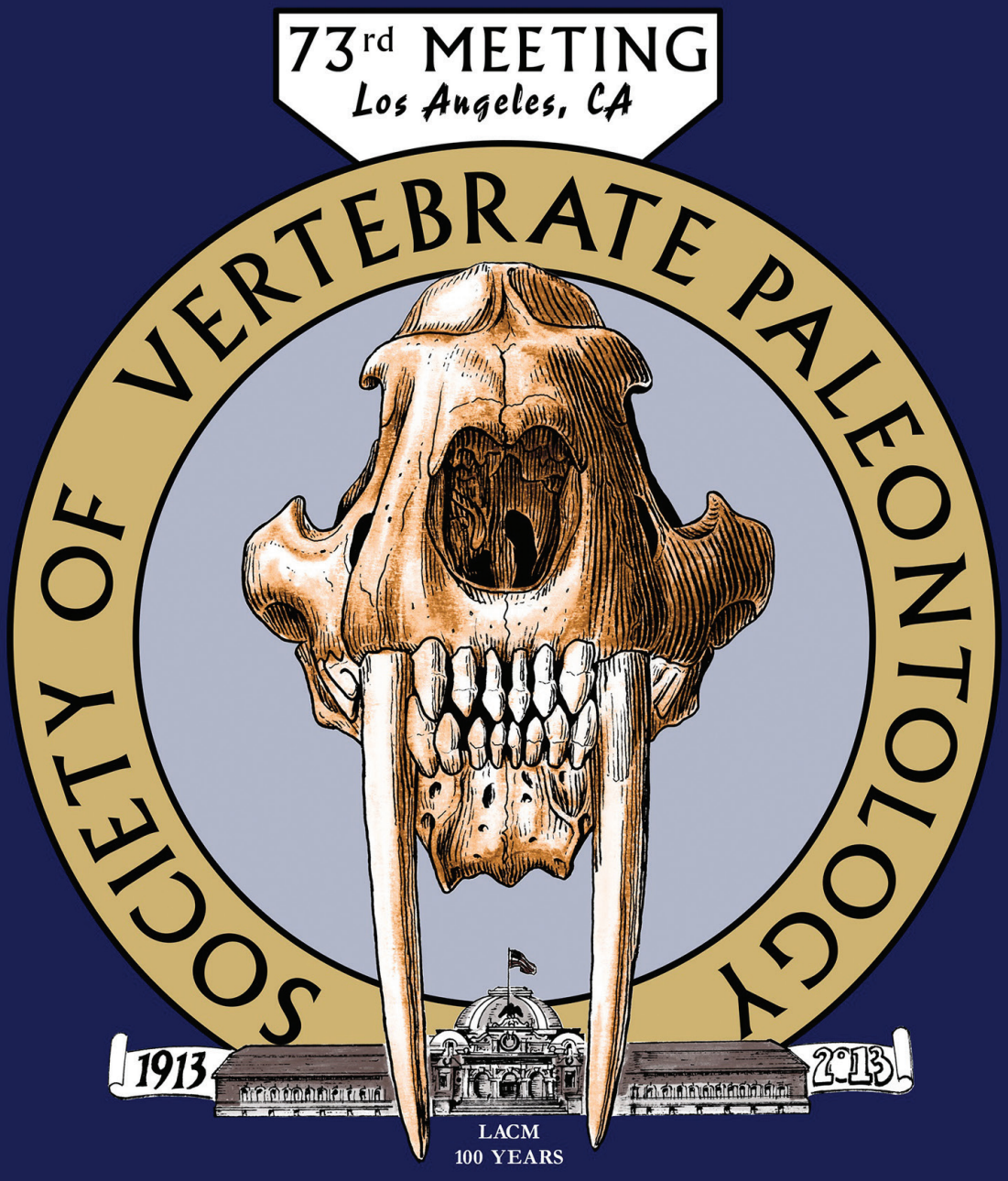
October 2013

PROGRAM AND ABSTRACTS



Westin Bonaventure Hotel & Suites • Los Angeles, CA, USA • October 30 – November 2, 2013

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SOCIETY OF VERTEBRATE PALEONTOLOGY
OCTOBER/NOVEMBER 2013
ABSTRACTS OF PAPERS
73RD ANNUAL MEETING

Westin Bonaventure Hotel & Suites
Los Angeles, CA, USA
October 30 – November 2, 2013

Save the Date!

SOCIETY OF VERTEBRATE PALEONTOLOGY

November 5 – 8, 2014

Estrel Berlin • Berlin, Germany

WELCOME TO LOS ANGELES

The Host Committee of the 73rd Annual Meeting is delighted to welcome all participants to the Society of Vertebrate Paleontology's 2013 meeting in Los Angeles, California. The meeting will take place at the Westin Bonaventure Hotel, close to the heart of downtown Los Angeles that in recent years has experienced a dramatic resurgence with exciting new dining and cultural opportunities. Your host committee members represent institutions from the Greater Los Angeles region and their research interests encompass many facets of the discipline of vertebrate paleontology.

This is the third time that the meeting will be hosted by the Natural History Museum of Los Angeles County and we are particularly thrilled that the Society will return to Los Angeles in the year that the museum celebrates both its centenary and a hundred years of excavations at the La Brea Tar Pits—a National Natural Landmark and one of the world's richest Ice Age fossil sites. Vertebrate paleontology has been at the core of our institution since its origin and continues to play a leading role in our research and educational mission. In this respect we are especially excited to showcase at our Welcome Reception the extensive renovation that has taken place during the past few years. This includes the opening of the award-winning Age of Mammals and Dinosaur Halls and nearly 300,000 square feet of renovated public space within and surrounding the museum. We hope you will also find time to visit our sister institutions—the Page Museum at the La Brea Tar Pits and the William S. Hart Museum.

Southern California offers a variety of paleontological opportunities. The scheduled field trips sample the diversity of marine and terrestrial vertebrate sites within easy reach of Los Angeles and provide brief opportunities to visit the newly founded Cooper Archaeological and Paleontological Center as well as the Page Museum and the La Brea Tar Pits. Most of the local collection centers will be closed during the meeting but will be accessible before and after by prior appointment.

Los Angeles is a premier travel destination and provides a great diversity of cultural opportunities. The spectrum ranges from the Getty Center and the Los Angeles County Museum of Art to the Grammy Museum and the Museum of Jurassic Technology. Los Angeles is home to the Huntington Library and Gardens, the Greater Los Angeles Zoo and Botanic Gardens, the LA County Arboretum, and the Aquarium of the Pacific. Adjacent to the Natural History Museum is the California Science Center—new home of the space shuttle Endeavor. Universal Studios, Disneyland, Knotts Berry Farm and Six Flags Magic Mountain are all within easy reach. And don't forget miles of exquisite beach!

It's going to be an exciting few days in Los Angeles as the 73rd meeting advances the frontiers of vertebrate paleontology and offers a forum for scientific discussion among researchers from around the world. We know you will enjoy the meeting, its workshops and field trips, and the diversity of social and cultural experiences in the newly vibrant downtown setting. Welcome to the City of Angels!

73rd Annual Meeting Host Committee

PRESENTATION POLICIES

SVP Abstracts are reviewed by the Program Committee and occasionally by outside reviewers. Authors are responsible for the technical content of their articles.

Unless specified otherwise, coverage of abstracts presented orally at the Annual Meeting is strictly prohibited until the start time of the presentation, and coverage of poster presentations is prohibited until the relevant poster session opens for viewing. As defined here, "coverage" includes all types of electronic and print media; this includes blogging, tweeting, advanced online publication and other intent to communicate or disseminate results or discussion presented at the SVP Annual Meeting.

Still photography, video and/or audio taping or any other electronic recording at the SVP Annual Meeting is strictly prohibited, with the exception of the designated SVP press event. (The SVP reserves the right to engage professional photographers or audo/videotape professionals to archive sections of the Meeting for the Society's use.)

Editorial policies of Science and Nature magazine: If you are planning to submit, or have submitted, your publication to Science or Nature, be sure you are familiar with their embargo policies.

Please address any questions about program practices to the Program Committee or to the Executive Committee.

Citing an Abstract in the 2013 SVP Program and Abstracts Book
This Program and Abstracts Book is an official supplement to the online version of the *Journal of Vertebrate Paleontology*. The citation format for an abstract printed in this book is: *Journal of Vertebrate Paleontology*, Program and Abstracts, 2013, <insert page number here>.

2013 SVP Workshop Offerings

For Pre-Registered Attendees

Day				
TUE, October 29	9:00am – 4:00pm Photogrammetry: Digital Data Collection in the Lab and Field **SANTA BARBARA B**	9:00am – 5:00pm Virtual 3D Analysis of Chewing in Mammals – Occlusal Fingerprint Analyser **SAN GABRIEL A**	10:00am – 4:00pm Practical Computing for Paleontologists **SAN GABRIEL BC**	2:00pm – 6:00pm Video Made Easy **SANTA BARBARA C**
WED, October 30	12:30pm – 1:45pm Paleontology and The Media – Communicating Your Research to the Popular Press **SANTA BARBARA B**			

2013 SVP Field Trip Offerings

For Pre-Registered Attendees

**All Field Trips will depart from the Figueroa Street Entrance to the Westin Bonaventure Hotel & Suites*

Day				
TUE, October 29	7:00am – 7:00pm Paleontology and Geology of Orange County, CA	8:30am – 9:00pm Stratigraphy and Vertebrate Paleontology of the Middle Miocene Barstow Formation, San Bernardino County, CA	9:00am – 4:00pm DreamWorks Animation Studios; Glendale, California	8:00am – 11:30am Field Trip to Rancho La Brea 1:00pm – 4:30pm Fieldtrip to Rancho La Brea
SUN, November 3	7:00am – 7:00pm Western Mojave Desert Geology and Vertebrate Paleontology with Special Emphasis on the Dove Spring Formation	7:30am – 6:00pm Sharktooth Hill National Natural Landmark	8:30am – 5:00pm Arikareean and Hemingfordian Vertebrate Paleontology of the Santa Monica Mountains National Recreation Area, California	

2013 SVP Schedule of Events (subject to change)

All events are held at the Westin Bonaventure Hotel & Suites unless otherwise noted with an **

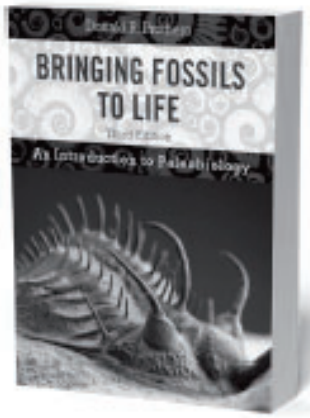
Event/Function	TUE, October 29	WED, October 30	THUR, October 31	FRI, November 1	SAT, November 2
Registration Desk	12:00pm – 6:00pm **CALIFORNIA FOYER**	7:00am – 5:00pm **CALIFORNIA FOYER**	7:00am – 5:00pm **CALIFORNIA FOYER**	7:30am – 5:00pm **CALIFORNIA FOYER**	8:00am – 5:00pm **CALIFORNIA FOYER**
Symposium		8:00am – 12:15pm Ontogeny Changes Everything: Paleobiological Implications of Dinosaur Growth **SAN FRANCISCO**	1:45pm – 4:15pm La Brea and Beyond: The Paleontology of Asphalt-Preserved Biotas **SACRAMENTO**	8:00am – 12:15pm The Tempo of Vertebrate Evolution: Geochronologic Advances in Dating the Fossil Record **SAN JOSE**	8:00am – 12:15pm Patterns from The Poles: Biodiversity and Paleocology of High Latitude Fossil Vertebrates **SACRAMENTO**
Romer Prize Session			8:00am – 12:15pm **SAN FRANCISCO**		
Preparators' Session			8:00am – 12:15pm **SAN JOSE**		
Colbert Student Poster Prize Session			4:15pm – 6:15pm **SAN DIEGO BALLOROOM / FOYER**		
Technical Sessions		8:00am – 12:15pm Technical Session I Tetrapods, Amphibians, Amniotes, Early Diapsids **SACRAMENTO**	8:00am – 12:15pm Technical Session VI Paleogene Mammals **SACRAMENTO**	8:00am – 12:15pm Technical Session IX Saurischian Dinosaurs **SAN FRANCISCO**	8:00am – 12:15pm Technical Session XIV Birds **SAN FRANCISCO**
		8:00am – 12:15pm Technical Session II Mammal Ecology **SAN JOSE**	1:45pm – 4:15pm Technical Session VII Dinosauria **SAN FRANCISCO**	8:00am – 12:15pm Technical Session X Quaternary & Neogene Mammals **SACRAMENTO**	8:00am – 12:15pm Technical Session XV Carnivores and Marine Mammals **SAN JOSE**
		1:45pm – 4:15pm Technical Session III Ornithischian Dinosaurs **SAN FRANCISCO**	1:45pm – 4:15pm Technical Session VIII Permo-Triassic Synapsids **SAN JOSE**	1:45pm – 4:15pm Technical Session XI Quantitative Analyses of Mammals **SAN FRANCISCO**	1:45pm – 4:15pm Technical Session XVI Anapsida, Testudines, Icthyosauria, and Pterosauria **SAN FRANCISCO**
		1:45pm – 4:15pm Technical Session IV Cenozoic South American Mammals **SACRAMENTO**		1:45pm – 4:15pm Technical Session XII Archosauria and Crocodylomorpha **SACRAMENTO**	1:45pm – 4:15pm Technical Session XVII Sarcopterygians to General Vertebrate Methods **SACRAMENTO**
		1:45pm – 4:15pm Technical Session V Lepidosaurmorpha **SAN JOSE**		1:45pm – 4:15pm Technical Session XIII Paleozoic Fishes **SAN JOSE**	1:45pm – 4:15pm Technical Session XVIII Mesozoic Mammals **SAN JOSE**
Poster Sessions Set-up: 7:30am – 9:30 am		Poster Session I: 9:30am – 6:15pm Mixer: 4:15pm – 6:15pm **SAN DIEGO BALLROOM/FOYER**	Poster Session II: 9:30am – 6:15pm Mixer: 4:15pm – 6:15pm **SAN DIEGO BALLROOM/FOYER**	Poster Session III: 9:30am – 6:15pm Mixer: 4:15pm – 6:15pm **SAN DIEGO BALLROOM/FOYER**	Poster Session IV: 9:30am – 6:15pm Mixer: 4:15pm – 6:15pm **SAN DIEGO BALLROOM/FOYER**

Event/Function	TUE, October 29	WED, October 30	THUR, October 31	FRI, November 1	SAT, November 2
Exhibit Viewing		9:30am – 6:15pm **SAN DIEGO BALLROOM/FOYER**	9:30am – 6:15pm **SAN DIEGO BALLROOM/FOYER**	9:30am – 6:15pm **SAN DIEGO BALLROOM/FOYER**	9:30am – 6:15pm **SAN DIEGO BALLROOM/FOYER**
SVP Business Meeting and Open Forum			12:30pm – 1:30pm **SAN FRANCISCO**		
Preparators' Meeting			2:00pm – 3:30pm **SANTA BARBARA ABC**		
Press Event			4:00pm –6:00pm **SAN GABRIEL BC**		
Social Events	7:00pm Special Presentation by Dr. Tim D. White from the University of California, Berkely ****NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY**	7:00pm – 10:00pm Welcome Reception ****NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY**	7:30pm – 11:30pm Student Roundtable Forum and Reprint Exchange **SACRAMENTO** 6:00pm – 9:00pm History of Vertebrate Paleontology Symposium ****NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY**	6:30pm – 12:00am Auction **PASADENA ROOM**	7:00pm – 10:00pm Awards Banquet **SAN FRANCISCO** 10:00pm – 1:00am After Hours Party **PASADENA ROOM**
Speaker Ready Room	7:00am – 4:00pm **BEAUDRY B**	7:00am – 4:00pm **BEAUDRY B**	7:00am – 4:00pm **BEAUDRY B**	7:00am – 4:00pm **BEAUDRY B**	7:00am – 4:00pm **BEAUDRY B**

PROGRAM AT A GLANCE

	San Francisco	Sacramento	San Jose	San Francisco	Sacramento	San Jose
	Symposium: Ontogeny Changes Everything: Paleobiological Implications of Dinosaur Growth	**Technical Session I**	**Technical Session II**	**Romer Prize Session**	**Technical Session VI**	**Preparators' Session**
	WED	**WED**	**WED**	**THUR**	**THUR**	**THUR**
8:00 am	Larsson	Cloutier	Tseng	Bonde	Lofgren	Kurtova
8:15 am	Werning	Kawano	Donohue	Brassey	Simmons	Lund
8:30 am	Horner	Sears	Saarinen	Brusatte	Gunnell	De Blieux
8:45 am	Woodward	Leary	DeSantis	Drewicz	Padian	Smith
9:00 am	Evans	Anderson	Barron-Ortiz	Drumheller	Manz	Van Beek
9:15 am	Scannella	Eltink	Cavin	Evans	Hooker	Bugbee
9:30 am	Morris	Fröbisch	Hopkins	Fischer	Dunn	Baziak
9:45 am	Kruk	Maddin	Famoso	Huttenlocker	Stroik	Rice
10:00 am	COFFEE					
10:15 am	Goodwin	Dias-Da-Silva	Gould	Kelley	Stevens	Brown
10:30 am	Reisz	Evans	Fox	Kimura	Borths	Vital
10:45 am	Sander	Chen	Pineda Munoz	Lautenschlager	Zack	Marcos
11:00 am	Woodruff	Sereno	Calede	Nakajima	Beard	Norris
11:15 am	Carrano	Leblanc	McHorse	Neenan	Schwermann	Getty
11:30 am	Varricchio	Bāhmer	Den Boer	Stocker	Hiard	Brown
11:45 am	Dial	Ezcurra	Cuozzo	Tomiya	Bibi	Lash
12:00 pm	Fowler	Chure	Miller	Tschopp	Mihlbachler	Rhue
12:15 pm	**BREAK**					
1:30 pm						
	San Francisco	**Sacramento**	**San Jose**	**San Francisco**	**Sacramento**	**San Jose**
	Technical Session III	**Technical Session IV**	**Technical Session V**	**Technical Session VII**	**Symposium: La Brea and Beyond: The Paleontology of Asphalt-Preserved Biotas**	**Technical Session VIII**
1:45 pm	Nabavizadeh	Croft	Apesteguia	Porter	Harris	Brocklehurst
2:00 pm	Spencer	Luna	Head	Eagle	Rincón	Castanhinha
2:15 pm	Loewen	West	Delfino	Sobral	Seymour	Kammerer
2:30 pm	Arbour	Tejada Lara	Kemp	Jerison	Martinez	Day
2:45 pm	Maiorino	Stromberg	Demar	Campione	Lindsey	Krentzel
3:00 pm	Farke	Bloch	Conrad	Tsai	Campbell	Botha-Brink
3:15 pm	Currie	Morgan	Richter	Sellers	Brannick	Owerkowicz
3:30 pm	Hedrick	Macfadden	Konishi	Brown	Haupt	Crompton
3:45 pm	Bourke	Barnosky	Sato	Bell	Shaw	Ruf
4:00 pm	Mallon	Koch	Scheyer	Benson	McDonald	Mancuso
4:15 pm	*Poster Session I*			*Poster Session II*		
6:15 pm						

	San Francisco	Sacramento	San Jose	San Francisco	Sacramento	San Jose
	Technical Session IX	**Technical Session X**	**Symposium: The Tempo of Vertebrate Evolution: Geochronologic Advances in Dating the Fossil Record**	**Technical Session XIV**	**Symposium: Patterns from the Poles: Biodiversity and Paleocology of High Latitude Fossil Vertebrates**	**Technical Session XV**
	FRI	**FRI**	**FRI**	**SAT**	**SAT**	**SAT**
8:00 am	Brink	Fisher	Bowring	Falkingham	Brazeau	Figueirido
8:15 am	Gates	Cherney	Rasbury	Pei	Steyer	Reid
8:30 am	You	Yann	Mundil	Habib	Sidor	Fitzgerald
8:45 am	Sertich	Secord	Hemming	Heers	Andres	Kienle
9:00 am	Burch	Terry	Rubidge	Field	Makovicky	Churchill
9:15 am	Miyashita	Maguire	Kent	Hall	Smith	Clementz
9:30 am	Lee	Cerling	Irmis	Foth	Godefroit	Wood
9:45 am	Balanoff	Patterson	Trujillo	Manning	Tarduno	Domning
10:00 am	COFFEE					
10:15 am	Kobayashi	Souron	Britt	Gearty	Vavrek	Gingerich
10:30 am	Morhardt	Garrett	Tucker	Egerton	Druckenmiller	Ekdale
10:45 am	Persons	Gilbert	Eberth	Chan	Fiorillo	Tsai
11:00 am	Smith	Begun	Roberts	Bright	Case	Boessenecker
11:15 am	Mannion	Eastham	Renne	Stidham	Mörs	Fordyce
11:30 am	Li	Madern	Clyde	Ksepka	Gottfried	Lambert
11:45 am	Wilson	Smiley	Riedel	Watanabe	Rybczynski	Pyenson
12:00 pm	Ullmann	Wang	Tsukui	Gilbert	MacPhee	Gutstein
12:15 pm	**BREAK**					
1:30 pm						
	San Francisco	**Sacramento**	**San Jose**	**San Francisco**	**Sacramento**	**San Jose**
	Technical Session XI	**Technical Session XII**	**Technical Session XIII**	**Technical Session XVI**	**Technical Session XVII**	**Technical Session XVIII**
1:45 pm	Foreman	Butler	Choo	Whatley	Lovelace	Pol
2:00 pm	Holroyd	Pritchard	Ahlberg	Upchurch	Anemone	Martin
2:15 pm	Fraser	Peecook	Chen	Motani	Lloyd	Bercovici
2:30 pm	Darroch	Wilberg	Dupret	Schmitz	Alroy	Levering
2:45 pm	Morse	Montefeltro	Béchard	Bever	Sansom	Chen
3:00 pm	D'Ambrosia	Brochu	Blais	Danilov	Watanabe	Hoffmann
3:15 pm	Slater	Gignac	Johanson	Stayton	Smithson	Rayfield
3:30 pm	Davis	Moreno-Bernal	Coates	Parham	Lu	Evans
3:45 pm	Lashinsky	Nestler	Sallan	Modesto	Chevrinais	Grossnickle
4:00 pm	Badgley	Sarrazin	Schumacher	Tsuji	Wendruff	Oreska
4:15 pm	*Poster Session III*			*Poster Session IV*		
6:15 pm						



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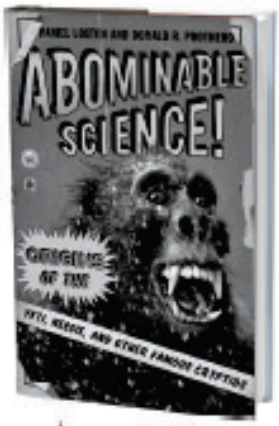

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The following people have made substantial donations to SVP funding initiatives from June 1, 2012, through June 1, 2013. SVP thanks them for their generous support.

Many of our members sponsored student memberships in 2013. Whether you gave a partial membership or donated several memberships, the Society is truly grateful for your generosity and your support of our students.

Information regarding all SVP funds and how to donate to those funds can be found on our website at www.vertpaleo.org. Anyone wishing to make a royalty donation to the Society should contact the SVP business office at: svp@vertpaleo.org or +1-301-634-7814.

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WEDNESDAY MORNING, OCTOBER 30, 2013

Symposium 1: Ontogeny Changes Everything: Paleobiological Implications of Dinosaur Growth

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: John Scannella and Denver Fowler

8:00 **Larsson, H., Du, T.** INTERPRETING DINOSAUR ONTOGENY AT SCALES FROM EMBRYOS TO BONE MICROSTRUCTURE TO PHENOTYPIC COVARIANCE

8:15 **Werning, S.** WHAT ARE WE ACTUALLY MEASURING? AN EVALUATION OF OSTEOHISTOLOGICAL INDICATORS OF DINOSAURIAN GROWTH RATE

8:30 **Horner, J., Rife, J.** ONTOGENETIC ASSESSMENT OF DINOSAURS USING CRANIAL AND POSTCRANIAL OSTEOHISTOLOGY

8:45 **Woodward, H., Horner, J., Freedman Fowler, E.** PREDICTING PEAK PERFORMANCE AND SENESCENCE IN THE ORNITHOPOD DINOSAUR *MAIASAURA PEEBLESORUM*

9:00 **Evans, D., Campione, N., Brink, K., Schott, R., Brown, C.** WASTED YOUTH: THE IMPORTANCE OF ONTOGENETICALLY EQUIVALENT SEMAPHORONTS IN DINOSAUR PHYLOGENETIC SYSTEMATICS

9:15 **Scannella, J., Fowler, D., Goodwin, M., Horner, J.** THE CLANDESTINE ROLE OF HETEROCHRONY IN CERATOPSIAN EVOLUTION AS REVEALED BY JUVENILE *TRICERATOPS*

9:30 **Morris, Z., Burroughs, R., Colbert, M.** DEVELOPMENTAL VARIATION COMPLICATES RECONSTRUCTIONS OF SKELETAL ONTOGENY OF EXTINCT VERTEBRATES: A LESSON FROM *TRICERATOPS* AND *TOROSAURUS*

9:45 **Kruk, B., Burns, M., Currie, P.** HISTOLOGICAL STUDY OF CRANIAL ELABORATION IN CERATOPSIAN DINOSAURS: FUNCTIONAL & DEVELOPMENTAL IMPLICATIONS

10:00 BREAK

10:15 **Goodwin, M., Horner, J., Schott, R., Evans, D.** NEW DATA ON DEVELOPMENTAL CRANIAL ONTOGENY IN PACHYCEPHALOSAURS

10:30 **Reisz, R., Leblanc, A., Sullivan, C., Huang, T.** EMBRYONIC DEVELOPMENT OF A SAUROPODOMORPH DINOSAUR FROM THE EARLY JURASSIC OF CHINA, PATTERNS OF OSSIFICATION AND GROWTH

10:45 **Sander, P., Griebeler, E., Klein, N.** AGING, MATURATION AND GROWTH OF SAUROPODOMORPH DINOSAURS: EVIDENCE FROM THE HISTOLOGICAL GROWTH MARK RECORD IN LONG BONES

11:00 **Woodruff, C., Fowler, D., Horner, J.** CHANGES IN VERTEBRAL MOPRHOLOGY ASSOCIATED WITH HISTOLOGIC DATA SUPPORT SIGNIFICANT CHANGE THROUGH ONTOGENY IN DIPLODOCID SAUROPODS

11:15 **Carrano, M., Mateus, O., Mitchell, J.** FIRST DEFINITIVE ASSOCIATION BETWEEN EMBRYONIC *ALLOSAURUS* BONES AND *PRISMATOOLITHUS* EGGS IN THE MORRISON FORMATION (UPPER JURASSIC, WYOMING, USA)

11:30 **Varricchio, D.** WOUNDING-TOOTH GROWS UP: ONTOGENY IN THE CRETACEOUS THEROPOD *TROODON FORMOSUS*

11:45 **Dial, K. P.** FUNCTION OF RUDIMENTARY LOCOMOTOR STRUCTURES IN THE ECOLOGY OF BIRDS: EVOLUTIONARY IMPLICATIONS

12:00 **Fowler, D., Freedman Fowler, L., Scannella, J., Horner, J.** THE INFLUENCE OF MULTI-NICHE ONTOGENY ON DIFFERENTIAL SURVIVORSHIP ACROSS THE K-PG BOUNDARY

WEDNESDAY MORNING, OCTOBER 30, 2013

Technical Session I

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Nadia Froebisch and Sergio Dias-Da-Silva

8:00 **Cloutier, R., Béchard, I.** A NEW PIECE OF THE DEVONIAN FISH-TO-TETRAPOD PUZZLE: THE DISCOVERY OF A COMPLETE SPECIMEN OF *ELPISTOSTEGE*

8:15 **Kawano, S., Blob, R.** FUNCTIONAL COMPARISONS BETWEEN FINS AND LIMBS DURING TERRESTRIAL LOCOMOTION: BIOMECHANICAL IMPLICATIONS FOR THE EVOLUTIONARY INVASION OF LAND

8:30 **Sears, K., Mabee, P., Dececchi, A.** EVOLUTION OF APPENDAGE MODULARITY DURING THE FIN TO LIMB TRANSITION

8:45 **Leary, B., Kavanagh, K.** TWO IF BY LAND, ONE IF BY SEA? EVIDENCE FOR MAJOR TRANSITIONS IN DIGIT MODULARITY OVER TETRAPOD EVOLUTION

9:00 **Anderson, J., Pardo, J., Germain, D., Ahlberg, P.** THREE DIMENSIONAL MICRO-CT STUDY OF THE AÏSTOPOD CRANIUM REVEALS HIDDEN MORPHOLOGICAL DIVERSITY AMONG THE EARLY TETRAPOD RADIATION

9:15 **Eltink, E., Langer, M.** A NEW SPECIMEN OF THE TEMNOSPONDYL *AUSTRALERPETON COSGRIFFI* FROM THE LATE PERMIAN OF BRAZIL (RIO DO RASTO FORMATION, PARANÁ BASIN): NEW ANATOMICAL INFORMATION AND PHYLOGENETIC RELATIONSHIPS.

9:30 **Froebisch, N., Witzmann, F., Bickelmann, C.** LIMB ABNORMALITIES IN THE DISSOROPHOID AMPHIBIAN *MICROMELERPETON CREDNERI* - PRIMARY PATHOLOGY OR FAILED REGENERATION?

9:45 **Maddin, H., Fröbisch, N., Evans, D., Milner, A.** REAPPRAISAL OF THE EARLY PERMIAN AMPHIBAMID *TERSOMIUS TEXENSIS* AND SOME REFERRED MATERIAL

10:00 BREAK

10:15 **Dias-Da-Silva, S., Hewison, R.** PHYLOGENETIC ANALYSIS AND PALAEOBIOGEOGRAPHY OF THE PANGAEAN LOWER TRIASSIC LYDEKKERINIDAE (TEMNOSPONDYLI, STEREOSPONDYLI)

10:30 **Evans, S., Groenke, J., Jones, M., Turner, A., Krause, D.** BIG, BAD, AND BIZARRE: NEW MATERIAL OF *BEELZEBUFO*, A HYPEROSSIFIED ANURAN FROM THE LATE CRETACEOUS OF MADAGASCAR, YIELDS FURTHER SURPRISES.

10:45 **Chen, J., Jia, J., Gao, K.** INCORPORATING FOSSILS, MORPHOLOGY AND MOLECULES: COMBINED PHYLOGENETIC ANALYSES OF THE CRYPTOBRANCHOIDEA (AMPHIBIA: URODELA)

11:00 **Sereno, P., Isch, A., Conroy, L.** SHOULDER GIRDLE ARCHITECTURE: A MAJOR CONSTRAINT IN THE EVOLUTION OF AMNIOTE LOCOMOTION

11:15 **Leblanc, A., Brink, K., Macdougall, M., Reisz, R.** PHYLOGENETIC PATTERNS AND FUNCTIONAL INTERPRETATIONS OF AMNIOTE PLICIDENTINE

11:30 **Böhmer, C., Rauhut, O., Wörheide, G.** NEW INSIGHTS INTO THE DEVELOPMENT AND EVOLUTION OF THE VERTEBRAL COLUMN IN ARCHOSAURS

11:45 **Ezcurra, M., Butler, R., Scheyer, T.** THE PERMIAN ARCHOSAUROMORPH RECORD REVISITED: A NEW SPECIES FROM TANZANIA AND THE POTENTIALLY OLDEST ARCHOSAURIFORM

WEDNESDAY MORNING, OCTOBER 30, 2013
Technical Session I (CONTINUED)

12:00 **Chure, D., Britt, B., Engelmann, G., Andrus, A., Scheetz, R.** DREPANOSAURS IN THE DESERT: MULTIPLE SKELETONS OF A NEW DREPANOSAURID FROM THE EOLIAN NUGGET SANDSTONE (?LATE TRIASSIC - EARLY JURASSIC), SAINTS AND SINNERS QUARRY, UTAH: MORPHOLOGY, RELATIONSHIPS, AND BIOSTRATIGRAPHIC IMPLICATIONS

WEDNESDAY MORNING, OCTOBER 30, 2013
Technical Session II
Westin Bonaventure Hotel & Suites, San Jose Ballroom
MODERATORS: Samantha Hopkins and Francois Gould

8:00 **Tseng, Z., Martín-Serra, A., Figueirido, B.** PROFILING THE DUROPHAGE: CONVERGENT SKULL SHAPE EVOLUTION BETWEEN BONE AND BAMBOO SPECIALISTS

8:15 **Donohue, S., Desantis, L., Schubert, B., Ungar, P.** WAS THE GIANT SHORT-FACED BEAR *ARCTODUS SIMUS* A HYPER-SCAVENGER? A NEW APPROACH TO THE DIETARY STUDY OF URSIDS USING DENTAL MICROWEAR TEXTURES

8:30 **Saarinen, J., Karme, A., Uno, K., Saila, L.** NEW APPROACH TO MAMMALIAN PALEOECOLOGY - OCCLUSAL WEAR ANGLES OF MOLAR TEETH AS A MEASURE OF DIET ABRASIVENESS IN ELEPHANTS AND THEIR FOSSIL RELATIVES (MAMMALIA, PROBOSCIDEA)

8:45 **Desantis, L., Scott, J., Schubert, B., Donohue, S., Mccray, B.** DIRECT COMPARISONS OF 2D AND 3D DENTAL MICROWEAR PROXIES IN EXTANT HERBIVOROUS AND CARNIVOROUS MAMMALS: THE IMPORTANCE OF DEPTH AND OBSERVER CONSISTENCY FOR RESOLVING DIET

9:00 **Barron-Ortiz, C., Mihlbachler, M., Rankin, B., Theodor, J.** INVESTIGATING THE APPLICABILITY OF OUTLINE-BASED GEOMETRIC MORPHOMETRIC TECHNIQUES TO THE STUDY OF UNGULATE MESOWEAR

9:15 **Cavin, J., Samuels, J.** MESOWEAR AND HYPSODONTY THROUGH TIME IN HYPERTRAGULIDS (ARTIODACTYLA) FROM THE TURTLE COVE MEMBER OF THE JOHN DAY FORMATION OF OREGON

9:30 **Hopkins, S.** DIFFERENTIAL TIMING OF HYPSODONTY EVOLUTION IN LARGE AND SMALL MAMMALS INDICATES COMPLEX FORCING OF CROWN HEIGHT EVOLUTION

9:45 **Famoso, N., Davis, E.** FRACTAL DIMENSIONALITY AS A MEASURE OF OCCLUSAL ENAMEL COMPLEXITY IN EQUIDAE (MAMMALIA: PERISSODACTYLA)

10:00 BREAK

10:15 **Gould, F.** TO 3D OR NOT TO 3D: DO 3D SURFACE ANALYSES IMPROVE ECOMORPHOLOGICAL INFERENCES?

10:30 **Fox, D., Keller, J., Haveles, A., Bagley, B.** DIETARY RECONSTRUCTION OF PLIO-PLEISTOCENE RODENTS FROM SOUTHWEST KANSAS USING STABLE CARBON ISOTOPES AND THREE DIMENSIONAL TOOTH SHAPE METRICS

10:45 **Pineda Munoz, S., Evans, A.** WHICH TOOTH BEST REPRESENTS WHOLE TOOTH ROW DENTAL COMPLEXITY IN MAMMALS?

11:00 **Calede, J., Glusman, J.** DISPARITY IN THE MOLAR MORPHOLOGY OF EXTANT AND FOSSIL GOPHERS (RODENTIA, GEOMYIDAE) IMPLICATIONS FOR TAXONOMIC RICHNESS

WEDNESDAY MORNING, OCTOBER 30, 2013

Technical Session II (CONTINUED)

11:15 **Mchorse, B., Scott, E., Mclaughlin, W., Davis, E., Hopkins, S.** IDENTIFYING ISOLATED POSTCRANIA USING DISCRIMINANT ANALYSIS

11:30 **Den Boer, W., Kear, B.** EVIDENCE FOR ECO-MORPH DIVERSITY WITHIN OLIGO-MIOCENE MACROPODIFORMS

11:45 **Cuozzo, F., Sauther, M.** WISDOM OF THE BONES: HOW PATTERNS OF TRAUMA AND PATHOLOGY IN A WILD LEMUR COMMUNITY INFORM THE PALEOECOLOGY OF MADAGASCAR'S RECENTLY EXTINCT LEMURS AND EARLIER EOCENE LEMURIFORM PRIMATES

12:00 **Miller, J., Behrensmeyer, A., Lyons, K., Ete, T.** SIZE-BIASED MODERN BONE ACCUMULATIONS CAN ACCURATELY RECORD WHOLE-COMMUNITY ECOLOGY

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Technical Session III

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: Mark Loewen and Andrew Farke

1:45 **Nabavizadeh, A.** JAW MECHANICS IN ORNITHISCHIAN DINOSAURS AND THE EVOLUTIONARY RELATIONSHIP BETWEEN MORPHOLOGY AND BITE FORCE

2:00 **Spencer, M.** PHYLOGENETIC AND BIOGEOGRAPHIC ASSESSMENT OF ORNITHISCHIAN DIVERSITY THROUGHOUT THE MESOZOIC: A SPECIES-LEVEL ANALYSIS OF PHYLOGENY FROM ORIGIN TO EXTINCTION

2:15 **Loewen, M., Kirkland, J.** THE EVOLUTION AND BIOGEOGRAPHIC DISTRIBUTION OF ANKYLOSAURIA: NEW INSIGHTS FROM A COMPREHENSIVE PHYLOGENETIC ANALYSIS

2:30 **Arbour, V., Currie, P.** THE ORIGIN OF THE ANKYLOSAURID TAIL CLUB

2:45 **Maiorino, L., Farke, A., Kotsakis, T., Piras, P.** CRANIAL AND MANDIBULAR SHAPE CHANGES DURING THE EVOLUTION OF CERATOPSIAN DINOSAURS

3:00 **Farke, A., Maxwell, D., Cifelli, R., Wedel, M.** BIOGEOGRAPHY OF BASAL NEOCERATOPSIAN DINOSAURS ILLUMINATED BY A SKULL FROM THE CLOVERLY FORMATION (LOWER CRETACEOUS) OF MONTANA

3:15 **Currie, P., Holmes, R., Ryan, M., Coy, C., Koppelhus, E.** THE SMALLEST, ARTICULATED CERATOPSID (DINOSAURIA)

3:30 **Hedrick, B., Dodson, P.** LUJIATUN PSITTACOSAURIDS: UNDERSTANDING INDIVIDUAL AND TAPHONOMIC VARIATION USING 3D GEOMETRIC MORPHOMETRICS

3:45 **Bourke, J., Porter, W., Lyson, T., Schachner, E., Bell, P.** NASAL TURBINATES IN PACHYCEPHALOSAURIDS (DINOSAURIA: ORNITHISCHIA): RECONSTRUCTING NASAL ANATOMY AND AIRFLOW, WITH IMPLICATIONS FOR PHYSIOLOGY

4:00 **Mallon, J., Evans, D.** PACHYCEPHALOSAUR DOMES: ALLOCHTHONOUS OR AUTOCHTHONOUS?

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Technical Session IV

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Anthony Barnosky and Darin Croft

1:45 **Croft, D., Anaya, F., Catena, A., Ciancio, M., Engelman, R.** NEW SPECIES, LOCAL FAUNAS, AND PALEOENVIRONMENTAL DATA FOR THE MIDDLE MIOCENE QUEBRADA HONDA FAUNA, BOLIVIA

2:00 **Luna, D., Flynn, J., Croft, D., Wyss, A.** TAXONOMY, BIOGEOGRAPHY, AND PHYLOGENY OF MIOCENE ENDEMIC SOUTH AMERICAN UNGULATES (MAMMALIA) FROM THE LAGUNA DEL LAJA REGION, ANDEAN MAIN RANGE, CENTRAL CHILE

2:15 **West, A., Flynn, J., Croft, D., Wyss, A.** A QUANTITATIVE MODEL FOR MORPHOLOGICAL EVOLUTION IN THE INTERATHERIIDAE (TYPOTHERIA, NOTOUNGULATA, MAMMALIA) AS A RESPONSE TO CLIMATIC AND TECTONIC CHANGES

2:30 **Tejada Lara, J., Macfadden, B., Antoine, P., Flynn, J., Salas Gismondi, R.** EVOLUTION OF MIOCENE AMAZONIAN ECOSYSTEMS: CAN OLD MAMMALS REVEAL SOMETHING NEW?

2:45 **Stromberg, C., Dunn, R., Madden, R., Kohn, M., Carlini, A.** WHERE HAVE ALL THE GRASSES GONE?: NEW MIDDLE MIOCENE PHYTOLITH RECORDS REVEAL THAT GRASSLANDS PLAYED A MINOR ROLE IN HYPSODONTY EVOLUTION IN SOUTHERN SOUTH AMERICA

3:00 **Bloch, J., Wood, A., Rincon Burbano, A., Woodruff, E., Foster, D.** FIRST FOSSILS OF A PLATYRRHINE MONKEY FROM PANAMA PROVIDE EVIDENCE FOR MAMMALIAN DISPERSAL ACROSS THE CENTRAL AMERICAN SEAWAY IN THE EARLY MIOCENE

3:15 **Morgan, G., Czaplewski, N., Rincon, A., Wood, A., Macfadden, B.** AN EARLY MIOCENE BAT (CHIROPTERA: PHYLLOSTOMIDAE) FROM PANAMA AND MID CENOZOIC CHIROPTERAN DISPERSALS BETWEEN THE AMERICAS

3:30 **Macfadden, B.** AGE OF THE TARIJA FAUNA, BOLIVIA: IMPLICATIONS FOR *EQUUS* DISPERSAL AND CALIBRATION OF GABI 3

3:45 **Barnosky, A., Lindsey, E., Villavecencio, N., Marshall, C.** ESTABLISHING THE CHRONOLOGY OF QUATERNARY MEGAFAUNAL EXTINCTION IN SOUTH AMERICA

4:00 **Koch, P., Pires, M., Guimaraes, P.** THE ROLE OF NETWORK STRUCTURE IN PLEISTOCENE MEGAFAUNA EXTINCTIONS

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Technical Session V

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: Massimo Delfino and Takuya Konishi

1:45 **Apesteguia, S., Garberoglio, F.** THE RETURN OF *NAJASH*: NEW, BETTER PRESERVED SPECIMENS CHANGE THE FACE OF THE BASALMOST SNAKE

2:00 **Head, J., Bloch, J., Moreno-Bernal, J., Rincon Burbano, A., Bourque, J.** CRANIAL OSTEOLOGY, BODY SIZE, SYSTEMATICS, AND ECOLOGY OF THE GIANT PALEOCENE SNAKE *TITANOBOA CERREJONENSIS*

2:15 **Delfino, M., Bolet, A., Fortuny, J., Robles, J., Alba, D.** A NEW EXTINCT SPECIES OF *BLANUS* (AMPHISBAENIA, BLANIDAE) FROM THE IBERIAN MIOCENE BASED ON THE FIRST KNOWN EUROPEAN AMPHISBAENIAN FOSSIL SKULL

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Technical Session V (Continued)

2:30 **Kemp, M., Hadly, E.** SIZE-BIASED EXTINCTION EXHIBITED BY QUATERNARY CARIBBEAN LIZARDS

2:45 **Demar, D., Wilson, G.** SQUAMATE TURNOVER IN THE 2 MILLION YEARS LEADING UP TO AND ACROSS THE K-PG BOUNDARY IN NORTHEASTERN MONTANA: EVIDENCE FOR A COMPLEX EXTINCTION SCENARIO

3:00 **Conrad, J., Wang, Y., Xu, X., Pyron, A., Clark, J.** SKELETON OF A HEAVILY ARMORED AND LONG LEGGED MIDDLE JURASSIC LIZARD (SQUAMATA, REPTILIA)

3:15 **Richter, A., Knötschke, N., Kosma, R., Sobral, G., Wings, O.** THE FIRST MESOZOIC LIZARD FROM NORTHERN GERMANY (PARAMACELLODIDAE, LATE JURASSIC, LANGENBERG QUARRY) AND ITS TAPHONOMY

3:30 **Konishi, T., Newbrey, M., Caldwell, M.** WHO GETS TO EAT WHAT: NICHE PARTITIONING BETWEEN PHYLOGENETICALLY CLOSELY RELATED BUT MORPHOLOGICALLY DISPARATE MOSASAURS (MOSASAURIDAE: MOSASAURINAE), *MOSASAURUS MISSOURIENSIS* AND *PROGNATHODON OVERTONI*, BASED ON NEW MATERIAL FROM THE UPPER CAMPANIAN BEARPAW FORMATION, ALBERTA CANADA

3:45 **Sato, T., Cheng, Y., Wu, X., Shan, H.** A NEW NOTHOSAUROID (REPTILIA, SAUROTPERYGIA) FROM THE MIDDLE TRIASSIC OF CHINA

4:00 **Scheyer, T., Neenan, J.** BONE HISTOLOGY OF PLACODONT MARINE REPTILES (SAUROPTERYGIA) FROM EUROPE

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Poster Session I

Westin Bonaventure Hotel & Suites, Exhibit Hall
Authors must be present from 4:15 - 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Sadleir, R., Makovicky, P., Hutchinson, J.** COMPARATIVE MASS ESTIMATE METHODS OF 3D DIGITAL MODELS OF ORNITHISCHIAN SKELETONS AND GASTROLITHS

2 **White, D.** PHYLOGENETIC VERSUS SERIAL VARIATION IN THE ORNITHISCHIAN DINOSAUR AXIAL SKELETON: A GEOMETRIC MORPHOMETRIC STUDY

3 **Poole, K.** FINITE ELEMENT ANALYSIS OF THE CARPUS OF *CAMPTOSAURUS* AND THE EVOLUTION OF CARPAL FUSION IN ANKYLOPOLLEXIA

4 **Krumenacker, L., Britt, B., Varricchio, D., Scheetz, R., Fearon, J.** OSTEOLOGICAL OBSERVATIONS ON NEW SPECIMENS OF *ORYCTODROMEUS* SP. FROM THE BLACKLEAF FORMATION OF MONTANA AND THE WAYAN FORMATION OF IDAHO

5 **Takasaki, R., Kobayashi, Y., Chiba, K.** REANALYSIS OF *NIPPONOSAURUS SACHALINENSIS* (ORNITHOPODA: DINOSAURIA) FROM UPPER CRETACEOUS OF SOUTHERN SAKHALIN AND ITS PHYLOGENETIC STATUS WITHIN LAMBEOSAURINAE

6 **Marquart, C.** MORPHOMETRIC APPROACHES TO TAXONOMIC QUESTIONS IN IGUANODONTIAN DINOSAURS

7 **Clayton, K., Loewen, M., Irmis, R.** PHYLOGENETIC UTILITY OF HADROSAURID DINOSAUR (ORNITHISCHIA: ORNITHOPODA) INTEGUMENTARY IMPRESSIONS

8 **Prieto-Marquez, A., Serrano Brañas, C., Torres Rodríguez, E., Reyes Luna, P., Espinosa Chávez, B.** JUVENILE SAUROLOPHINE SPECIMENS (DINOSAURIA: HADROSAURIDAE) FROM THE LATE CAMPANIAN (CRETACEOUS) OF NORTHEASTERN MEXICO

9 **Rivera-Sylva, H., Barrón, C.** DENTAL MICROWEAR ANALYSIS OF THE LATE CRETACEOUS (LATE CAMPANIAN) HADROSAURS FROM THE CERRO DEL PUEBLO FORMATION, NORTHERN MEXICO

Corresponding board numbers in left hand column

10 **Noto, C., Main, D., Poole, K.** PHYLOGENETIC AND BIOSTRATIGRAPHIC IMPLICATIONS OF NEW POSTCRANIAL MATERIAL OF *PROTOHADROS* (ORNITHOPODA, HADROSAUROIDEA) FROM THE WOODBINE FORMATION OF TEXAS

11 **Kay, D., Erickson, G., Norell, M.** EVOLUTION OF CERATOPSIAN DENTAL MICROSTRUCTURE

12 **Morschhauser, E., Lamanna, M.** A REEVALUATION OF THE OSSIFIED HYOID APPARATUS OF *PROTOCERATOPS ANDREWSI* (ORNITHISCHIA: CERATOPSIA) AND A REVIEW OF HYOID ELEMENTS IN ORNITHISCHIAN DINOSAURS

13 **Varriale, F.** THE UNIQUE PREMAXILLARY DENTITION OF *YINLONG DOWNSI*, AND THE MORPHOLOGY, FUNCTION, AND EVOLUTION OF PREMAXILLARY TEETH IN CERATOPSIA

14 **Ryan, M., Holmes, R., Mallon, J.** A NEW RELICT BASAL CERATOPSID FROM THE OLDMAN FORMATION (CAMPANIAN) OF ALBERTA WITH IMPLICATIONS FOR CENTROSAURINE EVOLUTION

15 **Tanoue, K., Li, D., You, H.** TOOTH REPLACEMENT PATTERN IN MAXILLARY DENTITION OF BASAL NEOCERATOPSIA (ORNITHISCHIA, DINOSAURIA)

16 **Vanburen, C., Campione, N., Tanke, D., Evans, D.** TESTING ADAPTIVE HYPOTHESES FOR ANTERIOR CERVICAL FUSION IN CERATOPSIA

17 **Campbell, J., Ryan, M., Schröder-Adams, C., Holmes, R., Evans, D.** A SPECIMEN-BASED PHYLOGENETIC ANALYSIS OF THE CHASMOSAURINE CERATOPSID *CHASMOSAURUS* (ORNITHISCHIA) FROM THE UPPER CRETACEOUS (CAMPANIAN) DINOSAUR PARK FORMATION OF WESTERN CANADA SUGGESTS THE VALIDITY OF ONLY ONE SPECIES

18 **Kirkland, J., Alcala, L., Loewen, M., Espilez, E., Mampel, L.** NEW NODOSAURID ANKYLOSAUR (DINOSAURIA) FROM THE LOWER ALBIAN ESCUCHA FORMATION, TERUEL, SPAIN REVEALS THAT SINCE THEIR APTIAN ORIGIN, NODOSAURID SPECIES IN NORTH AMERICA AND EUROPE DEFINE PALEOBIOGEOGRAPHICALLY SEPARATE CLADES

19 **Alicea, J., Loewen, M.** NEW *MINOTAURASAURUS* MATERIAL FROM THE DJODOKTA FORMATION ESTABLISHES NEW TAXONOMIC AND STRATIGRAPHIC CRITERIA FOR THE TAXON

20 **Wiersma, J., Irmis, R.** A NEW ANKYLOSAURID DINOSAUR (ORNITHISCHIA: THYREOPHORA) FROM THE UPPER CAMPANIAN KAIPAROWITS FORMATION OF GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, SOUTHERN UTAH

21 **Yang, J., You, H., Li, D., Kong, D.** A NEW ANKYLOSAUR DINOSAUR FROM THE EARLY CRETACEOUS HEKOU GROUP OF LANZHOU-MINHE BASIN, NORTH-CENTRAL CHINA

22 **Sullivan, R., Arbour, V., Burns, M., Lucas, S.** A NEW ANKYLOSAURID DINOSAUR (ORNITHISCHIA, ANKYLOSAURIA) FROM THE UPPER CRETACEOUS KIRTLAND FORMATION, SAN JUAN BASIN, NEW MEXICO, USA

Corresponding board numbers in left hand column

23 **Bramble, K., Arbour, V., Currie, P.** INTERPRETING THE FACIAL INTEGUMENT OF ANKYLOSAURS

24 **Burns, M., Hayashi, S., Currie, P., Watabe, M.** GROWTH, DEVELOPMENT, AND THE PROBLEM OF ANKYLOSAURIAN ONTOGENY

25 **Redelstorff, R., Huebner, T., Chinsamy-Turan, A., Sander, M.** BONE HISTOLOGY OF THE STEGOSAUR *KENTROSAURUS AETHIOPICUS* (ORNITHISCHIA: THYREOPHORA) FROM THE UPPER JURASSIC OF TANZANIA

26 **O'Keefe, F., Byrd, C.** ANATOMY OF A NEONATE SKULL OF *DOLICHORHYNCHOPS* (PLESIOSAURIA)

27 **Kato, T., Tanabe, K.** TOOTH IMPLANTATION AND REPLACEMENT IN POLYCOTYLID PLESIOSAURS

28 **Byrd, C.** ONTOGENETIC VARIATION AMONG POLYCOTYLID PLESIOSAURS (SAUROPTERYGIA: PLESIOSAURIA) AND ITS IMPLICATIONS FOR PLESIOSAUR GROWTH

29 **Serratos, D. J., Druckenmiller, P.** OSTEOLOGY OF A NEW SPECIMEN OF AN ELASMOSAURID PLESIOSAUR (REPTILIA: SAUROPTERYGIA) FROM THE UPPER CRETACEOUS BEARPAW SHALE, MONTANA

30 **Araujo, R., Lindgren, J., Jacobs, L., Polcyn, M., Schulp, A.** PHYLOGENY AND PAEDOMORPHISM IN ANGOLAN MAASTRICHTIAN ELASMOSAURIDS

31 **Ma, L., Jiang, D., Rieppel, O., Motani, R., Tintori, A.** A NEW PISTOSAUROID (REPTILIA: SAUROPTERYGIA) FROM THE LATEST LADINIAN XINGYI MARINE VERTEBRATE LEVEL, SOUTHWESTERN CHINA

32 **Ji, C., Jiang, D., Rieppel, O., Motani, R., Tintori, A.** A NEW SPECIMEN OF *NOTHOSAURUS YOUNGI* FROM THE MIDDLE TRIASSIC OF SOUTH CHINA BLURRING THE DISTINCTION BETWEEN *NOTHOSAURUS* AND *LARIOSAURUS*

33 **Jiang, D., Rieppel, O., Motani, R., Tintori, A., Ji, C.** EFFECT OF NEW RECORDS OF EARLY AND MIDDLE TRIASSIC EOSAUROPTERYGIANS FROM SOUTH CHINA ON RECONSTRUCTION OF SAUROPTERYGIAN TREE TOPOLOGY

34 **Mccartney, J.** USING VERTEBRAL MORPHOLOGY TO PREDICT HABITAT PREFERENCE IN EXTINCT SNAKES

35 **D'Amore, D.** USING GEOMETRIC MORPHOMETRICS TO QUANTIFY SHAPE-SIZE HETERODONTY IN NON-MAMMALIAN TAXA: A CASE STUDY INVESTIGATING DENTAL ONTOGENY IN THE NILE MONITOR, *VARANUS NILOTICUS*

36 **Ferrer, E.** WHY HIGHER SPECIES DIVERSITY DOES NOT ALWAYS EQUAL HIGHER MORPHOLOGICAL DISPARITY: AN EXAMPLE FROM VARANID LIZARDS

37 **Buynevich, I., Wiest, L., Bien, D., Smith, K., Nyquist, J.** GEOPHYSICAL IMAGING OF SNAKE BURROWS IN AEOLIAN SANDS: IMPLICATIONS FOR THE FOSSIL RECORD OF SQUAMATES

38 **Petermann, H., Field, D.** A NEW CT-BASED ANALYTICAL APPROACH FOR EXPLORING TAPHONOMIC BIASES IN TERRESTRIAL VERTEBRATE ASSEMBLAGES

Corresponding board numbers in left hand column

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Poster Session I (CONTINUED)

39 **Olori, J., Bell, C., Jass, C.** THE PLEISTOCENE HERPETOFAUNA FROM ROOM 2 OF CATHEDRAL CAVE, WHITE PINE COUNTY, NEVADA

40 **Scarpetta, S., Kemp, M., Hadly, E.** ANCIENT DNA AND THE ROLE OF ISLAND FRAGMENTATION IN DIVERGENCE OF LIZARDS OF THE GENUS *AMEIVA*

41 **Bolet, A., Delfino, M., Fortuny, J., Almécija, S., Alba, D.** A PARTIAL SKULL OF *OPHISAURUS* (SQUAMATA, ANGUIDAE) FROM THE MIOCENE OF CATALONIA (NE IBERIAN PENINSULA)

42 **Cernansky, A., Rage, J., Klembara, J.** WIESBADEN - AMONEBURG IN GERMANY: THE FIRST STEPS OF THE MODERN SQUAMATE FAUNA IN EUROPE DURING THE EARLIEST MIOCENE

43 **Chovanec, K., Schubert, B., Mead, J.** NON-ANGUIMORPH LIZARDS FROM THE LATE OLIGOCENE AND EARLY MIOCENE OF NORTHERN FLORIDA, USA AND IMPLICATIONS FOR NEW WORLD SQUAMATE BIOGEOGRAPHY

44 **Starck, E., Welsh, E.** THE FIRST REPORTED RECORD OF OLIGOCENE IGUANIDAE (REPTILIA: SQUAMATA) FROM THE WHITE RIVER GROUP OF BADLANDS NATIONAL PARK, SOUTH DAKOTA

45 **Croghan, J., Palci, A., Caldwell, M., Breithaupt, B. H.** SYSTEMATICS OF THE 32 MY OLD AGGREGATION OF SNAKES FROM THE WHITE RIVER FORMATION: REDEFINING THE ERYCINAE WITHIN BOOIDEA

46 **Folie, A., Rana, R., Augé, M., Kumar, K., Smith, T.** NEW LIZARDS FROM THE EARLY EOCENE VASTAN LIGNITE MINE OF INDIA

47 **Elshafie, S., Head, J.** DIVERSITY AND BODY SIZE EVOLUTION OF ANGUID LIZARDS THROUGH CLIMATIC TRANSITIONS OF THE NORTH AMERICAN CENOZOIC

48 **Nydam, R.** LIZARDS FROM THE JUDITH RIVER FORMATION (UPPER CRETACEOUS), HILL COUNTY, MONTANA

49 **Japundzic, D., Campbell, M., Krizmanic, K., Caldwell, M.** A NEW CENOMANIAN-TURONIAN PONTOSAUR FROM CROATIA

50 **Campbell, M., Krizmanic, K., Japundzic, D., Caldwell, M.** A NEW OPHIDIOMORPH TAXON FROM THE TURONIAN OF CROATIA

51 **Schulp, A., Jagt, J.** A NEW MOSASAUR FROM THE TYPE MAASTRICHTIAN

52 **Street, H., Caldwell, M., Konishi, T.** *MOSASAURUS LEMONNIERI* DOLLO, 1889: A DISTINCT AND DIAGNOSABLE TAXON OF MOSASAURINE MOSASAUR

53 **Jimenez-Huidobro, P., Caldwell, M.** *TYLOSAURUS KANSASENSIS*, *T. PRORIGER*, AND *T. NEPAEOLICUS*: CAN THEY BE DIFFERENTIALLY DIAGNOSED?

54 **Trevethan, I.** THERMOREGULATORY STATUS OF MOSASAURS FROM THE WESTERN INTERIOR SEAWAY OF KANSAS, USA

55 **Matthews, T., Patterson, D.** THE PALEOECOLOGY OF THE FROGS FROM THE EARLY PLIOCENE SITE OF LANGEBAANWEG (WEST COAST, SOUTH AFRICA)

56 **Bredehoeft, K., Samuels, J.** DIVERSITY IN FROGS (RANIDAE) FROM THE HAGERMAN LOCAL FAUNA, PLIOCENE OF IDAHO

Corresponding board numbers in left hand column

57 **Jacisin, J., Hopkins, S.** DESCRIPTION, CLASSIFICATION, AND PALEOECOLOGY OF THE OLIGOCENE SALAMANDERS OF OREGON.

58 **Blackburn, D., Roberts, E., Stevens, N.** A LATE OLIGOCENE ANURAN FAUNA FROM THE NSUNGWE FORMATION, SOUTHWESTERN TANZANIA

59 **Canoville, A., Chinsamy-Turan, A.** BONE MICROSTRUCTURE PROVIDES NEW EVIDENCE FOR TERRESTRIAL LIFESTYLE ADAPTATIONS FOR THE LOWER TRIASSIC STEREOSPONDYL *LYDEKKERINA* (TETRAPODA: TEMNOSPONDYLI)

60 **Huertas, S., Steyer, J., Segalen, L., Sidor, C., Angielczyk, K.** PALEOHISTOLOGY AND BIOGEOCHEMISTRY OF TRIASSIC TEMNOSPONDYLS FROM TANZANIA AND ZAMBIA: IMPLICATIONS FOR TAPHONOMY OF THE KAROO SYSTEM

61 **Dilkes, D.** THE CARPUS AND TARSUS OF TEMNOSPONDYLI

62 **Mchugh, J.** INCORPORATING LIFE HISTORY TRAITS AS DISCRETE MORPHOLOGICAL CHARACTERS IN PHYLOGENY RECONSTRUCTION

63 **Beightol V, C., Huttenlocker, A. K., Peecook, B., Sidor, C., Smith, R.** A NEW BASAL STEREOSPONDYL (TEMNOSPONDYLI) FROM THE LOWER TRIASSIC FREMOUW FORMATION OF ANTARCTICA

64 **Angielczyk, K., Cisneros, J., Marsicano, C., Smith, R., Gostling, N.** NEW VERTEBRATES FROM THE PERMIAN PEDRA DE FOGO FORMATION, PARNAIBA BASIN, NORTHEASTERN BRAZIL

65 **Fraser, N., Clack, J., Millward, D., Davies, S., Marshall, J.** NEW VERTEBRATE FAUNAS FROM THE EARLIEST CARBONIFEROUS OF SCOTLAND

66 **Hastings, A., Bourque, J., Bloch, J., Rincon Burbano, A., Jaramillo, C.** NEW FOSSIL LUNGFISHES (DIPNOI, LEPIDOSIRENIDAE) FROM THE PALEOGENE OF NORTHERN SOUTH AMERICA AND NEW METHODS FOR TOOTHPLATE IDENTIFICATION

67 **Chen, G., Chang, M., Liu, H.** A LATE EOCENE *PROCYPRIS*-LIKE CYPRINID (TELEOSTEI, PISCES) FROM SOUTH CHINA

68 **Liu, J., Wilson, M., Murray, A.** NORTH AMERICAN EOCENE SUCKERS AND THEIR IMPLICATIONS FOR THE SYSTEMATICS OF CATOSTOMIDAE (OSTARIOPHYSI, CYPRINIFORMES)

69 **Stevens, W., Claeson, K., Stevens, N.** ALESTID FISHES FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

70 **Divay, J., Murray, A.** ICHTHYOFAUNA OF THE CYPRESS HILLS FORMATION (LATE EOCENE–EARLY OLIGOCENE), EASTEND AREA, SASKATCHEWAN, CANADA

71 **Argyriou, T., Murray, A.** FISH DIVERSITY AND PALEOENVIRONMENTS FROM THE LATE MIOCENE OF SAHABI, LIBYA

72 **Murray, A., Argyriou, T., Cook, T.** ELASMOBRANCHS OF THE LOWER JBEL QATRANI FORMATION, FAYUM, EGYPT

73 **Shimada, K., Welton, B., Long, D.** A NEW FOSSIL MEGAMOUTH SHARK (LAMNIFORMES: MEGACHASMIDAE) FROM THE OLIGO-MIOCENE OF THE WESTERN UNITED STATES

74 **Pimiento, C., Balk, M.** CHRONOCLINAL BODY SIZE INCREASE OF THE EXTINCT GIANT SHARK MEGALODON (*CARCHARCOLES MEGALODON*)

Corresponding board numbers in left hand column

75 **Hastie, D., Fitzgerald, E.** A NEW ELASMOBRANCH ASSEMBLAGE FROM THE LATE MIOCENE OF AUSTRALIA SHEDS LIGHT ON THE EVOLUTION OF SHARK DIVERSITY IN THE SOUTHERN OCEAN

76 **Soto, L., Macfadden, B.** NEW CHONDRICHTHYAN FAUNA FROM MIDDLE MIOCENE (BARSTOVIAN), GADSEN COUNTY, FLORIDA, USA.

77 **Biasatti, D., Godfrey, S., Cooper, L.** PALEOECOLOGIES AND PALEOCLIMATES OF MIOCENE SHARK TAXA FROM CALVERT CLIFFS, MARYLAND, USA: EVIDENCE FROM STABLE CARBON AND OXYGEN ISOTOPES

78 **Maisch, Iv, H., Becker, M., Chamberlain,, Jr., J.** CHONDRICHTHYAN REMAINS FROM THE SHARK RIVER FORMATION (MIDDLE EOCENE) AND KIRKWOOD FORMATION (EARLY MIOCENE) LAG DEPOSIT, MONMOUTH COUNTY, NEW JERSEY

79 **Woodruff, E., Burleigh, G., Bloch, J.** SUPERTREE PERSPECTIVES ON THE PHYLOGENY OF FOSSIL AND EXTANT MAMMALS

80 **Halliday, T., Upchurch, P., Goswami, A.** A PHYLOGENETIC ANALYSIS OF PALAEOCENE MAMMALS: IMPLICATIONS FOR THE ORIGIN OF PLACENTAL MAMMAL ORDERS

81 **Williamson, T., Brusatte, S.** NEW SPECIMENS OF *WORTMANIA* (MAMMALIA, TAENIODONTA) FROM THE EARLY PALEOCENE (PUERCAN) OF NEW MEXICO

82 **Eberle, J., Lofgren, D., Hettinger, R., Mccomas, K., Soltis, C.** A NEW PUERCAN FAUNA FROM WYOMING'S GREAT DIVIDE BASIN

83 **Penkrot, T., Zack, S., Strait, S.** THE DIVERSITY OF SMALL MAMMALIAN TARSALS FROM CASTLE GARDENS, EARLIEST EOCENE OF WYOMING

84 **Strait, S., Bloch, J., Morse, P., Boyer, D.** DIVERSITY AND ABUNDANCE OF LATE PALEOCENE/EARLY EOCENE MULTITUBERCULATA FROM THE SOUTHEASTERN BIG HORN BASIN, WYOMING

85 **Smith, T., Russell, D., Habersetzer, J., Gunnell, G.** DIVERSITY OF ARCHAEONYCTERID BATS IN THE EARLY EOCENE OF EUROPE

86 **Ahrens, H.** FOOT POSTURE IN EARLY EOCENE HYAENODONTIDAE AND OXYAENIDAE FROM WYOMING

87 **Chew, A.** MAMMALIAN FAUNAL RESPONSE TO THE ETM2 AND H2 HYPERTHERMAL EVENTS IN THE CENTRAL PART OF THE BIGHORN BASIN, WY

88 **Rose, K., Dunn, R., Grande, L.** NEW EARLY EOCENE PANTOLESTID SKELETON FROM FOSSIL BUTTE MEMBER, WYOMING, AND SKELETAL ONTOGENY IN PANTOLESTIDAE (MAMMALIA, PANTOLESTA)

89 **Moore, J.** INVESTIGATING THE INFLUENCE OF TAXON AND ECOLOGY ON TAPHONOMIC MODIFICATION

90 **Santos, G., Cortez, C., Garibay, A., Magallanes, I., Parham, J.** NEW RECORDS OF TERRESTRIAL VERTEBRATES FROM AN EOCENE BONEBED IN ORANGE COUNTY, CALIFORNIA

Corresponding board numbers in left hand column

91 **Campisano, C., Kirk, E., Townsend, K., Deino, A., Mcdowell, F.** GEOCHRONOLOGICAL AND TAXONOMICAL REVISION OF THE MIDDLE EOCENE WHISTLER SQUAT QUARRY (DEVIL'S GRAVEYARD FORMATION, TEXAS) AND IMPLICATIONS FOR THE EARLY UINTAN IN WEST TEXAS

92 **Naylor, E., Krause, C., Stevens, N.** PHYLOGENETIC AND FUNCTIONAL CUES IN MICROMAMMAL TARSAL BONES FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF SOUTHWESTERN TANZANIA

93 **Bommersbach, B., Anemone, R., Emerson, C.** PREDICTIVE MODELING IN THE SEARCH FOR VERTEBRATE FOSSILS: GEOGRAPHIC OBJECT BASED IMAGE ANALYSIS (GEOBIA) IN THE EOCENE OF WYOMING

94 **Habersetzer, J., Engels, S., Smith, K.** DIVERSE STRATEGIES FOR IMPROVING CT SCANS OF VERTEBRATE FOSSILS

95 **Reynoso, D., Spell, T.** EVOLUTION OF DENTITION IN *MEROËHYRAX* FROM THE LATE OLIGOCENE OF KENYA: PALEONTOLOGICAL ANALYSIS AND $^{40}AR/^{39}AR$ DATING

96 **Koda, Y., Saegusa, H., Ando, H., Iizumi, K.** THE FIRST NEARLY COMPLETE SKULL OF *STEGOLOPHODON* (STEGODONTIDAE, PROBOSCIDEA) FROM THE LOWER MIOCENE OF JAPAN

97 **Sanders, W.** CLASSIFICATION AND BIOCHRONOLOGY OF AFRICAN MIOCENE PROBOSCIDEANS

98 **El Adli, J., Cherney, M., Fisher, D., Harris, J., Farrell, A.** LAST YEARS OF LIFE AND SEASON OF DEATH OF A COLUMBIAN MAMMOTH FROM RANCHO LA BREA

99 **Chiba, K., Kobayashi, Y., Jacobs, L., Graf, J., Tanaka, K.** A ROBUST DESMOSTYLID FROM HOKKAIDO, JAPAN, AND THE FEEDING STYLE OF DESMOSTYLIDS

100 **Uno, H., Taru, H., Kohno, N.** INTRA-TOOTH VARIATION IN MULTI-ELEMENTARY ISOTOPE ANALYSES ALONG GROWTH-LINES OF TOOTH ENAMEL OF *DESMOSTYLUS* (MAMMALIA, AFROTHERIA)

101 **Whalen, C., Fisher, D., Rountrey, A., Holmes, C.** QUANTITATIVE APPROACH TO RIB IDENTIFICATION AT AN ALASKAN PLEISTOCENE SITE

102 **Kalthoff, D.** EXTREMELY COARSE USE WEAR FEATURES IN TEETH OF AARDVARKS (MAMMALIA, TUBULIDENTATA, *ORYCTEROPUS AFER*)

103 **Fröbisch, J., Walther, M.** THE QUALITY OF THE FOSSIL RECORD OF ANOMODONTS (SYNAPSIDA, THERAPSIDA)

104 **Sullivan, C., Liu, J., Roberts, E., Huang, T., Yang, C.** THE STRUCTURE OF THE PELVIS IN TRITYLODONTIDS (SYNAPSIDA, EUCYNODONTIA) AND ITS PHYLOGENETIC AND FUNCTIONAL IMPLICATIONS

105 **Liu, J., Li, L., Sullivan, C.** NEW TETRAPOD FOSSILS FROM THE TRIASSIC TONGCHUAN FORMATION OF SHANXI PROVINCE, CHINA, AND THE AGE OF THE *SINOKANNNEMEYERIA-SHANSISUCHUS* ASSEMBLAGE

106 **Viglietti, P., Smith, R., Compton, J., Botha-Brink, J.** *LYSTROSAURUS* BONEBED ORIGINS AND THEIR PALAEOENVIRONMENTAL IMPLICATIONS FOR THE EARLIEST TRIASSIC KAROO BASIN, SOUTH AFRICA

Corresponding board numbers in left hand column

107 **Jansen, M., Reisz, R., Kammerer, C., Fröbisch, J.** A NEW BASAL DINOCEPHALIAN FROM THE MIDDLE PERMIAN MEZEN FAUNA (RUSSIA)

108 **Sigurdsen, T.** THE GORGONOPSIAN BRAINCASE AND THE EVOLUTION OF THERAPSID BRAINS

109 **Chinsamy-Turan, A.** EVIDENCE OF FUNGAL ATTACK ON THE BONES OF A PERMIAN THERAPSID

110 **Wretman, L., Blom, H., Kear, B.** THE LOWER JURASSIC ACTINOPTERYGIAN *PACHYCORMUS BOLLENSIS*: IMPLICATIONS FOR PACHYCORMIFORM PHYLOGENY AND PALEOBIOGEOGRAPHY

111 **Schröder, K., López-Arbarello, A., Rauhut, O.** REDESCRIPTION OF *ASPIDORHYNCHUS ORNATISSIMUS* AGASSIZ, 1834 FROM GERMANY

112 **Holloway, W., Claeson, K., Sertich, J., Sallam, H., O'Connor, P.** A NEW SPECIMEN OF *ENCHODUS* (ACTINOPTERYGII: PROTACANTHOPTERYGII) FROM THE LATE CRETACEOUS OF EGYPT AND ITS CONTRIBUTION TO THE WESTERN TETHYAN DISTRIBUTION OF THE GENUS

113 **Fielitz, C., Cowan, T.** TWO THREE DIMENSIONALLY PRESERVED TELEOST NEUROCRANIA FROM THE CORSICANA FORMATION (UPPER CRETACEOUS, MAASTRICHTIAN), BEXAR COUNTY, TEXAS, U.S.A.

114 **Schwimmer, D., Weems, R., Sanders, A.** A LATE CRETACEOUS SHARK COPROLITE WITH BABY TURTLE VERTEBRAE

115 **Frampton, E., Cook, T., Newbrey, M.** PRELIMINARY INVESTIGATIONS OF CHONDRICHTHYAN AND ACTINOPTERYGIAN FISHES FROM THE FISH SCALE SANDSTONE (ALBIAN TO CENOMANIAN), BIRCH MOUNTAINS, ALBERTA, CANADA

116 **Newbrey, M., Cook, T., Siverson, M., Wilson, M., Neuman, A.** ANACORACID VERTEBRAL MORPHOLOGY AND COMPARISON TO LAMNIFORMES AND CARCHARHINIFORMES SUGGEST AN ORDINAL ASSIGNMENT

117 **Boles, Z., Lacovara, K.** EVIDENCE OF EXTENSIVE SCAVENGING/PREDATION BY LATE CRETACEOUS MARINE ORGANISMS FROM THE BASAL HORNERSTOWN FORMATION, NEW JERSEY, USA

118 **Bice, K., Shimada, K., Decker, R.** FOSSIL MARINE FISHES FROM THE CODELL SANDSTONE MEMBER OF THE UPPER CRETACEOUS CARLILE SHALE IN NORTH-CENTRAL KANSAS, U.S.A.

119 **Meglei, A., Shimada, K., Kirkland, J.** FOSSIL MARINE VERTEBRATES FROM THE MIDDLE GRANEROS SHALE (UPPER CRETACEOUS: MIDDLE CENOMANIAN) IN SOUTHEASTERN NEBRASKA, U.S.A.

120 **Mcintosh, A., Shimada, K., Everhart, M.** LATE CRETACEOUS MARINE VERTEBRATE FAUNA FROM THE FAIRPORT CHALK MEMBER OF THE CARLILE SHALE IN SOUTHERN ELLIS COUNTY, KANSAS, U.S.A.

121 **Lindoso, R., Maisey, J., Carvalho, I.** THE PALEOICHTHYOFAUNA FROM THE CODÓ FORMATION (APTIAN OF THE PARNAÍBA BASIN) NORTHEASTERN BRAZIL

122 **Hunt-Foster, R., Foster, J.** PALEOFAUNA OF THE WILLIAMS FORK FORMATION (UPPER CRETACEOUS), NORTHWESTERN COLORADO: COASTAL DELTAIC DEPOSITS DOMINATED BY FRESHWATER TAXA

Corresponding board numbers in left hand column

WEDNESDAY AFTERNOON, OCTOBER 30, 2013

Poster Session I (CONTINUED)

123 **Zorigt, B., Horner, J.** INTRASKELETAL HISTOVARIABILITY DURING *PSITTACOSAURUS MONGOLIENSIS* ONTOGENY

124 **Carr, T.** USING ONTOGENY AND PHYLOGENY TO TEST HYPOTHESES OF ANAGENESIS IN THE VERTEBRATE FOSSIL RECORD: A CASE STUDY OF THE SISTER GROUP RELATIONSHIP BETWEEN *DASPLETOSAURUS* AND *TYRANNOSAURUS* (DINOSAURIA, COELUROSAURIA)

THURSDAY MORNING, OCTOBER 31, 2013

Preparators' Session

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: Howell W. Thomas and Vanessa R. Rhue

8:00 **Kurtova, A., Kharlamova, A., Protopopov, A., Plotnikov, V., Potapova, O.** THE YUKA WOOLLY MAMMOTH (*MAMMUTHUS PRIMIGENIUS* BLUM) BRAIN EXTRACTION AND PRESERVATION: THE METHODS AND RESULTS

8:15 **Lund, E., Lawrence, D.** UNDER THE HEADWALL: FIELD LOGISTICS OF EXCAVATING FOSSILS FROM LARGE VERTICAL EXPOSURES

8:30 **De Blieux, D., Kirkland, J., Madsen, S.** TARPOLOGY 501 - ADVANCED SHADE TARP TECHNIQUES FOR PALEONTOLOGICAL FIELD EXCAVATIONS; STRATEGIES FOR FIELD PALEONTOLOGY ON A WARMING PLANET

8:45 **Smith, M.** CUTTING OUT THE MIDDLE MAN: ARCHIVAL SUPPORT CRADLE DESIGN FOR USE DURING PREPARATION

9:00 **Van Beek, C.** A FINE KETTLE OF FISH: PREPARATION OF A LARGE CRETACEOUS FIELD JACKET CONTAINING MULTIPLE ASIPENCERIFORMES

9:15 **Bugbee, M., Wilkins, W.** DAMAGE CONTROL, SAFETY, AND PREPARATION ON A VOLUNTEER-BASED EXCAVATION OF AN *IN SITU* BONEBED AT THE MAMMOTH SITE OF HOT SPRINGS, SD, INC.

9:30 **Baziak, B.** PREPARATION OF A CROCODYLIFORM AND SAUROPOD DINOSAUR FROM MONTANA: SOLUTIONS TO COMPLEX MOLDING PROBLEMS

9:45 **Rice, K., Lai, K., Sessions, A., Takeuchi, G.** NEW TECHNIQUE TO REMOVE ASPHALT FROM MICROFOSSIL-RICH MATRIX FROM RANCHO LA BREA

10:00 BREAK

10:15 **Brown, G.** PRACTICAL METHODS FOR THE USE OF CYCLODECANE IN VERTEBRATE MICROFOSSIL PREPARATION

10:30 **Vital, D., Davidson, A., Zdinak, A., Brown, G.** ROCK, PAPER, ADHESIVE: DEVELOPING VARIOUS METHODS FOR THE USE OF PAPER IN ARCHIVAL FOSSIL REPAIR

10:45 **Marcos, F., Blanco, M., Díaz, S., Ortega, F.** LASER CLEANING OF MACROVERTEBRATE FOSSILS FROM THE UPPER CRETACEOUS SITE OF “LO HUECO” (CUENCA, SPAIN)

11:00 **Norris, C., Yarborough-Fitzgerald, V., Fox, M.** MOVING MARSH'S DINOSAURS INTO THE 21ST CENTURY

11:15 **Getty, M.** MOVING COLLECTIONS INTO THE NEW NATURAL HISTORY MUSEUM OF UTAH

11:30 **Brown, M.** FOSSIL SPECIMENS AS THEORETICAL MODELS

THURSDAY MORNING, OCTOBER 31, 2013

Preparators' Session (Continued)

11:45 **Lash, C., Smith, M., Parker, W.** A TALE OF TWO EXHIBITS: THE FOSSIL PREPARATOR AS AN INTEGRAL PART OF MUSEUM OUTREACH

12:00 **Rhue, V.** IMPARTING OUR KNOWLEDGE: EDUCATING THE NEXT GENERATION OF FOSSIL PREPARATORS AND COLLECTIONS PERSONNEL

THURSDAY MORNING, OCTOBER 31, 2013

Romer Prize Session

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: David Fox and Ken Angielczyk

8:00 **Bonde, A.** STABLE ISOTOPE PALEOECOLOGY OF LATE PLEISTOCENE MEGAHERBIVORES FROM WESTERN NORTH AMERICA

8:15 **Brassey, C.** HIND LIMB ROBUSTICITY IN TWO FAMILIES OF SOUTH ISLAND NEW ZEALAND MOA (AVES, DINORNITHIFORMES) COMPARED TO MODERN RATITES: NEW VOLUMETRIC BODY MASS ESTIMATES AND FINITE ELEMENT ANALYSIS

8:30 **Brusatte, S.** THE PHYLOGENY OF COELUROSAURIAN THEROPODS (ARCHOSAURIA: DINOSAURIA) AND PATTERNS OF MORPHOLOGICAL EVOLUTION DURING THE DINOSAUR-BIRD TRANSITION

8:45 **Drewicz, A.** QUANTIFYING PERIODS OF DIFFUSION IN MARINE AND TERRESTRIAL MAMMALIAN VERTEBRATE FOSSILS USING RARE EARTH ELEMENTS

9:00 **Drumheller, S.** PHYLOGENETIC TAPHONOMY: SYNTHESIZING BITE MARK DATASETS USING STATISTICAL AND CLADISTIC METHODS

9:15 **Evans, T.** EMPIRICAL AUTHENTICATION OF OUR UNDERSTANDING OF FLUVIAL TAPHONOMIC PROCESSES

9:30 **Fischer, V.** THE EXTINCTION OF ICHTHYOSAURS IS A FACET OF A MAJOR CENOMANIAN TURNOVER IN MARINE ECOSYSTEMS

9:45 **Huttenlocker, A. K.** THE MEANING AND MECHANISM OF 'LILLIPUT' PATTERNS IN NONMAMMALIAN THERAPSIDS IN THE AFTERMATH OF THE END-PERMIAN EXTINCTION

10:00 BREAK

10:15 **Kelley, N.** ECOMORPHOLOGICAL DIVERSITY OF TRIASSIC MARINE REPTILES

10:30 **Kimura, Y.** DENTAL ADAPTATIONS LINKED TO ISOTOPIC DIET AND EVOLUTIONARY PATTERN IN MURINE RODENTS FROM THE MIOCENE OF PAKISTAN

10:45 **Lautenschlager, S.** UNRAVELING THERIZINOSAUR PALEOBIOLOGY – A MULTI-ANGLE APPROACH

11:00 **Nakajima, Y.** ESTIMATION OF THE BONE GROWTH CENTER USING INNER BONE STRUCTURAL FEATURES AND ITS APPLICATION FOR PALEOHISTOLOGY

11:15 **Neenan, J.** ORIGINS, SYSTEMATICS AND PALEOECOLOGY OF PLACODONT MARINE REPTILES (SAUROPTERYGIA, PLACODONTIA)

11:30 **Stocker, M.** CONTEXTUALIZING VERTEBRATE FAUNAL DYNAMICS: NEW PERSPECTIVES FROM THE TRIASSIC AND EOCENE OF WESTERN NORTH AMERICA

THURSDAY MORNING, OCTOBER 31, 2013

Romer Prize Session (Continued)

11:45 **Tomiya, S.** CONCORDANCE AND DISCORDANCE OF DIVERSITY DYNAMICS ACROSS MAMMALIAN TROPHIC GROUPS IN THE MIDDLE EOCENE OF COASTAL SOUTHERN CALIFORNIA

12:00 **Tschopp, E.** A SPECIMEN-BASED PHYLOGENETIC ANALYSIS OF DIPLODOCIDAE (DINOSAURIA, SAUROPODA)

THURSDAY MORNING, OCTOBER 31, 2013

Technical Session VI

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Nancy Simmons and Rachel Dunn

8:00 **Lofgren, D., Williamson, T., Nydam, R.** NEW RECORDS OF EUTHERIAN AND METATHERIAN MAMMALS FROM THE GOLER FORMATION OF CALIFORNIA AND THEIR IMPLICATIONS FOR LATE PALEOCENE PROVINCIALITY

8:15 **Simmons, N., Seiffert, E., Gunnell, G.** A NEW FAMILY OF LARGE OMNIVOROUS BATS FROM THE LATE EOCENE OF EGYPT

8:30 **Gunnell, G., Smith, R., Smith, T.** NEW BATS (CHIROPTERA) FROM THE EARLIEST OLIGOCENE BOUTERSEM-TGV LOCALITY IN BELGIUM DOCUMENT THE EARLIEST OCCURRENCE OF *MYOTIS*

8:45 **Padian, K., Dial, K.** NEW MORPHOLOGICAL DATA ILLUMINATE HINDLIMB FUNCTION AND THE ECOLOGICAL CONTEXT OF FLIGHT IN THE EARLIEST BATS

9:00 **Manz, C., Bloch, J.** SYSTEMATICS OF PALEOGENE *LEPTACODON* AND *PLAGIOCTENODON* (MAMMALIA, NYCTITHERIIDAE) WITH DESCRIPTION OF A NEW SPECIES FROM THE LATE PALEOCENE OF THE CLARKS FORK BASIN, WYOMING, USA

9:15 **Hooker, J.** NEW POSTCRANIALS OF THE EXTINCT FAMILY NYCTITHERIIDAE FROM THE LATE EOCENE: IMPLICATIONS FOR LIFESTYLE AND AFFINITIES

9:30 **Dunn, R., Rose, K., Kumar, K., Rana, R., Smith, T.** NEW PRIMATE POSTCRANIA FROM THE EARLY EOCENE OF VASTAN MINE, GUJARAT, INDIA

9:45 **Stroik, L.** THE ROLE OF DIETARY COMPETITION IN THE ORIGINATION OF EUPRIMATES IN NORTH AMERICA.

10:00 BREAK

10:15 **Stevens, N., Seiffert, E., Roberts, E., O'Connor, P.** PRIMATE DIVERSITY IN THE LATE OLIGOCENE NSUNGWE FORMATION OF SOUTHWESTERN TANZANIA

10:30 **Borths, M., Simons, E., Seiffert, E.** THE MOST COMPLETE AFRICAN HYAENODONTID (MAMMALIA, "CREODONTA") FROM THE LATEST EOCENE OF EGYPT AND THE EVOLUTION OF APTERODONTINAE

10:45 **Zack, S.** A REASSESSMENT OF THE MONOPHYLY OF CARNIVORAMORPHA (MAMMALIA)

11:00 **Beard, K., Coster, P., Salem, M., Chaimanee, Y., Jaeger, J.** A NEW EARLY OLIGOCENE VERTEBRATE FAUNA FROM ZALLAH OASIS, SIRT BASIN, LIBYA YIELDS THE OLDEST KNOWN AFRICAN CARNIVORAN

11:15 **Schwermann, L., Von Koenigswald, W.** DIFFERENTIATION AND SIMPLIFICATION IN DENTAL MORPHOLOGY AND FUNCTION DURING ARTIODACTYL EVOLUTION

THURSDAY MORNING, OCTOBER 31, 2013

Technical Session VI (Continued)

11:30 **Hiard, F., Mennecart, B.** EUROPEAN ARTIODACTYLS THROUGH THE EOCENE: UPDATED BIOSTRATIGRAPHY AND A TIMELINE OF FAUNAL TURNOVER

11:45 **Bibi, F.** THE IMPORTANCE OF THE FOSSIL RECORD FOR MOLECULAR PHYLOGENETICS: THE CASE OF BOVIDAE (ARTIODACTYLA, RUMINANTIA)

12:00 **Mihlbachler, M., Samuels, J.** LITTLE TITANS OF THE EOCENE: COPE'S RULE OR SAMPLING ARTIFACT?

THURSDAY AFTERNOON, OCTOBER 31, 2013

Symposium 2: La Brea and Beyond: The Paleontology of Asphalt-Preserved Biotas

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Emily Lindsey and John Harris

1:45 **Harris, J., Farrell, A., Takeuchi, G., Cox, S., Howard, C.** *EX* RANCHO LA BREA" *SEMPER ALIQUID NOVUM*

2:00 **Rincón, A., Solórzano, A., Mcdonald, H.** PALEONTOLOGY OF VENEZUELAN TAR PITS AND THE GREAT AMERICAN BIOTIC INTERCHANGE

2:15 **Seymour, K.** PERUSING TALARA: OVERVIEW OF THE LATE PLEISTOCENE FOSSIL VERTEBRATES FROM THE TAR SEEPS OF PERU

2:30 **Martinez, J., Cadenillas, R., Zapata, J.** THE LATE PLEISTOCENE VERTEBRATE FAUNA OF THE TALARA TAR SEEPS (NORTHWESTERN PERU) - PAST, PRESENT AND FUTURE

2:45 **Lindsey, E., Seymour, K.** "TAR PITS" OF THE WESTERN COASTAL NEOTROPICS: PALEOECOLOGY, TAPHONOMY, AND MAMMALIAN BIOGEOGRAPHY

3:00 **Campbell, K.** THE OWLS OF RANCHO LA BREA: PREDATORS, NOT SCAVENGERS, RULE

3:15 **Brannick, A., Meachen, J., O'Keefe, F.** NUTRITIONAL STRESS INDUCES MORPHOLOGICAL CHANGES IN DIRE WOLVES FROM RANCHO LA BREA

3:30 **Haupt, R., Desantis, L.** INSIGHTS FROM DENTAL MICROWEAR TEXTURE ANALYSIS INTO THE SURVIVAL OF COUGARS (*PUMA CONCOLOR*) THROUGH THE LATE PLEISTOCENE EXTINCTION

3:45 **Shaw, C., Quinn, J.** THE ADDITION OF *SMILODON FATALIS* (MAMMALIA, CARNIVORA, FELIDAE) TO THE BIOTA OF THE LATE PLEISTOCENE CARPINTERIA ASPHALT DEPOSITS WITH ONTOGENETIC AND ECOLOGIC IMPLICATIONS FOR THE SPECIES

4:00 **Mcdonald, H.** A REEXAMINATION OF THE ORIGIN OF ASPHALT PRESERVED BIOTAS: ARE WE STUCK IN THE SAME OLD PARADIGM?

THURSDAY AFTERNOON, OCTOBER 31, 2013

Technical Session VII

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: Nicolás Campione and Caleb Brown

1:45 **Porter, W., Witmer, L.** EVIDENCE FOR SITES OF PHYSIOLOGICAL HEAT EXCHANGE IN THE HEADS OF DINOSAURS

2:00 **Eagle, R., Enriquez, M., Grellet-Tinner, G., Tutken, T., Eiler, J.** MEASURING THE BODY TEMPERATURE OF A DINOSAUR? THE POTENTIAL FOR PALEOPHYSIOLOGICAL STUDIES FROM THE ANALYSIS OF ^{13}C-^{18}O BOND ORDERING IN FOSSIL BIOMINERALS

THURSDAY AFTERNOON, OCTOBER 31, 2013

Technical Session VII (Continued)

2:15 **Sobral, G., Mueller, J.** PATTERNS OF MIDDLE EAR AND BRAINCASE EVOLUTION IN DINOSAURIA

2:30 **Jerison, H.** BIG-BRAINED DINOSAURS AND THEIR BODIES

2:45 **Campione, N., Evans, D., Brown, C., Carrano, M.** A NEW MATHEMATICALLY DERIVED SCALING EQUATION FOR ESTIMATING BODY MASS IN EXTINCT BIPEDS

3:00 **Tsai, H., Middleton, K., Holliday, C.** ANATOMY OF SAURISCHIAN HIP JOINT SOFT TISSUES AND ITS SIGNIFICANCE IN BODY SIZE EVOLUTION

3:15 **Sellers, W., Margetts, L., Coria, R., Manning, P. L.** ESTIMATING MUSCLE PARAMETERS FOR STUDIES OF SAUROPOD LOCOMOTION

3:30 **Brown, C., Campione, N., Evans, D.** BODY SIZE RELATED TAPHONOMIC BIASES IN THE LATEST MAASTRICHTIAN; IMPLICATIONS FOR THE END-CRETACEOUS EXTINCTION

3:45 **Bell, M., Upchurch, P., Mannion, P., Lloyd, G.** USING THE CHARACTER COMPLETENESS METRIC TO EXAMINE COMPLETENESS OF MESOZOIC DINOSAURS: A MAASTRICHTIAN HIGH AND A PALEOEQUATORIAL LOW

4:00 **Benson, R., Choniere, J.** RATES OF DINOSAUR LIMB EVOLUTION PROVIDE EVIDENCE FOR EXCEPTIONAL RADIATION IN MESOZOIC BIRDS

THURSDAY AFTERNOON, OCTOBER 31, 2013

Technical Session VIII

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: Christian Kammerer and Rui Castanhinha

1:45 **Brocklehurst, N., Kammerer, C., Fröbisch, J.** THE INFLUENCE OF SAMPLING ON THE FOSSIL RECORD OF PALEOZOIC SYNAPSIDS, AND THE EFFECT OF OLSON'S EXTINCTION ON THEIR EVOLUTION

2:00 **Castanhinha, R., Araújo, R., Costa Júnior, L., Angielczyk, K., Martins, G. G.** NEUROANATOMY AND OSSEOUS LABYRINTH OF A NEW PERMIAN DICYNODONT FROM MOZAMBIQUE

2:15 **Kammerer, C., Jansen, M., Fröbisch, J.** THERAPSID PHYLOGENY REVISITED

2:30 **Day, M., Rubidge, B.** MIDDLE PERMIAN TETRAPOD BIODIVERSITY CHANGE AND THE GUADALUPIAN EXTINCTION: INSIGHTS FROM THE BEAUFORT GROUP OF SOUTH AFRICA.

2:45 **Krentzel, D., Flynn, J., Kammerer, C.** HIGH RESOLUTION X-RAY COMPUTED TOMOGRAPHY RECONSTRUCTION OF A NEW, WELL PRESERVED THEROCEPHALIAN SKULL, WITH INSIGHTS ON THEROCEPHALIAN PHYLOGENETICS AND CHARACTER EVOLUTION

3:00 **Botha-Brink, J., Codron, D.** LIFE HISTORY AND REPRODUCTIVE STRATEGY OF THE PERMO-TRIASSIC DICYNODONT *LYSTROSAURUS*

3:15 **Owerkowicz, T., Crompton, A.** EFFECTIVE COUNTERCURRENT EXCHANGE AT THE RESPIRATORY TURBINATES REQUIRED A STIFF THORAX IN SYNAPSIDS

3:30 **Crompton, A., Musinsky, C., Owerkowicz, T.** RECONSTRUCTION OF THE NASAL REGION IN NON-MAMMALIAN CYNODONTS AND MAMMALIAFORMES SUGGESTS ABSENCE OF INTRANARIAL LARYNX AND A COMPROMISED COUNTERCURRENT EXCHANGE AT RESPIRATORY TURBINATES

3:45 **Ruf, I., Maier, W., Rodrigues, P., Schultz, C.** NASAL ANATOMY OF THE ADVANCED CYNODONT *BRASILITHERIUM RIOGRANDENSIS* REVEALS NEW ASPECTS OF MAMMALIAN EVOLUTION

THURSDAY AFTERNOON, OCTOBER 31, 2013

Technical Session VIII (Continued)

4:00 **Mancuso, A., Gaetano, L., Leardi, J., Abdala, F., Arcucci, A.** MIDDLE TRIASSIC CONTINENTAL FAUNAS FROM GONDWANA: THE CHANARES FORMATION TETRAPOD ASSEMBLAGE, A CASE STUDY FROM WESTERN ARGENTINA

THURSDAY AFTERNOON, OCTOBER 31, 2013

Poster Session II

Westin Bonaventure Hotel & Suites, Exhibit Hall
Authors must be present from 4:15 - 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Lehmann, S., Patterson, D., Matthews, T., Levin, N.** REGIONAL AND LANDSCAPE-SCALE PLEISTOCENE PALEOECOLOGY USING CARBON AND OXYGEN ISOTOPES FROM *IN SITU* MACRO- AND MICROMAMMAL TOOTH ENAMEL AT ELANDSFONTEIN, WESTERN CAPE, SOUTH AFRICA.

2 **Kharlamova, A., Saveliev, S., Boeskorov, G., Uschakov, V., Maschenko, E.** PRELIMINARY ANALYSES OF BRAIN GROSS MORPHOLOGY OF THE WOOLLY MAMMOTH, *MAMMUTHUS PRIMIGENIUS*, FROM YAKUTIA, RUSSIA

3 **Ferraro, J., Binetti, K., Richmond, B., Manthi, F.** THE EARLY PLEISTOCENE MAMMALIAN FAUNA OF 'MARSABIT ROAD', CHALBI BASIN, NORTHERN KENYA

4 **Chritz, K., Cerling, T.** ISOTOPIC INDICATORS OF MONSOON-INDUCED TERRESTRIAL ECOSYSTEM CHANGE IN THE TURKANA BASIN, KENYA: IMPLICATIONS FOR THE FOSSIL RECORD

5 **George, C.** GIS ANALYSIS OF THE FAUNMAP II DATABASE TO RECOGNIZE GEOGRAPHIC BIAS IN THE IDENTIFICATION OF FOSSILS

6 **Priego-Vargas, J., Bravo-Cuevas, V.** DIETARY BEHAVIOR AND HABITAT OF A MAMMAL ASSOCIATION FROM THE RANCHOLABREAN OF HIDALGO, CENTRAL MEXICO

7 **Reynolds, R., Sample, L., Conkling, S.** THE EL CASCO SUBSTATION FAUNA AND FLORA: NEW RECORDS FROM THE PLIOCENE–PLEISTOCENE AGE SAN TIMOTEO FORMATION, RIVERSIDE COUNTY, CALIFORNIA

8 **Palmqvist, P., Espigares, M., Pérez-Claros, J., Martín-Serra, A., Janis, C.** TAPHONOMY OF CARNIVOROUS AND HERBIVOROUS MAMMALS PRESERVED IN RANCHO LA BREA TAR PITS: SHIPS THAT PASS IN THE NIGHT?

9 **Holden, A., Harris, J., Timm, R.** PALEOECOLOGICAL AND TAPHONOMIC IMPLICATIONS OF INSECT-DAMAGED VERTEBRATE REMAINS FROM RANCHO LA BREA, SOUTHERN CALIFORNIA

10 **Stegner, M.** THE MESCAL CAVE FAUNA (SAN BERNARDINO COUNTY, CALIFORNIA): TESTING ASSUMPTIONS OF HABITAT FIDELITY IN THE QUATERNARY FOSSIL RECORD

11 **Macias, M., Kitao, E., Gray, R.** NEW PLEISTOCENE MEGAFAUNA LOCALITIES IN SANTA BARBARA COUNTY, CALIFORNIA: PALEONTOLOGICAL RECONNAISSANCE OF THE MARINE TERRACE DEPOSITS AT VANDENBERG AIR FORCE BASE

12 **Brandborg, D., Matthias, A., Graham, R.** EXCAVATION AND FOSSIL RECOVERY AT DON'S GOOSEBERRY PIT, BLACK HILLS, SD

Corresponding board numbers in left hand column

13 **Ellison, M., Flynn, J.** A NEW PHYLOGENETICALLY-INFORMED LIFE RECONSTRUCTION OF THE GIANT EOCENE CARNIVOROUS ARTIODACTYL *ANDREWSARCHUS MONGOLIENSIS* (MAMMALIA, ARTIODACTYLAMORPHA, CETANCODONTOMORPHA)

14 **Tsubamoto, T., Koda, Y., Hasegawa, Y., Nabana, S., Tomida, Y.** A PALEOGENE MAMMALIAN FAUNA FROM THE IWAKI FORMATION, JAPAN, AND IMPLICATIONS FOR AGE AND PALEOBIOGEOGRAPHY

15 **Samuels, J., Mackenzie, K., Fremd, T.** THE FIRST RECORDS OF LEPTOCHOERIDS (ARTIODACTYLA) FROM THE JOHN DAY FORMATION OF OREGON

16 **O'Brien, H.** THE EVOLUTIONARY HISTORY OF CRANIAL VASCULATURE IN BASAL RUMINANTS

17 **Emery, M., Davis, E., Hopkins, S.** CHARACTER VARIATION IN MODERN CAMELS AND SHEEP HIGHLIGHTS PROBLEMS IN THE GENUS-LEVEL TAXONOMY OF AGRIOCHOERID OREODONTS

18 **Walters, K., Emery, M., Davis, E.** DECIDUOUS TEETH SHOW CLOSE RELATIONSHIPS BETWEEN OREODONT GENERA (*EUCROTAPHUS, MERYCOCHOERUS* AND *PROMERYCOCHOERUS*)

19 **Mclaughlin, W., Davis, E.** SEXUAL DIMORPHISM IN THE POSTCRANIA OF EXTANT ARTIODACTYLA AND IMPLICATIONS FOR FALSELY ELEVATED DIVERSITY IN THE PALEOMERYCIDAE

20 **Yamada, E., Hasumi, E., Miyazato, N., Nakaya, H., Watabe, M.** EXTANT HYPSODONT UNGULATES PROVIDE NEW INSIGHT ON MESOWEAR ANALYSIS FOR THE LATE MIOCENE UNGULATES FROM MARAGHEH, IRAN

21 **Ludtke, J., Racicot, R.** EXAMINING THE CONGRUENCE BETWEEN DIFFERENT SOURCES OF PHYLOGENETIC DATA FROM ARTIODACTYLA

22 **Rowan, J., Reed, K.** ENDEMISM AND DISPERSAL IN EAST AFRICAN BOVIDAE FROM THE LATE MIOCENE THROUGH THE RECENT

23 **Scott, J., O'Hara, M.** THE RELIABILITY OF MAXILLARY AND MANDIBULAR FIRST AND SECOND MOLARS FOR IDENTIFYING DIETARY CATEGORY IN EXTANT BOVIDS VIA DENTAL MICROWEAR TEXTURE ANALYSIS

24 **Rössner, G., Ruf, I., Maier, W.** NEW INSIGHT IN THE EARLY EVOLUTION OF PECORA: CRANIAL ANATOMY OF *AMPHIMOSCHUS* (MAMMALIA, ARTIODACTYLA, RUMINANTIA)

25 **Heckeberg, N., Roessner, G., Asher, R.** THE POWER OF TOOTH MORPHOLOGY IN THE INTERPRETATION OF CERVID EVOLUTION (RUMINANTIA, ARTIODACTYLA, MAMMALIA)

26 **Nishioka, Y., Takai, M., Vidthayanon, C., Hanta, R., Jintasakul, P.** TAXONOMIC, MORPHOLOGICAL, AND PALEOENVIRONMENTAL REVISIONS ON FOSSIL BOVIDS (ARTIODACTYLA) FROM CONTINENTAL SOUTHEAST ASIA

27 **Kloess, P., Farke, A.** TRACKS AND BODY FOSSILS PRESERVE DIFFERENT CAMELID POPULATIONS IN THE BARSTOW FORMATION (MIOCENE) OF SOUTHERN CALIFORNIA

28 **Hensley-Marschand, B., Njau, J., Vermillion, W.** *HIPPOPOTAMUS* AT OLDUVAI GORGE INDICATES PERSISTENT WETLAND ENVIRONMENTS DURING A PERIOD OF INCREASING ARIDIFICATION IN EARLY HOMININ EVOLUTION

Corresponding board numbers in left hand column

29 **Boisserie, J.** CONTINENTAL DWARFISM OF AN EARLY PLEISTOCENE HIPPOPOTAMID FROM THE SHUNGURA FORMATION, LOWER OMO VALLEY, ETHIOPIA

30 **Lewis, P., Horstman, E., Johnson, E., Buchanan, B.** EARLY HOLOCENE *BISON ANTIQUUS* SIZE CLINE ON THE SOUTHERN PLAINS

31 **Bormet, A.** BISON DO NOT MARCH IN UNISON: A GEOMETRIC MORPHOMETRIC APPROACH TO DIFFERENTIATING NORTH AMERICAN BISON SPECIES BASED ON HOOF SHAPE MORPHOLOGY

32 **Schubert, A., Ruf, I.** INNER EAR MORPHOMETRY OF *MYOTRAGUS BALEARICUS* (BOVIDAE, CETARTIODACTYLA) SUPPORTS DECREASE IN LOCOMOTOR AGILITY

33 **Ramdarshan, A., Beard, K.** NICHE PARTITIONING AMONG PLESIADAPIFORMES: AN EXAMPLE FROM THE LATE PALEOCENE OF SOUTHWESTERN WYOMING

34 **Birlenbach, D., Marcot, J.** TESTING MECHANISMS OF BODY SIZE TRENDS IN NORTH AMERICAN PLESIADAPIFORMES (MAMMALIA, ?PRIMATES)

35 **López-Torres, S., Silcox, M.** PHYLOGENETIC RELATIONSHIPS OF THE EUROPEAN PAROMOMYIDAE (PRIMATES, MAMMALIA) AND THEIR BIOGEOGRAPHIC IMPLICATIONS

36 **Chester, S., Sargis, E., Bloch, J., Boyer, D.** NEARLY COMPLETE SKELETON OF THE EARLY EOCENE *TINIMOMYS GRAYBULLIENSIS* (PRIMATES, MICROMOMYIDAE)

37 **Maiolino, S., Boyer, D.** DISTAL PHALANGEAL EVOLUTION IN EARLY EUPRIMATES

38 **Engels, S., Habersetzer, J., Kullmer, O., Hurum, J.** THE MESSEL ADAPIDS - 3D RECONSTRUCTION, REPOSITIONING, AND FUNCTIONAL ANALYSIS OF THE DENTITIONS

39 **Harrington, A., Silcox, M., Bloch, J.** FIRST VIRTUAL ENDOCAST OF AN EOCENE NORTH AMERICAN ADAPIFORM PRIMATE

40 **Allen, K.** ENDOCAST SHAPE EVOLUTION IN PRIMATES

41 **Prufrock, K., Silcox, M.** PHALANGERIFORM MODELS FOR THE ESTIMATION OF BODY MASS IN STEM PRIMATES

42 **Yapuncich, G., Gladman, J., Boyer, D.** ESTIMATING BODY MASS OF FOSSIL PRIMATES: A COMPARISON OF DENTAL AND TARSAL VARIABLES

43 **Perry, J., Macneill, K., Heckler, A., Hartstone-Rose, A.** RECONSTRUCTIONS OF THE CHEWING MUSCLES IN EUROPEAN ADAPIDS AND SUBFOSSIL LEMURS

44 **Samonds, K., Godfrey, L., Crowley, B., Sutherland, M.** THE CHRONOLOGY OF LEMUR EXTINCTION IN NEAR AND DEEP TIME

45 **St. Clair, E., Babbitt, C., Wray, G., Wall, C.** ENAMEL THICKNESS MEASUREMENTS AND RECONSTRUCTION OF ANCESTRAL MORPHOTYPES IN PRIMATES

46 **Atwater, A., Holroyd, P., Davis, E.** NEW EVIDENCE THAT OMOMYID DIET, NOT BODY SIZE, WAS AFFECTED BY GLOBAL CLIMATE CHANGE

47 **Minwer-Barakat, R., Marigo, J., Badiola, A., Moya-Sola, S.** THE WESTERNMOST RECORD OF THE GENUS *MICROCHOERUS* (OMOMYIDAE, PRIMATES) IN THE IBERIAN PENINSULA AND ITS PALAEOBIOGEOGRAPHIC IMPLICATIONS

Corresponding board numbers in left hand column

THURSDAY AFTERNOON, OCTOBER 31, 2013
Poster Session II (CONTINUED)

48 **Albright, L., Samuels, J., Fremd, T.** THE LAST FOSSIL PRIMATE IN NORTH AMERICA: NEW MATERIAL OF THE ENIGMATIC *EKGMOWECHASHALA* FROM THE ARIKAREEAN OF OREGON

49 **Patel, B., Desilva, J., Steininger, C.** NEW CERCOPITHECOID PRIMATE POSTCRANIAL FOSSILS FROM COOPER'S D, SOUTH AFRICA

50 **Maclatchy, L., Kingston, J., Kityo, R.** MORE OF THE FEMUR OF *MOROTOPITHECUS*

51 **Moyà-Solà, S., Alba, D., Almécija, S.** A PROXIMAL RADIUS OF *BARBERAPITHECUS HUERZELERI* (PRIMATES, PLIOPITHECIDAE) FROM THE MIOCENE SITE OF CASTELL DE BARBERÀ (NE IBERIAN PENINSULA)

52 **Alba, D., Delson, E., Colombero, S., Delfino, M., Pavia, M.** OLDEST JOINT RECORD OF *MACACA* AND *MESOPITHECUS* (PRIMATES, CERCOPITHECIDAE) BASED ON MATERIAL FROM THE LATEST MIOCENE OF MONCUCCO TORINESE (ITALY)

53 **Smith, H.** EVOLUTION AND GENETIC DISTANCES OF NEANDERTAL AND ANATOMICALLY MODERN HUMAN (AMH) FOSSILS AS INDICATED BY BASICRANIAL MORPHOLOGY.

54 **Heck, C., Wilson, H., Varricchio, D., Jackson, F., Jin, X.** EVALUATING DEFORMATION IN *SPHEROOLITHUS* DINOSAUR EGGS FROM ZHEJIANG, CHINA

55 **Oser, S.** NEW FOSSIL EGGS, EGGSHELL, AND PERINATAL OSTEOLOGICAL REMAINS FROM THE EGG MOUNTAIN LOCALITY, UPPER CRETACEOUS TWO MEDICINE FORMATION, MONTANA, USA

56 **Watabe, M., Fastovsky, D., Tsogtbaatar, K., Chinzorig, T.** DINOSAUR EGGSHELL OOFAUNA FROM THE NEMEGT AND BARUNGOYOT FORMATIONS IN THE GOBI DESERT, MONGOLIA - TAXONOMY AND TAPHONOMY

57 **Mcdonald, A., Wolfe, D., Hedrick, B., Cordero, S., Laing, A.** NEW DISCOVERIES OF DINOSAURS AND OTHER VERTEBRATES FROM THE UPPER CRETACEOUS (CAMPANIAN) MENEFEE FORMATION OF NEW MEXICO

58 **Stubbs, A., Boyd, C., Ksepka, D.** QUANTIFYING HISTORICAL PATTERNS IN THE STRATIGRAPHIC COMPLETENESS OF THE DINOSAUR FOSSIL RECORD

59 **Lockley, M., Houck, K., Lim, J., Kim, K.** A NEW DINOSAUR FREEWAY IN THE CRETACEOUS OF WESTERN COLORADO: TOWARDS A WORLD CLASS TETRAPOD TRACK SAMPLE AND DATABASE FOR THE CRETACEOUS DAKOTA GROUP

60 **Platt, B., Shell, R., Suarez, C., Boss, S., Williamson, M.** THE FIRST THEROPOD TRACKWAYS FROM THE LOWER CRETACEOUS (ALBIAN) DE QUEEN FORMATION, SOUTHWEST ARKANSAS

61 **Suarez, C., Boss, S., Platt, B., Shell, R., Williamson, M.** PRESERVATION OF LARGE THEROPOD AND SAUROPOD TRACKWAYS FROM THE LOWER CRETACEOUS DEQUEEN FORMATION, ARKANSAS USING LIDAR: CREATING A VIRTUAL TRACKWAY LAB FOR USE IN TEACHING INTRODUCTORY AND UPPER DIVISION LABORATORIES

62 **Viefhaus, H., Nguyen Tuan, L., Lins, Y., Marty, D., Schanz, T.** ANALYSIS OF DESICCATION CRACK PATTERN FOR QUANTITATIVE INTERPRETATION OF DINOSAUR TRACKS

63 **Stoller, H., Rowland, S.** TRACKS OF DINOSAURS, SYNAPSIDS, AND ARTHROPODS IN THE AZTEC SANDSTONE OF SOUTHERN NEVADA: A FINAL REPORT

Corresponding board numbers in left hand column

64 **Gorscak, E., O'Connor, P.** INTEGRATING TEMPORAL DATA WITHIN A PHYLOGENETIC ANALYSIS: A BAYESIAN APPROACH FOR CHARACTERIZING DIVERGENCE ESTIMATES IN AN EXTINCT CLADE

65 **Fairman, J., Nabavizadeh, A., Weishampel, D.** EARLY SAUROPODOMORPH JAW APPARATUS ANATOMY: A COMPARATIVE STUDY WITH IGUANIAN LIZARDS

66 **Moacdieh, E.** VARIATION IN SAUROPOD (DINOSAURIA: SAUROPODA) CERVICAL CENTRUM LENGTH

67 **D'Emic, M., Sereno, P.** BONE HISTOLOGY OF SAUROPOD DINOSAURS FROM NIGER

68 **Fronimos, J., Wilson, J.** FUNCTION AND POLARITY OF CONCAVO-CONVEX ARTICULATIONS IN THE VERTEBRAL CENTRA OF SAUROPOD DINOSAURS WITH IMPLICATIONS FOR OTHER VERTEBRATES

69 **Machado, E., Avilla, L., Nava, W., Campos, D., Kellner, A.** A NEW TITANOSAUR (DINOSAURIA, SAUROPODA) FROM THE LATE CRETACEOUS BAURU BASIN, BRAZIL

70 **Knoll, F., Witmer, L., Ridgely, R., Ortega, F., Sanz, J.** A NEW TITANOSAURIAN SAUROPOD NEUROCRANIUM FROM THE LATE CRETACEOUS OF SPAIN

71 **Riff, D., Costa, A., Machado, E.** NEW INFORMATION ON TITANOSAURIDAE REMAINS (DINOSAURIA, SAUROPODA) FROM THE MARILIA FORMATION (MAASTRICHTIAN, BAURU BASIN) OF CAMPINA VERDE, MINAS GERAIS STATE, BRAZIL

72 **Poropat, S., Hocknull, S., Kear, B., Elliott, D.** PALEOBIOGEOGRAPHIC IMPLICATIONS OF AUSTRALIA'S CRETACEOUS SAUROPODS

73 **Díez Díaz, V., Ortega, F., Sanz, J.** MICROWEAR PATTERNS OF THE TITANOSAURIAN TEETH FROM THE LATE CRETACEOUS OF "LO HUECO" (CUENCA, SPAIN)

74 **Yoshida, J., Carpenter, K., Kobayashi, Y.** NEW SAUROPOD FROM THE CEDAR MOUNTAIN FORMATION OF UTAH, USA

75 **Wings, O., Berensmeier, M.** UNIQUE TAPHONOMY OF THE DWARFED SAUROPOD *EUROPASAURUS* FROM LATE JURASSIC MARINE STRATA OF THE LANGENBERG QUARRY (LOWER SAXONY, NORTHERN GERMANY)

76 **Whitlock, J., D'Emic, M., Smith, K.** COMPLEX TOOTH HISTOLOGY IN A SAUROPOD DINOSAUR

77 **Foster, J.** A SMALL SAUROPOD DINOSAUR (*HAPLOCANTHOSAURUS*?) FROM THE LOWER MORRISON FORMATION (UPPER JURASSIC) OF CENTRAL COLORADO

78 **Schmitt, A., Tschopp, E., Knoll, F., Sander, M.** PALEONEUROANATOMY AND BRAINCASE MORPHOLOGY INDICATES THE PRESENCE OF AT LEAST TWO DIPLODOCINE TAXA (DINOSAURIA: SAUROPODA) AT HOWE RANCH (WYOMING, USA)

79 **Mocho, P., Royo-Torres, R., Ortega, F., Silva, B.** MACRONARIAN RECORD FROM THE UPPER JURASSIC OF PORTUGAL

80 **Mateus, O., Tschopp, E.** *CATHETOSAURUS* AS A VALID SAUROPOD GENUS AND COMPARISONS WITH *CAMARASAURUS*

Corresponding board numbers in left hand column

81 **Krupandan, E., Otero, A., Chinsamy-Turan, A.** PRELIMINARY PHYLOGENETIC AND HISTOLOGICAL ANALYSIS OF A LATE TRIASSIC SAUROPODOMORPH FROM THE LOWER ELLIOT FORMATION OF LESOTHO

82 **Apaldetti, C., Pol, D., Martinez, R.** EVOLUTIONARY PATTERNS AND MORPHOLOGICAL DISPARITY OF SAUROPODOMORPHS OVER THE TRIASSIC–JURASSIC BOUNDARY

83 **Läbe, S., Sander, P., Schanz, T., Preuschoft, H., Witzel, U.** GAIT RECONSTRUCTION FROM SAUROPOD TRACKWAYS USING PHOTOGRAMMETRY AND SOIL MECHANICAL FINITE ELEMENT ANALYSIS: A CASE STUDY FROM THE MIDDLE KIMMERIDGIAN BARKHAUSEN TRACKSITE, GERMANY

84 **Farlow, J., Falkingham, P. L., Bates, K.** A PHOTOGRAMMETRIC RECREATION OF ROLAND T. BIRD'S PALUXY RIVER THEROPOD-SAUROPOD "CHASE SEQUENCE" TRACKSITE QUARRY (GLEN ROSE FORMATION, LOWER CRETACEOUS, DINOSAUR VALLEY STATE PARK, SOMERVELL COUNTY, TEXAS)

85 **Iijima, M., Kobayashi, Y.** CONVERGENCES AND TRENDS IN THE EVOLUTION OF THE ARCHOSAUR PELVIS

86 **Lucas, S., Spielmann, J., Rinehart, L., Sullivan, R.** THE MOST COMPLETE JUVENILE PHYTOSAUR SKULL: *REDONDASAURUS* FROM THE UPPER TRIASSIC CHINLE GROUP AT GHOST RANCH, NEW MEXICO

87 **Rubilar-Rogers, D., Ezcurra, M., Irmis, R., Desojo, J., Soto-Acuña, S.** A SILESAURID (ARCHOSAURIA: DINOSAURIFORMES) FROM THE TRIASSIC OF THE ATACAMA DESERT, CHILE

88 **Heckert, A., Schneider, V., Fraser, N., Webb, R.** THE AETOSAUR (ARCHOSAURIA: SUCHIA) FAUNA OF THE UPPER TRIASSIC PEKIN FORMATION (NEWARK SUPERGROUP), DEEP RIVER BASIN, NORTH CAROLINA, USA, AND ITS IMPLICATIONS FOR THE PHYLOGENY AND BIOSTRATIGRAPHY OF AETOSAURS

89 **Nesbitt, S., Flynn, J., Ranivoharimanina, L., Pritchard, A., Wyss, A.** RELATIONSHIPS AMONG THE BIZARRE: THE ANATOMY OF *AZENDOHSAURUS MADAGASKARENSIS* AND ITS IMPLICATIONS FOR RESOLVING EARLY ARCHOSAURMORPH PHYLOGENY

90 **Sookias, R., Sennikov, A., Butler, R.** REDESCRIPTION AND PHYLOGENETIC ASSESSMENT OF THE BASAL ARCHOSAURIFORM *DOROSUCHUS NEOETUS* FROM THE MIDDLE TRIASSIC OF RUSSIA

91 **Tennant, J.** COMPARATIVE ECOMORPHOLOGY OF ORNITHOPOD AND RUMINANT SNOUTS - A GEOMETRIC MORPHOMETRIC APPROACH

92 **Button, D.** BIOMECHANICAL EVIDENCE FOR NICHE PARTITIONING BETWEEN SYMPATRIC SAUROPOD DINOSAURS

93 **Vitek, N.** NEW PATTERNS OF SPATIOTEMPORAL VARIATION IN THE EASTERN BOX TURTLE (*TERRAPENE CAROLINA*) AND THEIR INFLUENCE ON EVOLUTIONARY HYPOTHESES

94 **Tanaka, K.** EGGSHELL POROSITY REVEALS NEST TYPES AND INCUBATION BEHAVIOR IN ARCHOSAURS

95 **Vietti, L.** INSIGHTS INTO THE MICROBIAL DEGRADATION OF BONE IN MARINE ENVIRONMENTS: GENETIC SEQUENCING OF BIOFILMS FROM LAB-SIMULATED WHALE-FALLS

Corresponding board numbers in left hand column

96 **Miller-Camp, J.** WHEN SPECIALISTS BECOME GENERALISTS: LONGIROSTRY IN *ALLIGATOR*

97 **Winkler, D.** ENAMEL RIDGE ALIGNMENT IN UNGULATES: A CUT ABOVE

98 **Yi, H.** INNER-EAR MORPHOLOGY SUGGESTS BURROWING BEHAVIOUR IN EARLY SNAKES

99 **Kawabe, S.** ENIGMATIC AFFINITY IN BRAIN MORPHOLOGY BETWEEN PLOTOPTERIDS AND PENGUINS WITH COMPREHENSIVE COMPARISON AMONG WATER BIRDS

100 **Metello, T.** *DIOGENORNIS FRAGILIS*, THE OLDEST RATITE: CLAWS, LOCOMOTOR BEHAVIOR AND TAXONOMIC IMPLICATIONS

101 **Jones, M.** RECOGNIZING BAT TRACKS AND TRACKWAYS IN THE FOSSIL RECORD: PROPOSED MORPHOLOGICAL CRITERIA BASED ON TRACKWAYS OF THE NEOTROPICAL FRUIT BAT *CAROLLIA PERSPICILLATA*

102 **Hattori, S.** EVOLUTION OF THE PEDAL FUNCTION IN NON-AVIAN THEROPODS

103 **Atterholt, J.** DISSECTING DINOSAURS: THE USE OF RESEARCH SPECIMENS IN HIGH SCHOOL BIOLOGY CLASSROOMS TO ENGAGE STUDENTS AS CITIZEN SCIENTISTS AND PROMOTE SCIENTIFIC LITERACY

104 **Marrs, B., Scott, E.** THE EVO-ECO-BIO CURRICULUM: HELPING SECONDARY SCHOOL STUDENTS DISCOVER, EXPERIENCE, AND CONNECT TO THEIR LIFE HISTORY, TO THEIR BIOSPHERE, AND TO PROCESSES IN NATURE

105 **Early, C., Hall, M.** TEEN SCIENCE CAFÉS: A NOVEL WAY TO ENGAGE FUTURE SCIENTISTS

106 **Cussen, L., Mychajliw, A., Hadly, E.** CONSERVING AND UNDERSTANDING A MAMMALIAN "LIVING FOSSIL" *SOLENODON PARADOXUS*, THROUGH PALEONTOLOGICAL OUTREACH IN THE DOMINICAN REPUBLIC

107 **Wilkins, W., Pagnac, D., Ellingsen, M.** CHEWING THE FAT WITH *ARCTODUS*: COLLABORATIVE UNDERGRADUATE DEVELOPMENT OF A CALIBRATE APPARATUS FOR USE IN BITE FORCE RESEARCH

108 **Daniel, J.** PALEOAERIE: MULTIPLE AVENUES BRINGING EVOLUTION EDUCATION TO FORMAL AND INFORMAL EDUCATORS AND THE PUBLIC AT THE SAME TIME

109 **Toth, N., Seppi, J.** "WHAT ROCK IS THAT?" (AND OTHER COMMON 4TH GRADE QUESTIONS)- A FREE PROFESSIONAL DEVELOPMENT OPPORTUNITY FOR TEACHERS WITH NHMU

110 **Chiappe, L., Bell, A., Kisiel, J.** PROYECTO DINOSAURIOS – A MENTOR-CENTERED APPROACH TO ENGAGING UNDER-REPRESENTED STUDENTS IN PALEONTOLOGICAL RESEARCH

111 **Gallagher, W., Browne, K.** REDESIGNING THE DINOSAURS COURSE: AN INQUIRY-BASED APPROACH TO TEACHING PALEONTOLOGY

112 **Desantis, L., Lashinsky, N., Romer, J., Greshko, M., Loffredo, L.** UNIVERSITY STUDENTS' ACCEPTANCE OF CLIMATE CHANGE AND EVOLUTION: ARE SKEPTICS JUST ANTI-SCIENCE?

113 **Desantis, D., Desantis, L.** IMMERSION OF EVOLUTIONARY CONCEPTS ACROSS SCIENCE CURRICULA

Corresponding board numbers in left hand column

114 **Gensler, P., Morgan, G., Moore, J., Aby, S., Foss, S.** USING PARTNERSHIPS AND VOLUNTEERS TO MANAGE MIOCENE-AGED (HEMINGFORDIAN-BARSTOVIAN NALMA) PALEONTOLOGICAL RESOURCES ON BLM LANDS IN THE ESPANOLA BASIN OF NEW MEXICO

115 **Shinya, A.** USE OF SILICONE CAULK AS A SEPARATOR FOR FIELD JACKETS

116 **Schubert, B., Cox, S., Coltrain, J.** THE SIGNIFICANCE OF RANCHO LA BREA FOR INTERPRETING THE PALEOBIOLOGY OF GIANT SHORT-FACED BEARS

117 **Fuller, B., Fahrni, S., Harris, J., Farrell, A., Southon, J.** RADIOCARBON DATING AND ISOTOPIC ANALYSIS OF PLEISTOCENE FAUNA FROM PROJECT 23 AT RANCHO LA BREA: A NOVEL METHOD FOR TAR REMOVAL FROM BONE COLLAGEN BY ULTRAFILTRATION

118 **Brown, K., Scott, E., Akersten, W.** *EQUUS OCCIDENTALIS* LEIDY FROM ASPHALTO, KERN COUNTY, CALIFORNIA

119 **Hartstone-Rose, A., Donadeo, B., Boyde, B., Long, R., Farrell, A.** BROKEN AND HEALED BACULA OF LA BREA: A WHOLE NEW DEFINITION OF TOUGH TIMES!

120 **Sholts, S., Wärmländer, S., Carlson, J., Hlusko, L.** DENTAL HISTOLOGY OF DIRE WOLF FOSSILS FROM TAR SEEP DEPOSITS: TAPHONOMIC CONSIDERATIONS FOR LIFE HISTORY STUDIES

121 **Akersten, W., Jefferson, G.** THE ASPHALTO/MCKITTRICK COMPLEX: QUATERNARY FOSSILS ASSOCIATED WITH ASPHALT DEPOSITS FROM THE SOUTHWESTERN MARGIN OF THE SAN JOAQUIN VALLEY, 23 KM NORTHEAST OF TAFT, KERN COUNTY, CALIFORNIA

122 **Cadenillas, R., Martinez, J., Czaplewski, N.** ADDITIONAL BATS FROM THE LATE PLEISTOCENE OF THE TALARA TAR SEEPS (NORTHWESTERN PERU) - PALEOENVIRONMENTAL IMPLICATIONS

123 **Solorzano, A., Rincon, A., Mcdonald, H.** A NEW MAMMAL ASSEMBLAGE FROM THE LATE PLEISTOCENE EL BREAL DE OROCUAL, NORTHEAST OF VENEZUELA

124 **Zapata, J., Martinez, J., Rincon, A.** SIGMODONTINE RODENTS FROM THE LATE PLEISTOCENE OF THE TALARA TAR SEEPS (NORTHWESTERN PERU) - SYSTEMATICS, PALEOENVIRONMENTAL INFERENCES, AND PRELIMINARY TAPHONOMIC STUDY

Corresponding board numbers in left hand column

FRIDAY MORNING, NOVEMBER 1, 2013

Technical Session IX

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: Joseph Sertich and Ashley Morhardt

8:00 **Brink, K., Leblanc, A., Evans, D., Reisz, R.** PREVALENCE, ORIGIN, AND ANATOMY OF DENTICLE AMPULLAE IN THEROPOD DINOSAUR TEETH

8:15 **Gates, T., Zanno, L.** OSSIFIED CRANIAL ORNAMENTATION CORRELATES WITH MID- TO LARGE-BODY MASS IN THEROPOD DINOSAURS

8:30 **You, H., Azuma, Y., Wang, T., Dong, Z.** A NEW COELOPHYSOID THEROPOD DINOSAUR FROM THE EARLY JURASSIC LUFENG FORMATION OF YUNNAN PROVINCE, CHINA

8:45 **Sertich, J., O'Connor, P., Seiffert, E., Manthi, F.** A GIANT ABELISAURID THEROPOD FROM THE LATEST CRETACEOUS OF NORTHERN TURKANA, KENYA

9:00 **Burch, S.** THE MYOLOGICAL CONSEQUENCES OF EXTREME LIMB REDUCTION: NEW INSIGHTS FROM THE FORELIMB MUSCULATURE OF ABELISAURID THEROPODS

9:15 **Miyashita, T., Currie, P., Paulina-Carabajal, A.** A NEW SPECIES OF *DASPLETOSAURUS* (THEROPODA: TYRANNOSAURIDAE) FROM THE CAMPANIAN OF SOUTHERN ALBERTA REPRESENTED BY A GROWTH SERIES OF WELL-PRESERVED SKULLS AND SKELETONS

9:30 **Lee, Y., Barsbold, R., Currie, P., Kobayashi, Y., Lee, H.** NEW SPECIMENS OF *DEINOCHEIRUS MIRIFICUS* FROM THE LATE CRETACEOUS OF MONGOLIA

9:45 **Balanoff, A., Bever, G., Norell, M.** THE RELATIONSHIPS OF OVIRAPTOROSAUR DINOSAURS AND ENDOCRANIAL EVOLUTION ALONG A MORPHOLOGICALLY BIZARRE LINEAGE

10:00 BREAK

10:15 **Kobayashi, Y., Lee, Y., Barsbold, R., Zelenitsky, D., Tanaka, K.** FIRST RECORD OF A DINOSAUR NESTING COLONY FROM MONGOLIA REVEALS NESTING BEHAVIOR OF THERIZINOSAUROIDS

10:30 **Morhardt, A., Ridgely, R., Varricchio, D., Witmer, L.** NEW STUDIES OF BRAINCASE ANATOMY, BRAIN SIZE, AND BRAIN STRUCTURE IN THE LATE CRETACEOUS THEROPOD *TROODON FORMOSUS* (DINOSAURIA: SAURISCHIA) BASED ON CT SCANNING AND 3D VISUALIZATION

10:45 **Persons, W., Xing, L., Bell, P., Currie, P., Miyashita, T.** NEW DIRECT AND MORPHOLOGICALLY-INFERRED EVIDENCE OF PISCIVORY IN *MICRORAPTOR*

11:00 **Smith, R., Mancuso, A., Pol, D., Marsicano, C.** TAPHONOMY OF A DINOSAUR BREEDING COLONY IN SOUTHERN PATAGONIA

11:15 **Mannion, P., Schwarz-Wings, D., Upchurch, P., Wings, O., Rauhut, O.** TAXONOMIC AFFINITIES AND BIOGEOGRAPHIC IMPLICATIONS OF THE PUTATIVE TITANOSAURS (DINOSAURIA: SAUROPODA) FROM THE LATE JURASSIC TENDAGURU FORMATION OF TANZANIA

11:30 **Li, L., You, H., Li, D., Dodson, P.** A NEW, EARLY CRETACEOUS TITANOSAURIFORM SAUROPOD DINOSAUR WITH UNIQUE OSTEOLOGY FROM THE HEKOU GROUP OF LANZHOU BASIN, GANSU PROVINCE, CHINA

11:45 **Wilson, J., Allain, R.** OSTEOLOGY OF *REBBACHISAURUS GARASBAE*, A DIPLODOCOID (DINOSAURIA: SAUROPODA) FROM THE EARLY LATE CRETACEOUS KEM KEM BEDS OF SOUTHEASTERN MOROCCO

FRIDAY MORNING, NOVEMBER 1, 2013

Technical Session IX (CONTINUED)

12:00 **Ullmann, P., Bonnan, M., Lacovara, K.** MORPHOMETRIC EXPLORATION OF THE EVOLUTION OF WIDE GAUGE FEATURES IN THE STYLOPODIAL LIMB ELEMENTS OF TITANOSAURIFORM SAUROPODS

FRIDAY MORNING, NOVEMBER 1, 2013

Symposium 3: The Tempo of Vertebrate Evolution: Geochronologic Advances in Dating the Fossil Record

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: Randall Irmis and Eric Roberts

8:00 **Bowring, S., Blackburn, T., Burgess, S., Ramezani, J.** EARTHTIME: HIGH PRECISION GEOCHRONOLOGY AND THE CALIBRATION OF EARTH HISTORY

8:15 **Rasbury, T., Cole, J., Parrish, R., Bowring, S., Lanzirotti, A.** U-PB DATING OF CARBONATES FROM TERRESTRIAL VERTEBRATE FAUNA-BEARING UNITS

8:30 **Mundil, R., Irmis, R.** THE INS AND OUTS OF HIGH-RESOLUTION GEOCHRONOLOGY APPLIED TO STRATIGRAPHIC PROBLEMS

8:45 **Hemming, S., Fire Clay Group, Earthtime** 40AR/39AR SANIDINE AND U-PB ZIRCON TESTS FOR A CARBONIFEROUS-AGE NATURAL GEOCHRONOLOGY STANDARD

9:00 **Rubidge, B., Erwin, D., Ramezani, J., Bowring, S., Day, M.** U/PB RADIOMETRIC DATES FROM THE KAROO SUPERGROUP (SOUTH AFRICA) ENABLE CORRELATION OF PERMIAN CONTINENTAL SEDIMENTARY SUCCESSIONS AND CONSTRAIN MID-LATE PERMIAN TETRAPOD BIODIVERSITY CHANGES

9:15 **Kent, D., Olsen, P., Muttoni, G.** INTEGRATION OF MAGNETIC POLARITY STRATIGRAPHY AND ORBITAL CYCLOSTRATIGRAPHY TOWARDS A LATE TRIASSIC CHRONOLOGY

9:30 **Irmis, R., Mundil, R., Marsicano, C., Mancuso, A.** U-PB DATING OF REDEPOSITED VOLCANICS IN NON-MARINE SEDIMENTARY STRATA: CASE STUDIES FROM THE EARLY MESOZOIC

9:45 **Trujillo, K., Chamberlain, K.** THE MORRISON FORMATION U/PB DATING PROJECT: USING HIGH-PRECISION, CHEMICAL ABRASION (CA-TIMS), SINGLE ZIRCON, ASHFALL DATES FOR CHRONOSTRATIGRAPHIC CORRELATIONS

10:00 BREAK

10:15 **Britt, B., Greenhalgh, B., Mori, H., Mackay Sorensen, A., Scheetz, R.** PRELIMINARY SEQUENCE STRATIGRAPHY OF THE CEDAR MOUNTAIN FORMATION OF UTAH WITH U-PB LA-ICP-MS DETRITAL ZIRCON AGES FOR EACH SEQUENCE

10:30 **Tucker, R., Roberts, E., Salisbury, S.** ADVANCES IN DATING THE LATE CRETACEOUS VERTEBRATE RECORD OF NORTHEASTERN AUSTRALIA USING U-PB LA-ICMPS DETRITAL ZIRCON GEOCHRONOLOGY

10:45 **Eberth, D., Roberts, E., Deino, A., Bowring, S., Ramezani, J.** TWENTY-THREE YEARS OF RADIOMETRIC DATING AT DINOSAUR PROVINCIAL PARK (UPPER CRETACEOUS, ALBERTA, CANADA)

11:00 **Roberts, E., O'Connor, P., Stevens, N.** A SYSTEMATIC APPROACH TO DATING MESOZOIC-PALEOGENE CONTINENTAL VERTEBRATE ASSEMBLAGES IN AFRICA

FRIDAY MORNING, NOVEMBER 1, 2013

Symposium 3: The Tempo of Vertebrate Evolution: Geochronologic Advances in Dating the Fossil Record (CONTINUED)

11:15 **Renne, P., Sprain, C., Wilson, G., Clemens, W.** $^{40}AR/^{39}AR$ GEOCHRONOLOGY OF THE LANCIAN-TORREJONIAN INTERVAL, HELL CREEK REGION, MONTANA

11:30 **Clyde, W., Barnum, T., Krause, J., Ibañez-Mejia, M.** NEW MAGNETOSTRATIGRAPHIC AND RADIOISOTOPIC RESULTS FROM THE RÍO CHICO GROUP IN THE LAS FLORES AREA OF THE SAN JORGE BASIN (PATAGONIA, ARGENTINA); IMPLICATIONS FOR THE TEMPORAL CALIBRATION OF PALEOGENE SOUTH AMERICAN LAND MAMMAL AGES

11:45 **Riedel, J., Clyde, W., Stucky, R., Raynolds, B.** MAGNETOSTRATIGRAPHY ACROSS THE WASATCHIAN/BRIDGERIAN NORTH AMERICAN LAND MAMMAL AGE BOUNDARY IN THE WIND RIVER BASIN, WYOMING

12:00 **Tsukui, K., Flynn, J., Ramezani, J., Machlus, M., Bowring, S.** TEMPORAL CALIBRATION OF THE BRIDGERIAN NORTH AMERICAN LAND MAMMAL AGE (NALMA): MAGNETOSTRATIGRAPHY AND HIGH PRECISION U-PB ZIRCON GEOCHRONOLOGY OF THE MIDDLE EOCENE BRIDGER FORMATION, WYOMING

FRIDAY MORNING, NOVEMBER 1, 2013

Technical Session X

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Kaitlin Clare Maguire and David Patterson

8:00 **Fisher, D., El Adli, J., Calamari, Z.** 3D OSTEOLOGY OF THE AMERICAN MASTODON

8:15 **Cherney, M., Calamari, Z., Fisher, D.** NO OBSERVED EFFECTS OF CLIMATE CHANGE ON SNOWMASS MASTODON TUSK GROWTH

8:30 **Yann, L., Desantis, L., Koch, P., Lundelius, E.** THE INFLUENCE OF FEEDING ECOLOGY ON THE DISTRIBUTION OF NORTH AMERICAN PLEISTOCENE CAMELIDS

8:45 **Secord, R., Lilienthal, N.** SHIFTING ENVIRONMENTS AND CONTROLS ON BODY SIZE IN PLEISTOCENE HORSES FROM THE GREAT PLAINS

9:00 **Terry, R., Koch, P.** DYNAMICS OF HOLOCENE ABUNDANCE AND RESOURCE USE IN DESERT MICE

9:15 **Maguire, K.** TESTING FOR ECOLOGICAL NICHE STABILITY OF MAMMALIAN SPECIES FROM THE LAST GLACIAL MAXIMUM TO PRESENT

9:30 **Cerling, T., Harris, J., Leakey, M., Levin, N., Manthi, F.** ECOLOGICAL CHANGES IN THE TURKANA BASIN OVER 4 MA

9:45 **Patterson, D., Faith, T., Bobe, R., Wood, B.** A COMPARISON OF THE FOSSIL EVIDENCE OF THREE MAMMALIAN FAMILIES FROM EAST AND SOUTHERN AFRICA OVER THE PAST 3 MILLION YEARS: THE EFFECTS OF SAMPLING BIAS

10:00 BREAK

10:15 **Souron, A., Bibi, F., Bocherens, H., Uno, K., Boisserie, J.** DECOUPLING BETWEEN MORPHOLOGY AND STABLE CARBON ISOTOPES IN PLIO-PLEISTOCENE HERBIVEROUS MAMMALS FROM THE SHUNGURA FORMATION (LOWER OMO VALLEY, ETHIOPIA)

FRIDAY MORNING, NOVEMBER 1, 2013

Technical Session X (CONTINUED)

10:30 **Garrett, N., Fox, D., Tryon, C., Faith, J., Peppe, D.** STABLE ISOTOPIC PALEOENVIRONMENTAL RECONSTRUCTION OF THE LATE PLEISTOCENE SITES ON RUSINGA AND MFANGANO ISLANDS, LAKE VICTORIA, KENYA

10:45 **Gilbert, C., Bibi, F., Hill, A., Beech, M., Rossie, J.** EARLY OLD WORLD MONKEYS FROM AFRICA AND ARABIA: IMPLICATIONS FOR THE ORIGINS AND BIOGEOGRAPHY OF MAJOR CERCOPITHECID CLADES

11:00 **Begun, D.** OLDEST DIRECT EVIDENCE OF DENTAL DEVELOPMENTAL DELAY AND ENCEPHALIZATION IN A LATE MIOCENE HOMININE.

11:15 **Eastham, L., Feranec, R., Begun, D., Kordos, L.** STABLE ISOTOPE AND TRACE ELEMENT PALEOECOLOGY OF THE RUDABÁNYA FAUNA DURING THE LATE MIOCENE

11:30 **Madern, A., Casanovas Vilar, I., Alba, D., Demiguel, D., Van Den Hoek Ostende, L.** THE ABRUPT COLLAPSE OF A DIVERSITY HOTSPOT? RECONSIDERING VALLESIAN (LATE MIOCENE) DIVERSITY IN ITS TYPE AREA

11:45 **Smiley, T., Badgley, C., Finarelli, J.** MIOCENE MAMMAL DIVERSITY IN RELATION TO TECTONIC AND CLIMATIC HISTORY OF THE BASIN AND RANGE PROVINCE

12:00 **Wang, X., Tseng, Z., Slater, G., Takeuchi, G., Li, Q.** MIO-PLIOCENE CARNIVORANS FROM WESTERN TIBET AND THE EARLIEST RECORD OF PANTHERINE FELIDS

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Technical Session XI

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: Patricia Holroyd and Catherine Badgley

1:45 **Foreman, B., Hajek, E., Straub, K.** PROCESSED-BASED ESTIMATES OF STRATIGRAPHIC COMPLETENESS: IMPLICATIONS FOR THE ALLUVIAL VERTEBRATE FOSSIL RECORD

2:00 **Holroyd, P., Rankin, B., Ferrer, E.** THE MYSTERY OF THE MISSING MARSUPIALS AND THE PROBLEM OF DETECTION BIAS

2:15 **Fraser, D., Hassall, C., Gorelick, R., Rybczynski, N.** GLOBAL CLIMATE DRIVES TEMPORAL PATTERNS OF NORTH AMERICAN MAMMAL BETA DIVERSITY

2:30 **Darroch, S., Longrich, N., Webb, A., Belmaker, J.** PALEOCENE-EOCENE EVOLUTION OF BETA-DIVERSITY AMONG UNGULATE MAMMALS IN NORTH AMERICA

2:45 **Morse, P., Wood, A., Bloch, J.** CHANGES IN DENTAL DEVELOPMENT IN TWO HERBIVOROUS MAMMAL TAXA FOLLOWING THE PALEOCENE-EOCENE THERMAL MAXIMUM IN THE BIGHORN BASIN, WYOMING

3:00 **D'Ambrosia, A., Clyde, W., Fricke, H., Snell, K., Gingerich, P.** MAMMALIAN DWARFISM ASSOCIATED WITH THE EARLY EOCENE ETM2 HYPERTHERMAL EVENT, BIGHORN BASIN, WYOMING

3:15 **Slater, G.** TEMPO OR MODE IN EVOLUTION? THE CASE OF MAMMALIAN BODY SIZE EVOLUTION

3:30 **Davis, E., Emery, M., Famoso, N., Mcguire, J.** WHEN WAS THE MODERN LATITUDINAL RICHNESS GRADIENT ESTABLISHED?

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Technical Session XI (CONTINUED)

3:45 **Lashinsky, N., Desantis, L., Yann, L., Donohue, S., Haupt, R.** IS RAPOPORT'S RULE A RECENT PHENOMENON? A DEEP TIME PERSPECTIVE ON POTENTIAL CAUSAL MECHANISMS

4:00 **Badgley, C., Domingo, S., Barry, J., Flynn, L., Morgan, M.** THREE BIOGEOGRAPHIC MODES OF CHANGE IN MIOCENE MAMMAL DIVERSITY FROM THE SIWALIK SEQUENCE OF THE INDIAN SUBCONTINENT

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Technical Session XII

Westin Bonaventure Hotel & Suites, Sacremento Ballroom

MODERATORS: Brandon Peecook and Eric Wilberg

1:45 **Butler, R., Hancox, J., Botha-Brink, J., Sennikov, A., Gower, D.** A NEW SPECIES OF THE ERYTHROSUCHID *GARJAINIA* FROM THE EARLY TRIASSIC OF SOUTH AFRICA PROVIDES NEW INSIGHTS INTO THE EARLY ARCHOSAURIFORM RADIATION

2:00 **Pritchard, A., Nesbitt, S., Turner, A., Irmis, R., Smith, N.** MORPHOLOGY AND SYSTEMATICS OF THE REPTILE CLADE TANYSTROPHEIDAE: IMPLICATIONS FOR LATE TRIASSIC BIOGEOGRAPHY AND EARLY ARCHOSAUROMORPH EVOLUTION

2:15 **Peecook, B., Huttenlocker, A. K., Sidor, C.** BONE HISTOLOGY IN NEW, EARLY SILESAURIDS (DINOSAURIFORMES) FROM ZAMBIA: IMPLICATIONS FOR THE ORIGIN OF DINOSAURIAN GROWTH PATTERNS

2:30 **Wilberg, E.** A REDESCRIPTION OF *PEIPEHSUCHUS TELEORHINUS* (CROCODYLOMORPHA: THALATTOSUCHIA) AND ITS IMPLICATIONS FOR THE ORIGIN OF TELEOSAURIDAE AND THE EVOLUTION OF MARINE ADAPTATIONS IN THALATTOSUCHIA

2:45 **Montefeltro, F., Larsson, H., Langer, M.** AN ADVANCED NEOSUCHIAN FROM THE JURASSIC OF BRAZIL

3:00 **Brochu, C., Langston, W., Rowe, T.** A NEW, PHYLOGENETICALLY SIGNIFICANT ALLIGATOROID FROM THE LATE CRETACEOUS (CAMPANIAN) OF MÉXICO

3:15 **Gignac, P., Kley, N.** INFERENCES ON THE FEEDING BIOMECHANICS OF THE BIZARRE PUG-NOSED CROCODYLIFORM *SIMOSUCHUS CLARKI*

3:30 **Moreno-Bernal, J., Head, J., Jaramillo, C.** FOSSIL CROCODYLIANS FROM THE MIOCENE-PLIOCENE OF THE HIGH GUAJIRA PENINSULA, COLOMBIA

3:45 **Nestler, J., Aiello-Lammens, M.** MODELING THE HISTORICAL RANGE OF *ALLIGATOR* AND ITS IMPLICATIONS FOR CROCODYLIANS AS PALEOCLIMATE PROXIES

4:00 **Sarrazin, J., Schachner, E., Farmer, C.** EXPLORATION OF AIRFLOW PATTERNS IN THE LUNG OF *ALLIGATOR MISSISSIPPIENSIS* (ARCHOSAURIA: CROCODYLIA) USING CFD MODELING, AND IMPLICATIONS FOR THE EVOLUTION OF UNIDIRECTIONAL AIRFLOW IN ARCHOSAURIA

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Technical Session XIII

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: Vincent Dupret and Lauren Sallan

1:45 **Choo, B., Zhu, M., Qu, Q., Yu, X.** A NEW OSTEICHTHYAN FROM THE LATE SILURIAN OF YUNNAN, CHINA AND THE OLDEST GNATHOSTOME-DOMINATED VERTEBRATE FAUNA

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Technical Session XII (Continued)

2:00 **Ahlberg, P., Blom, H., Zhu, M., Märss, T., Sanchez, S.** OSTEOLOGY AND MORPHOLOGY OF THE PROBABLE STEM-GROUP OSTEICHTHYAN *LOPHOSTEUS SUPERBUS* PANDER, FROM THE SILURIAN OF ESTONIA

2:15 **Chen, D., Ahlberg, P., Blom, H., Sanchez, S.** DENTAL DEVELOPMENT OF THE STEM OSTEICHTHYAN *ANDREOLEPIS HEDEI* REVEALED BY THREE-DIMENSIONAL SYNCHROTRON VIRTUAL PALEOHISTOLOGY

2:30 **Dupret, V., Sanchez, S., Goujet, D., Tafforeau, P., Ahlberg, P.** THE ORIGIN OF THE JAWED VERTEBRATE FACE: NEW INSIGHTS FROM A SYNCHROTRON SCANNED SKULL OF THE PRIMITIVE PLACODERM *ROMUNDINA*

2:45 **Béchard, I., Arsenault, F., Cloutier, R., Kerr, J.** EXTERNAL MORPHOLOGY OF THE DEVONIAN PLACODERM *BOTHRIOLEPIS CANADENSIS* REVISITED IN 3D

3:00 **Blais, S., Wilson, M.** ARTICULATED ISCHNACANTHID ACANTHODIAN JAWS FROM THE MOTH LOCALITY PROVIDE EVIDENCE FOR SPECIALIZED FEEDING IN EARLY DEVONIAN GNATHOSTOMES

3:15 **Johanson, Z., Meredith Smith, M., Kearsley, A., Mark-Kurik, E., Howard, C.** INVASIVE DENTINE GROWTH IN A 380-MILLION YEAR OLD FISH IS CO-OPTED FOR WOUND REPAIR IN DERMAL BONE AS THE FIRST STEP IN THE EVOLUTION OF DAMAGE REPAIR

3:30 **Coates, M., Criswell, K., Verner, E.** WARDIE NODULES UNPACKED: COMPUTED TOMOGRAPHIC INVESTIGATION OF NEWLY RECOGNIZED SPECIMENS OF *TRISTYCHIUS*, A PIVOTAL TAXON IN CHONDRICHTHYAN PHYLOGENY

3:45 **Sallan, L.** THE ONTOGENY OF ROMER'S GAP FISHES (TOURNAISIAN, CARBONIFEROUS) AND THE ESTABLISHMENT OF POST-HANGENBERG RAY-FINNED FISH (ACTINOPTERYGII) DIVERSITY

4:00 **Schumacher, B., Maltese, A.** WHEN PLANKTON RULED THE COMANCHE NATIONAL GRASSLAND: DISCOVERY OF A THIRD NORTH AMERICAN CRETACEOUS FILTER-FEEDING VERTEBRATE

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Poster Session III

Westin Bonaventure Hotel & Suites, Exhibit Hall
Authors must be present from 4:15 - 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Devlin, K., Jefcoat, B., Sumida, S.** DIGITAL MODELING AND 3D VISUALIZATION OF THE AXIAL SKELETON OF THE EARLY PERMIAN CAPTORHINID REPTILE *LABIDOSAURUS*

2 **Sumida, S., Berman, D., Jefcoat, B., Henrici, A., Martens, T.** NEW INFORMATION ON THE HINDLIMB STRUCTURE OF THE EARLY PERMIAN BOLOSAURID REPTILE *EUDIBAMUS CURSORIS*, THE EARLIEST KNOWN FACULTATIVE BIPED

3 **Imai, T., Varricchio, D., Cahoon, J., Plymesser, K.** SEDIMENTOLOGICAL ANALYSES OF EGGSHELL TRANSPORT AND DEPOSITION: IMPLICATIONS AND APPLICATION TO EGGSHELL TAPHONOMY

4 **Engelmann, G., Britt, B., Chure, D., Andrus, A., Scheetz, R.** MICROVERTEBRATES FROM THE SAINTS AND SINNERS QUARRY (NUGGET SANDSTONE: ?LATE TRIASSIC–EARLY JURASSIC): A REMARKABLE WINDOW ONTO THE DIVERSITY AND PALEOECOLOGY OF SMALL VERTEBRATES IN AN ANCIENT EOLIAN ENVIRONMENT

Corresponding board numbers in left hand column

5 **Thomson, T.** FIRST OCCURRENCE OF REPTILE TRACKS (*PROCOLOPHONICHNIUM*) FROM THE LOWER TRIASSIC MOENKOPI FORMATION (SHNABKAIB MEMBER) OF SOUTHWESTERN UTAH WITH PALEOENVIRONMENTAL IMPLICATIONS

6 **Matsumoto, R., Evans, S.** FEEDING BEHAVIOR AND THE FUNCTIONAL ANATOMY OF THE NECK IN THE LONG-SNOUTED CHORISTODERANS *CHAMPSOSAURUS* AND *SIMOEDOSAURUS* (REPTILIA: DIAPSIDA)

7 **Bailleul, A., Scannella, J., Horner, J.** ONTOGENY OF CRANIAL SUTURES IN *ALLIGATOR MISSISSIPPIENSIS*: IMPLICATIONS FOR MATURITY ASSESSMENT IN NON-AVIAN DINOSAURS

8 **Salas-Gismondi, R., Antoine, P., Clarke, J., Baby, P., Urbina, M.** CROC'S TWO REALMS: NEW CENOZOIC DISCOVERIES FROM THE AMAZONIAN BASIN AND THE PACIFIC COAST OF PERU

9 **Gold, M., Norell, M.** SIZING UP THE POSITION OF *GAVIALIS* USING GEOMETRIC MORPHOMETRICS OF CROCODYLIAN BRAINCASES

10 **King, L., Lynch, E., Schubert, B.** CRANIAL PIT DEVELOPMENT IN EXTANT AND FOSSIL *ALLIGATOR*

11 **Souza, R., Riff, D., Kellner, A.** PHYLOGENETIC ANALYSIS OF SOUTH AMERICAN GAVIALOIDS

12 **Cidade, G., Riff, D., Souza-Filho, J., Hsiou, A., Montefeltro, F.** DESCRIPTION OF NINE NEW SPECIMENS OF *MOURASUCHUS NATIVUS* (ALLIGATOROIDEA, CAIMANINAE), AND COMMENTS ON ONTOGENETIC DEVELOPMENT AND INTRASPECIFIC VARIATION OF THE SKULL TABLE

13 **Whiting, E., Hastings, A.** LATE EOCENE FOSSIL ALLIGATORS FROM NEBRASKA AND THEIR IMPLICATIONS FOR THE BIOGEOGRAPHIC ORIGIN OF *ALLIGATOR*

14 **Ehret, D., Hastings, A.** AN EOCENE OCCURRENCE OF A DYROSAURID (CROCODYLOMORPHA, MESOEUCROCODYLIA) FROM ALABAMA, USA

15 **Andrade, R., Sayão, J.** DESCRIPTIVE PALEOHISTOLOGY ON *GUARINISUCHUS MUNIZI* (DYROSAURIDAE, CROCODYLOMORPHA) LONG BONES AND THEIR INFERENCES ON ITS LIFESTYLE

16 **Burkey, M.** A PHYLOGENETIC ANALYSIS OF *WOODBINESUCHUS BYERSMAURICEI*, AND A POTENTIAL NEW CLADE OF NEOSUCHIANS

17 **Carbot-Chanona, G., Brochu, C., Buscalioni, A., Reynoso Rosales, V.** NEW LIGHT ON THE EVOLUTIONARY RELATIONSHIPS BETWEEN "THORACOSAURS" AND MODERN GHARIALS: EVIDENCE FROM A NEW GAVIALOID FROM THE LATE CRETACEOUS OF CHIAPAS, MÉXICO

18 **Leardi, J., Pol, D., Novas, F., Suárez Riglos, M.** THE POSTCRANIAL ANATOMY OF *YACARERANI BOLIVIENSIS* AND THE EVOLUTION OF THE NOTOSUCHIAN POSTCRANIAL SKELETON

19 **Godoy, P., Montefeltro, F., Langer, M.** FIRST RECORD OF ABDOMINAL CONTENTS IN FOSSIL CROCODYLIFORMES

20 **Wayrynen, K., Carrano, M.** AN ASSESSMENT OF CLOVERLY FORMATION (LOWER CRETACEOUS) CROCODYLOMORPH DIVERSITY USING TOOTH MORPHOLOGY

Corresponding board numbers in left hand column

21 **Belmonte, S., Figueiredo, R., Carvalho, L., Azevedo, S., Romano, P.** ON THE APPENDICULAR ANATOMY OF *MARILIASUCHUS AMARALI* (CROCODYLIFORMES: NOTOSUCHIA) FROM THE UPPER CRETACEOUS (BAURU GROUP) OF BRAZIL

22 **Bremer, O., Kear, B.** REASSESSMENT OF THE 'LAST' GONIOPHOLIDID: *DENAZINOSUCHUS KIRTLANDICUS* FROM THE LATE CRETACEOUS OF NEW MEXICO

23 **Brandau, D.** CROCODYLIFORM FEEDING TRACES ON CERATOPSID DINOSAURS FROM THE UPPER CRETACEOUS (LATE CAMPANIAN) KAIPAROWITS FORMATION, SOUTHERN UTAH

24 **Dinter, C., Irmis, R.** CROCODYLIFORM BITE MARKS ON AN ARTICULATED *GRYPOSAURUS* (DINOSAURIA: HADROSAURIDAE) CRANIUM FROM THE UPPER CRETACEOUS OF SOUTHERN UTAH

25 **Delcourt, R., Nascimento, P., Carvalho, A., Zaher, H.** PELVIC GIRDLE AND HIND LIMB MUSCULATURE OF *BAURUSUCHUS ALBERTOI*: A BIOMECHANICAL APPROACH

26 **Arcucci, A., Ortega, F., Pol, D., Chiappe, L.** A NEW CROCODYLOMORPH FROM THE MORRISON FORMATION (LATE JURASSIC: KIMMERIDGIAN - EARLY TITHONIAN?) FROM THE FRUITA PALEONTOLOGICAL AREA, WESTERN COLORADO, USA

27 **Drymala, S., Zanno, L., Nesbitt, S., Schneider, V.** A LARGE NEW CROCODYLOMORPH (SUCHIA, ARCHOSAURIA) WITH BIZARRE SKULL MORPHOLOGY FROM THE UPPER TRIASSIC OF NORTH CAROLINA

28 **Parker, W., Stocker, M.** THE EFFECT OF PROXY 'HOLOTYPES' ON TAXONOMIC PRACTICES FOR VERTEBRATE FOSSILS

29 **Barrett, P., Evans, D.** DINOSAUR INTEGUMENT: WHAT DO WE REALLY KNOW?

30 **Kim, J., Lee, E., Choi, M., Kim, Y.** CORRELATIVE MICROSCOPIC INVESTIGATIONS OF MICROSTRUCTURES AND PHASES FROM DINOSAUR RIB BONES AND THE ASSOCIATED MUDSTONE

31 **Howell, L., Heckert, A.** A NEW DATABASE OF DINOSAURIAN PALEOPATHOLOGY

32 **Anne, J., Wogelius, R., Edwards, N., Sellers, W., Manning, P. L.** SYNCHROTRON ANALYSIS OF PATHOLOGIC BONE: CHEMISTRY AND MORPHOLOGY IN EXTINCT AND EXTANT ARCHOSAUR BONE

33 **Xu, X., Zhao, Q., Han, F.** HOMEOTIC TRANSFORMATION IN THE EVOLUTION OF THE THEROPOD SEMILUNATE CARPAL

34 **Stiegler, J., Wang, S., Xu, X., Clark, J.** CODING INDIVIDUAL SPECIMENS AS TAXA: TEST CASES AID IN RESOLVING THE RELATIONSHIPS OF BASAL NEOTHEROPODA, GAUGE TOPOLOGICAL SENSITIVITY TO TAXON SAMPLING, AND PRODUCE NOVEL TAXONOMIC HYPOTHESES

35 **Dececchi, A., Habib, M., Larsson, H.** TESTING WING ASSISTED INCLINE RUNNING (WAIR): INVESTIGATING THE TERRESTRIAL ORIGIN OF THE AVIAN FLIGHT STROKE

36 **Pittman, M., Hutchinson, J.** THE EVOLUTION OF TAIL JOINT STIFFNESS IN OVIRAPTOROSAUR DINOSAURS AND ITS CONSEQUENCES FOR TAIL FUNCTION

Corresponding board numbers in left hand column

37 **Wang, S., Zhang, S., Xu, X.** NEW OVIRAPTORID (THEROPODA, OVIRAPTOROSAURIA) EMBRYOS FROM THE UPPER CRETACEOUS OF SOUTHERN CHINA

38 **Funston, G., Currie, P., Murray, A.** EXAMINING THE DIET OF A TOOTHLESS DINOSAUR: EVIDENCE SUPPORTING A HERBIVOROUS DIET IN *CAENAGNATHUS* (DINOSAURIA: OVIRAPTOROSAURIA)

39 **Button, K., Zanno, L.** TOOTH ENAMEL MICROSTRUCTURE OF THE EARLY CRETACEOUS THERIZINOSAURIAN *FALCARIUS UTAHENSIS* (THEROPODA, MANIRAPTORA)

40 **Smith, D.** RECONSTRUCTION OF THE BRAINCASE AND ASSOCIATED SOFT TISSUES OF THE NORTH AMERICAN THERIZINOSAUR *NOTHRONYCHUS MCKINLEYI*

41 **Dyke, G., De Kat, R., Palmer, C., Naish, D., Ganapathisubramani, B.** AERODYNAMIC PERFORMANCE OF THE FEATHERED DINOSAUR *MICRORAPTOR* AND ITS IMPLICATIONS FOR THE EVOLUTION OF FEATHERED FLIGHT

42 **Parsons, W., Parsons, K.** ONTOGENY OR PHYLOGENY? CLADISTIC PLACEMENT OF A JUVENILE DROMAEOSAURID FROM THE LOWER CRETACEOUS OF MONTANA

43 **Anduza, D., Fowler, D., Noto, C., Horner, J.** NEW ALVAREZSAURID MATERIAL FROM THE HELL CREEK FORMATION, MONTANA

44 **Mcfeeters, B., Ryan, M., Schröder-Adams, C.** NEW DATA ON A PARTIAL SKELETON REFERRED TO *STRUTHIOMIMUS ALTUS* (ORNITHOMIMIDAE) FROM DINOSAUR PROVINCIAL PARK, ALBERTA

45 **Cuff, A.** FUNCTIONAL MECHANICS OF ORNITHOMIMOSAURS

46 **Judd, H., Irmis, R., Kirkland, J.** A NEW LARGE-BODIED THEROPOD DINOSAUR FROM THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION (RUBY RANCH MEMBER) IN CENTRAL UTAH

47 **Larson, P.** THE VALIDITY OF *NANOTYRANNUS LANCENSIS* (THEROPODA, LANCIAN – UPPER MAASTRICHTIAN OF NORTH AMERICA)

48 **Bradley, G., Currie, P.** TOOTH AND POSTCRANIAL GROWTH RATES IN A JUVENILE *GORGOSAURUS LIBRATUS*

49 **Evers, S., Foth, C., Rauhut, O., Pabst, B., Mateus, O.** TRAUMATIC PATHOLOGIES IN THE POSTCRANIUM OF AN ADULT *ALLOSAURUS* SPECIMEN FROM THE MORRISON FORMATION OF THE HOWE QUARRY, WYOMING, U.S.A.

50 **Bykowski, R.** ASSESSING THE POTENTIAL FOR ONTOGENETIC ECOMORPHOLOGY IN THEROPODS: A CASE STUDY USING *ALLOSAURUS FRAGILIS* FROM THE CLEVELAND-LLOYD QUARRY

51 **Cuesta, E., Ortega, F., Sanz, J.** SOLVING THE SYNONYMY ISSUE IN *CONCAVENATOR CORCOVATUS* AND *BECKLESPINAX ALTISPINAX*, TWO DISTINCT THEROPODS FROM THE LOWER CRETACEOUS OF EUROPE

52 **Simon, D., Barta, D., Maxwell, W., Varricchio, D.** ELONGATOOLITHID (DINOSAURIA: THEROPODA) EGGSHELL FROM THE LOWER CRETACEOUS CLOVERLY FORMATION, MONTANA: A TAPHONOMIC INVESTIGATION OF APPARENT EGGSHELL DIVERSITY

53 **Ribeiro, V., Holwerda, F., Mateus, O.** THEROPOD EGG SITES FROM THE LOURINHA FORMATION, PORTUGAL

Corresponding board numbers in left hand column

FRIDAY AFTERNOON, NOVEMBER 1, 2013

Poster Session III (CONTINUED)

54 **Larson, D., Brown, C., Evans, D.** DISPARITY DYNAMICS OF SMALL THEROPOD (COELUROSAURIA: DINOSAURIA) TOOTH ASSEMBLAGES FROM THE LATE CRETACEOUS OF NORTH AMERICA

55 **Magana, J., D'Amore, D., Molnar, R., Hall, J.** IDENTIFYING ISOLATED SHED TEETH FROM THE KIRTLAND FORMATION OF NORTHWESTERN NEW MEXICO

56 **Serrano-Martínez, A., Ortega, F., Knoll, F.** ISOLATED THEROPOD TEETH FROM THE "ARGILES DE L'IRHAZER" (MIDDLE JURASSIC) OF NIGER

57 **Torices, A., Bradley, G., Currie, P.** ONTOGENETIC VARIABILITY IN UPPER CRETACEOUS THEROPOD TEETH

58 **Cullen, T., Ryan, M., Capobianco, C., Newbrey, M., Evans, D.** A VERTEBRATE MICROFOSSIL SITE WITH A TERRESTRIAL-DOMINATED FAUNAL ASSEMBLAGE FROM THE UPPER FOREMOST FORMATION (CAMPANIAN) OF ALBERTA

59 **Schwermann, A., Kullmer, O., Martin, T.** MORPHOLOGY AND FUNCTION OF THE EXTANT *DIDELPHIS* MOLAR DENTITION IN COMPARISON TO MESOZOIC DIDELPHIMORPHA

60 **Urban, D., Beck, A., Marcot, J., Sears, K.** EVOLUTIONARY TRENDS IN BODY SIZE OF THE SYNAPSID LINEAGE LEADING TO MESOZOIC MAMMALS

61 **Smith, S., Wilson, G.** MAMMALIAN DENTAL ECOMORPHOLOGY AND DISPARITY ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY: A COMPARISON OF 3D METRICS

62 **Montellano, M., Fox, R., Scott, C.** SPECIES COMPOSITION OF THE LATE CRETACEOUS EUTHERIAN MAMMAL *PARANYCTOIDES* FOX

63 **Krause, D., Hoffmann, S., Nestler, J.** FIRST ASSOCIATED UPPER DENTITION OF A GONDWANATHERIAN MAMMAL

64 **Rich, T., Trusler, P., Evans, A., Vickers-Rich, P., Siu, K.** TWO UPPER TRIBOSPHENIC MOLARS FROM THE MESOZOIC OF AUSTRALIA AND TWO HYPOTHESES

65 **Rougier, G., Martinelli, A., Schöning, M.** NEW SPECIMENS OF THE LATE CRETACEOUS MAMMAL *COLONIATHERIUM CILINSKII* (MAMMALIA, MERIDOLESTIDA): DENTAL ANATOMY, RECONSTRUCTION OF THE DENTAL SERIES, AND RELATIONSHIPS OF SOUTH AMERICAN MERIDOLESTIDS

66 **Raisanen, D., Hasiotis, S.** POTENTIAL VERTEBRATE BURROWS IN THE SALT WASH MEMBER, UPPER JURASSIC MORRISON FORMATION

67 **Schultz, J., Ruf, I., Averianov, A., Lopatin, A., Martin, T.** FIRST DOCODONT PETROSALS FROM THE MIDDLE JURASSIC OF WESTERN SIBERIA (RUSSIA)

68 **Jäger, K., Luo, Z., Martin, T.** CT SCANING AND 3D IMAGE ANALYSIS OF THE POSTCRANIAL SKELETON OF *HENKELOTHERIUM GUIMAROTAE* (CLADOTHERIA, MAMMALIA) FROM THE LATE JURASSIC OF PORTUGAL AND ITS LOCOMOTOR ADAPTATIONS

69 **Brinkkötter, J., Martin, T.** MOLAR MORPHOLOGY AND FUNCTION OF *HALDANODON EXSPECTATUS* (DOCODONTA, MAMMALIAFORMES)

70 **Templeman, T., Williamson, T.** A VERTEBRATE FAUNA FROM THE SANTONIAN – LOWER CAMPANIAN MENEFEE FORMATION, SAN JUAN BASIN, NEW MEXICO

Corresponding board numbers in left hand column

71 **Buscalioni, A., Marugan Lobon, J., De Miguel, C., Poyato-Ariza, F.** THE VERTEBRATES OF LAS HOYAS: A PRELIMINARY ASSESSMENT OF THE ROLE OF PAST AND PRESENT ECOMORPHOTYPES

72 **Sonobe, H., Kobayashi, Y., Lü, J., Barsbold, R., Chiba, K.** VERTEBRATE COPROLITES FROM THE GURVAN EREEN FORMATION (LOWER CRETACEOUS) IN TATAL, WESTERN MONGOLIA

73 **Bonde, J., Hilton, R., Jackson, F., Druschke, P.** VERTEBRATES OF THE NEWARK CANYON FORMATION (BARREMIAN?-ALBIAN?), EAST-CENTRAL NEVADA: A PRELIMINARY REPORT AND IMPLICATIONS FOR MID-CRETACEOUS GEOGRAPHY OF THE INTERMOUNTAIN WEST

74 **Martínez, R., Apaldetti, C., Praderio, A., Fernandez, E., Colombi, C.** TRIASSIC-JURASSIC BOUNDARY IDENTIFIED WITH VERTEBRATE FOSSILS IN NORTHWESTERN ARGENTINA (MARAYES-EL CARRIZAL BASIN)

75 **Harrison, A., Heckert, A., Krzyzanowski, S.** A MICROVERTEBRATE ASSEMBLAGE FROM THE UPPER TRIASSIC BLUE MESA MEMBER, PETRIFIED FOREST FORMATION (ADAMANIAN) OF THE BLUE HILLS IN EAST-CENTRAL ARIZONA

76 **Sues, H., Schoch, R.** A REMARKABLE ASSEMBLAGE OF LADINIAN-AGE VERTEBRATES FROM SOUTHERN GERMANY: A NEW WINDOW ON LATE MIDDLE TRIASSIC CONTINENTAL TETRAPOD BIODIVERSITY

77 **Egi, N., Tsubamoto, T., Watabe, M., Saneyoshi, M., Tsogtbaatar, K.** NIMRAVIDS AND STENOPLESICTIDS (MAMMALIA, CARNIVORA) FROM THE UPPER EOCENE OF MONGOLIA AND THEIR PALEOBIOGEOGRAPHIC SIGNIFICANCE

78 **Boyd, C., Welsh, E.** INVESTIGATING THE TAXONOMIC UTILITY OF SERRATION DENSITY ON THE CANINES OF NORTH AMERICAN NIMRAVID FELIFORMS

79 **Spaulding, M., Hughes, E., Flynn, J.** THE BRAIN AND INTERNAL CRANIAL ANATOMY OF *VIVERRAVUS MINUTUS* (MAMMALIA: CARNIVORAMORPHA): DETERMINING THE TIMING OF ACQUISITION OF KEY CARNIVORAMORPHAN ENDOCRANIAL CHARACTERISTICS

80 **Welsh, E.** NEW MATERIAL FROM THE RARE AMPHICYONID GENUS *PARADAPHOENUS* AND ITS IMPLICATIONS ON THE VALIDITY OF CANIFORM CARNIVORES IDENTIFIED WITHIN CHADRONIAN THROUGH ARIKAREEAN COLLECTIONS

81 **Robles, J., Madurell-Malapeira, J., Casanovas-Vilar, I., Abella, J., Alba, D.** THE SCIMITAR-TOOTHED CAT *MACHAIRODUS APHANISTUS* (CARNIVORA, FELIDAE) IN THE VALLÈS-PENEDÈS BASIN (NE IBERIAN PENINSULA): NEW REMAINS AND TAXONOMIC REVISION

82 **Anton, M., Siliceo, G., Salesa Calvo, M., Morales, J.** COMPARATIVE ANATOMY OF THE FRONTAL SINUSES OF THE SCIMITAR-TOOTHED FELID MACHAIRODUS APHANISTUS *(FELIDAE, CARNIVORA)* FROM THE LATE MIOCENE SITES OF BATALLONES-1 AND BATALLONES-3 (MADRID, SPAIN)

83 **Vinuesa, V., Madurell-Malapeira, J., Fortuny, J., Alba, D.** THE INTERNAL CRANIAL MORPHOLOGY OF THE EXTINCT BONE-CRACKING HYENA *PLIOCROCUTA PERRIERI* (CARNIVORA, HYAENIDAE)

84 **Fox, N., Wallace, S., Mead, J.** PARTITIONING OF *MUSTELA NIGRIPES* AND *MUSTELA VISON* DENTARIES FROM SNAKE CREEK BURIAL CAVE, NV.

85 **Gilmore, L.** THREE NEW PROCYONIDS FROM THE BLANCAN OF FLORIDA

Corresponding board numbers in left hand column

86 **Rincon, A., Morgan, G., Hulbert, Jr., R., Bloch, J., Wood, A.** NEW EARLY MIOCENE BASAL PROCYONIDS FROM PANAMA: THE OLDEST NORTH AMERICAN PROCYONID AND ORIGIN OF THE TRIBE POTOSINI (CARNIVORA, PROCYONIDAE).

87 **Wallace, S., Fulwood, E.** NEW SKELETON OF *PRISTINAILURUS BRISTOLI* (AILURIDAE, AILURINAE) SUGGESTS STRONG SEXUAL DIMORPHISM IN THIS RARE CARNIVORAN

88 **Mackenzie, K., Orcutt, J., Hopkins, S.** THE FIRST RECORD OF *OSBORNODON IAMONENSIS* FOR OREGON AND OTHER CANIDS OF THE ARIKAREEAN, FROM COGLAN BUTTES, OREGON

89 **Pagnac, D., Welsh, E.** NEW PERSPECTIVES ON THE DIVERSITY OF THE CANIDAE IN THE UPPER POLESLIDE MEMBER (WHITNEYAN), BRULE FORMATION, BADLANDS NATIONAL PARK, SOUTH DAKOTA

90 **Koretsky, I., Rahmat, S., Gilland, E.** ORIGINS, EVOLUTION, AND CLASSIFICATION OF TRUE SEALS AND THEIR PALEOBIOGEOGRAPHICAL IMPLICATIONS

91 **Valenzuela-Toro, A., Gutstein, C., Cozzuol, M., Pyenson, N., Suarez, M.** A NEW DWARF SEAL FROM CHILE REVEALS A HIDDEN MORPHOLOGICAL DIVERSITY OF PINNIPEDS FROM THE NEOGENE OF SOUTH AMERICA

92 **Dewar, E., Crocker, C.** CAN SKULL SHAPE INDICATE AGGRESSIVE BEHAVIOR IN SEALS?

93 **Rahmat, S., Koretsky, I., Gilland, E.** EVIDENCE OF SEXUAL DIMORPHISM WITHIN CYSTOPHORINAE (CARNIVORA, PHOCIDAE) FROM NEW MIDDLE MIOCENE SEALS OF THE NORTHERN PARATETHYS

94 **Durrani, M., Beatty, B.** MAPPING THE ORAL BIOLOGY OF THE AQUATIC TO TERRESTRIAL TRANSITION: DENTAL PATHOLOGIES AS A FUNCTION OF DIET, FEEDING LOCATION AND BEHAVIOR IN OTTERS, SEALS, AND SEA LIONS

95 **Villavicencio, N., Tomiya, S., Hofmeister, J., Lindberg, D.** FEMUR DIMENSIONS AND BODY SIZE ESTIMATION TO TRACK PREHISTORIC POPULATION CHANGES IN THE SOUTHERN SEA OTTER *ENHYDRA LUTRIS NEREIS*.

96 **Koper, L.** DISTINGUISHING DISASSOCIATED ELEMENTS OF *CANIS DIRUS* FROM *CANIS LUPUS* AT RANCHO LA BREA: LINEAR TRENDS OFFER A NEW INSIGHT INTO SPECIES IDENTIFICATION WHEN CRANIAL AND DENTAL INFORMATION IS UNAVAILABLE

97 **Curtis, A., Van Valkenburgh, B.** A THREE-DIMENSIONAL STUDY OF PARANASAL SINUSES IN CARNIVORA

98 **Balisi, M., Brown, C., Van Valkenburgh, B., Shaw, C.** WHAT CAN PALEOPATHOLOGY TELL US ABOUT HUNTING MODES?

99 **Bennett, B., Scott, K., Scott, E., Rega, E., Sumida, S.** A PATHOLOGICAL TIMBER WOLF (*CANIS LUPUS*) FEMUR INDICATES EXTENDED SURVIVAL AFTER TRAUMATIC AMPUTATION INJURY

100 **Madurell-Malapeira, J., Alba, D., Aurell-Garrido, J., Moyà-Solà, S.** NEW IBERIAN REMAINS OF THE EURASIAN JAGUAR *PANTHERA GOMBASZOEGENSIS* (CARNIVORA, FELIDAE) AND A TAXONOMIC REVISION OF EURASIAN FOSSIL JAGUAR-LIKE CATS

Corresponding board numbers in left hand column

101 **Carlon, B., Naples, V.** CONFIRMATION OF LIFESTYLES OF EXTINCT FELIDS BASED ON COMPARISON OF HOMOLOGOUS CHARACTERS OF LIVING CATS

102 **Milideo, L., Graham, R.** TAPHONOMIC INDICATORS OF WOLF DEN ASSEMBLAGES

103 **Moretti, J., Johnson, E., Arroyo-Cabrales, J., Lewis, P.** EXPLORING THE RELATIONSHIPS OF THE NORTH AMERICAN DIMINUTIVE SKUNK GENERA *SPILOGALE* AND *BUISNICTIS*

104 **Bird, D., Amirkhanian, A., Davydov, Y., Pang, B., Van Valkenburgh, B.** CRIBIFORM PLATE MORPHOLOGY AS A PROXY FOR OLFACTORY INNERVATION IN CARNIVORA

105 **Martin-Serra, A., Figueirido, B., Serrano, F., Janis, C., Palmqvist, P.** INTEGRATION PATTERNS IN THE EVOLUTION OF CARNIVORAN LIMBS: AN APPROACH BASED ON 3D GEOMETRIC MORPHOMETRICS

106 **Perez-Claros, J., Martin-Serra, A., Figueirido, B., Janis, C., Palmqvist, P.** A MORPHOMETRIC CHARACTERIZATION OF CRANIAL SHAPE IN TERRESTRIAL CARNIVORANS BASED ON FOURIER ANALYSIS

107 **Snively, E., Fahlke, J.** BITE FORCE OF THE EOCENE WHALE *BASILOSAURUS ISIS* CONSISTENT WITH POWERFUL ANTERIOR SEIZURE AND POSTERIOR CRUSHING OF LARGE PREY

108 **Sawamura, H., Ando, T., Shinmura, T.** IS THE FAMILY AETIOCETIDAE MONOPHYLETIC?

109 **Beatty, B.** THE SUBTLE HETERODONTY OF ODONTOCETES

110 **Velez-Juarbe, J., Wood, A., Ridgwell, N., Bloch, J., Macfadden, B.** PARTIAL SKELETON OF A TOOTHED WHALE (ODONTOCETI, CETACEA) FROM THE MID TO LATE MIOCENE GATUN FORMATION, PANAMA

111 **Maruyama, S.** THE ESTIMATED RANGE OF INTRASPECIFIC VARIATION IN RECENT DELPHINID SKULLS AND ITS APPLICATION FOR THE TAXONOMY OF THE EXTINCT DELPHINOIDEA

112 **Racicot, R.** PHYLOGENETIC AND FUNCTIONAL IMPLICATIONS OF INNER EAR MORPHOLOGY IN FOSSIL AND EXTANT PORPOISES (CETACEA, PHOCOENIDAE)

113 **Buchholtz, E., Roston, R.** EXTERNAL AND INTERNAL ANATOMY OF A BLUE WHALE FETUS: DOCUMENTING MILESTONES IN BALAENOPTERID DEVELOPMENT

114 **Murakami, M., Koda, Y.** A NEW DOLPHIN (CETACEA, ODONTOCETI, DELPHINIDAE) FROM THE PLIOCENE OF IBARAKI, CENTRAL JAPAN

115 **Bisconti, M.** NEW BALAENIDS FROM THE ITALIAN PLIOCENE (MAMMALIA, CETACEA, MYSTICETI)

116 **Shaw, B.** DOES SIZE MATTER? ISOMETRIC VS. ALLOMETRIC SCALING IN ARMADILLOS, PAMPATHERES, AND GLYPTODONTS (ORDER CINGULATA)

117 **Gillette, D., Carranza-Castañeda, O.** ONTOGENY AND SEXUAL DIMORPHISM IN THE NORTH AMERICAN GLYPTODONT, *GLYPTOTHERIUM* (XENARTHRA, CINGULATA)

118 **Carranza-Castañeda, O., Gillette, D.** VARIATION OF OSTEODERM ANATOMY IN THE CARAPACE OF THE NORTH AMERICAN GLYPTODONT, *GLYPTOTHERIUM* (XENARTHRA, CINGULATA)

119 **Grass, A.** COMPARISON OF ALLOMETRIC GROWTH TRAJECTORIES OF *MEGALONYX* AND *PARAMYLODON* SCAPULAE

Corresponding board numbers in left hand column

120 **Naples, V., Mcafee, R.** DELIMITING THE FORELIMB MORPHOLOGY AMONG PLEISTOCENE (ENSENADEAN-LUJANIAN) MYLODONTIDS SLOTHS (MAMMALIA, PILOSA) AND THE IMPLICATIONS FOR FUNCTIONALITY

121 **Mcafee, R.** DENTAL VARIATIONS AND ANOMALIES IN EXTINCT PILOSAN SLOTHS (MAMMALIA, XENARTHRA)

122 **Green, J., Mcafee, R.** THE INFLUENCE OF BITE FORCE ON THE FORMATION OF DENTAL MICROWEAR IN XENARTHRANS (MAMMALIA)

123 **Hilbert-Wolf, H., Roberts, E., Brown, R., O'Connor, P., Stevens, N.** DECIPHERING THE LINKS BETWEEN LANDSCAPE CHANGE AND VERTEBRATE EVOLUTION USING U/PB GEOCHRONOLOGY AND DETRITAL THERMOCHRONOLOGY: A CASE STUDY FROM THE RUKWA RIFT BASIN

124 **Jinnah, Z., Roberts, E., Dirks, P.** POTENTIAL OF DETRITAL ZIRCONS FOR PROVIDING AGE CONSTRAINTS FOR KAROO SUPERGROUP VERTEBRATES

125 **Ratsimbaholison, N., O'Connor, P., Felice, R.** ONTOGENETIC TRENDS IN THE CRANIOMANDIBULAR SKELETON OF *MAJUNGASAURUS CRENATISSIMUS* AND DERIVATION OF THE ABELISAURID SKULL MORPHOTYPE

Corresponding board numbers in left hand column

SATURDAY MORNING, NOVEMBER 2, 2013

Symposium 4: Patterns from the Poles: Biodiversity and Paleocology of High Latitude Fossil Vertebrates

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Matthew Vavrek and Nathan Smith

8:00 **Brazeau, M., Giles, S., Friedman, M.** AN OSTEICHTHYAN-LIKE SKULL FROM SIBERIA AND THE EVOLUTION OF CROWN GNATHOSTOME BRAINCASE MORPHOLOGY

8:15 **Steyer, J., Sidor, C., Hammer, W.** TRIASSIC TEMNOSPONDYLS FROM ANTARCTICA ILLUSTRATE THE RECOVERY OF HIGH-LATITUDE FAUNAS AFTER THE PERMO-TRIASSIC EXTINCTION

8:30 **Sidor, C., Huttenlocker, A. K., Peecook, B., Smith, R., Vilhena, D.** NEW DATA ON THE MIDDLE TRIASSIC TETRAPODS OF ANTARCTICA AND FAUNAL PROVINCIALIZATION ACROSS SOUTHERN PANGEA

8:45 **Andres, B., Smith, N.** THE FIRST PTEROSAUR FROM ANTARCTICA

9:00 **Makovicky, P., Boudreau, D., Hammer, W., Smith, N.** GROWTH PATTERNS OF EARLY JURASSIC ANTARCTIC DINOSAURS INFERRED FROM PALEOHISTOLOGICAL ANALYSIS

9:15 **Smith, N., Hammer, W., Makovicky, P.** ANATOMY OF A NEW SAUROPODOMORPH DINOSAUR FROM THE EARLY JURASSIC HANSON FORMATION OF ANTARCTICA

9:30 **Godefroit, P., Sinitsa, S., Dhouailly, D., Bolotsky, Y., Sizov, A.** FEATHER-LIKE STRUCTURES AND SCALES IN A JURASSIC NEORNITHISCHIAN DINOSAUR FROM SIBERIA

9:45 **Tarduno, J., Brinkman, D., Clarke, J., Bono, R., Higgins, P.** THE ULTRA-WARM ARCTIC CA. 90 MILLION YEARS AGO: CONSTRAINTS ON PALEOCLIMATE AND BIOGEOGRAPHY FROM VERTEBRATE FOSSILS

10:00 BREAK

10:15 **Vavrek, M. J., Harrison, L., Cumbaa, S., Becker, M., Larsson, H.** LATITUDINAL GRADIENTS AND PROVINCIALITY IN CHONDRICHTHYAN FAUNAS FROM THE LATE CRETACEOUS NORTH AMERICA

10:30 **Druckenmiller, P., Erickson, G., Brinkman, D., Brown, C., Mori, H.** EVIDENCE FOR A DISTINCT EARLY MAASTRICHTIAN POLAR DINOSAUR FAUNA FROM THE PRINCE CREEK FORMATION OF NORTHERN ALASKA

10:45 **Fiorillo, A., Tykoski, R.** DISTRIBUTION AND POLAR PALEOENVIRONMENTS OF LARGE THEROPOD SKELETAL REMAINS FROM THE PRINCE CREEK FORMATION (EARLY-LATE MAASTRICHTIAN) OF NORTHERN ALASKA

11:00 **Case, J.** VERTEBRATE DIVERSITY AND RESPONSE TO OCEAN TEMPERATURE DECLINE DURING THE LATEST CRETACEOUS IN THE ANTARCTIC PENINSULA

11:15 **Mörs, T., Gelfo, J., Reguero, M., Lorente, M., López, G.** THE OLDEST KNOWN (EARLY EOCENE) MAMMAL FROM ANTARCTICA

11:30 **Gottfried, M., Eberle, J., Hutchison, J.** NEW BONY FISH RECORDS FROM THE CANADIAN ARCTIC EOCENE GREENHOUSE OF BANKS ISLAND, NORTHWEST TERRITORIES

11:45 **Rybczynski, N., Fraser, D., Buckley, M., Gosse, J.** FIRST EVIDENCE FOR A HIGH ARCTIC CAMEL SUGGESTS HIGH LATITUDE ORIGINS FOR *CAMELUS* ANCESTOR

12:00 **Macphee, R., Zazula, G.** PLEISTOCENE LARGE MAMMAL DISPERSALS AND REGIONAL EXTIRPATIONS IN HIGH-LATITUDE NORTH AMERICA

SATURDAY MORNING, NOVEMBER 2, 2013

Technical Session XIV

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: Michael Habib and Daniel Ksepka

8:00 **Falkingham, P., Gatesy, S.** USING AVIAN SUBSURFACE 3D FOOT MOTION TO SIMULATE FOSSIL TRACK DIVERSITY

8:15 **Pei, R., Li, Q., Meng, Q., Norell, M., Gao, K.** EXCELLENTLY PRESERVED NEW SPECIMENS OF *ANCHIORNIS* AND THE IMPLICATION OF EARLY EVOLUTION IN PARAVES

8:30 **Habib, M.** EVIDENCE AGAINST RUNNING TAKEOFF IN *ARCHAEOPTERYX*: BREAKING THE TERRESTRIAL VS. ARBOREAL DICHOTOMY

8:45 **Heers, A., Dial, K.** WINGS VERSUS LEGS IN THE THEROPOD-AVIAN LINEAGE: MECHANISTIC UNDERPINNINGS OF VARIATION IN LOCOMOTOR STRATEGIES

9:00 **Field, D., Lynner, C.** PRECISE INFERENCE OF AVIALAN FLIGHT ABILITY FROM SHOULDER JOINT DIMENSIONS

9:15 **Hall, J., Habib, M.** FUNCTIONAL SIGNIFICANCE OF FEATHER ASYMMETRY IN EXTANT AVIANS AND PREDICTED FLIGHT PERFORMANCE IN EXTINCT TAXA

9:30 **Foth, C., Rauhut, O.** A NEW LOOK FOR AN OLD BIRD: A NEW SPECIMEN OF *ARCHAEOPTERYX* WITH EXCEPTIONAL FEATHER PRESERVATION PROVIDES NEW INSIGHTS INTO THE EVOLUTION OF FEATHER PLUMAGES WITHIN MANIRAPTORA

9:45 **Manning, P., Wogelius, R., Bergmann, U., Schwarz-Wings, D., Sellers, W.** SYNCHROTRON-BASED CHEMICAL IMAGING REVEALS PLUMAGE PATTERNS IN *ARCHAEOPTERYX*.

10:00 BREAK

10:15 **Gearty, W., D'Alba, L., Vinther, J., Shawkey, M., Field, D.** MELANIN CONCENTRATION GRADIENTS IN MODERN AND FOSSIL FEATHERS

10:30 **Egerton, V., Bergmann, U., Wogelius, R., Norell, M., Manning, P. L.** SYNCHROTRON-BASED IMAGING REVEALS CHEMOTAPHONOMY OF TWO BIRDS FROM THE GREEN RIVER FORMATION (EOCENE)

10:45 **Chan, N.** THE DROMORNITHID OR THE EGG? SIZE CONSTRAINTS IN FLIGHTLESS BIRDS

11:00 **Bright, J., Cobb, S., Marugan-Lobon, J., Rayfield, E.** CAN MORPHOLOGY PREDICT DIETARY ECOLOGY IN LIVING AND EXTINCT BIRDS OF PREY?

11:15 **Stidham, T., Ni, X.** REWRITING AVIAN BIOGEOGRAPHY WITH THE PALEOGENE FOSSIL RECORD FROM CHINA

11:30 **Ksepka, D.** NEW OLIGOCENE WATERBIRDS: PHYLOGENETIC ANALYSES AND IMPLICATIONS FOR TRANSITIONS IN THE WESTERN ATLANTIC AVIFAUNA

11:45 **Watanabe, J., Matsuoka, H.** SYSTEMATICS OF A FLIGHTLESS DUCK FROM THE PLEISTOCENE OF SHIRIYA, NORTHEAST JAPAN

12:00 **Gilbert, K., Koch, P., Mccarthy, M., Baroni, C., Lorenzini, S.** ILLUMINATING HOLOCENE DIET SHIFTS IN PENGUINS WITH COMPOUND SPECIFIC ISOTOPE ANALYSIS

SATURDAY MORNING, NOVEMBER 2, 2013

Technical Session XV

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: Robert Fordyce and Aaron Wood

8:00 **Figueirido, B., Martín-Serra, A., Pérez-Claros, J., Palmqvist, P., Janis, C.** ON THE EVOLUTION OF THE PREDATORY BEHAVIOR OF NORTH AMERICAN CANIDS AND ITS RELATIONSHIP WITH ENVIRONMENTAL TRANSFORMATION AND CLIMATIC CHANGE

8:15 **Reid, R., Koch, P.** DID INTERFERENCE COMPETITION BETWEEN GRIZZLY BEARS AND COYOTES PREVENT HOLOCENE COASTAL COYOTES FROM CONSUMING MARINE FOODS?

8:30 **Fitzgerald, E., Hastie, D., Buckeridge, J., Scofield, P.** EARLIEST SEALS FROM AUSTRALASIA REVEAL COLONIZATION OF THE SOUTHERN OCEAN BY ARCHAIC MONACHINAE (PHOCIDAE)

8:45 **Kienle, S., Berta, A.** PINNIPED SKULLDUGGERY: THE EVOLUTION OF FEEDING STRATEGIES IN PHOCIDS (PINNIPEDIA, PHOCIDAE)

9:00 **Churchill, M., Clementz, M.** EVIDENCE FOR PIERCE FEEDING IN *ENALIARCTOS* (CARNIVORA, PINNIPEDIMORPHA) FROM TOOTH SPACING AND CROWN SIZE

9:15 **Clementz, M., Velez-Juarbe, J.** ESTIMATING THE STRENGTH OF SIRENIAN AND SEAGRASS ASSOCIATIONS OVER THE CENOZOIC THROUGH PHYLOGENETIC AND STABLE ISOTOPE ANALYSES

9:30 **Wood, A., Velez-Juarbe, J., Bourque, J., Bloch, J., Jaramillo, C.** DIFFERENCES IN INFERRED FORAGING BEHAVIOR AMONG EARLY MIOCENE SPECIES OF *DIPLOTHERIUM*: EVIDENCE FROM A NEW FOSSIL DUGONG FROM THE PANAMA CANAL

9:45 **Domning, D., Velez-Juarbe, J.** THE SIRENIAN GENUS *METAXYTHERIUM*: WHAT'S UP WITH THOSE ANIMALS??

10:00 BREAK

10:15 **Gingerich, P., Antar, M., Zalmout, I.** FAUNAS OF WHALES AND SEA COWS (CETACEA AND SIRENIA) FROM MIDDLE AND UPPER EOCENE STRATA IN WESTERN FAYUM PROVINCE, EGYPT

10:30 **Ekdale, E.** INNER EAR STRUCTURE OF EARLY MYSTICETES (CETACEA) FROM THE LATE OLIGOCENE OF SOUTH CAROLINA: IMPLICATIONS FOR THE EVOLUTION OF HEARING IN BALEEN WHALES

10:45 **Tsai, C., Fordyce, R.** EARLY EVOLUTIONARY RADIATION IN BALEEN WHALES (CETACEA: MYSTICETI) FROM THE OLIGOCENE OF NEW ZEALAND

11:00 **Boessenecker, R., Fordyce, R.** ANATOMY AND ONTOGENY OF A TRANSITIONAL BALEEN WHALE: A NEW EOMYSTICETID (MAMMALIA, CETACEA) FROM THE LATE OLIGOCENE OTEKAIKE LIMESTONE OF NEW ZEALAND

11:15 **Fordyce, R., Aguirre-Fernández, G., Loch, C.** LATE OLIGOCENE TUSKED DOLPHIN FROM THE WAITAKI REGION, NEW ZEALAND

11:30 **Lambert, O., Bianucci, G., De Muizon, C., Urbina, M.** A NEW ARCHAIC SHARK-TOOTHED DOLPHIN FROM THE LATE OLIGOCENE-EARLY MIOCENE OF PERU

11:45 **Pyenson, N., Gutstein, C., Cozzuol, M., Velez-Juarbe, J., Suárez, M.** NEW MATERIAL OF *ODOBENOCETOPS* FROM THE LATE MIOCENE OF CHILE CLARIFIES THE SYSTEMATICS AND PALEOBIOLOGY OF WALRUS-CONVERGENT ODONTOCETES

SATURDAY MORNING, NOVEMBER 2, 2013

Technical Session XV (CONTINUED)

12:00 **Gutstein, C., Pyenson, N., Figueroa-Bravo, C., Canals, M., Cozzuol, M.** FACIAL MORPHOLOGY PROXIES OF SKULL PATTERNS IN TOOTHED WHALES AND THEIR IMPLICATIONS FOR STUDYING SOUND GENERATION IN FOSSIL ODONTOCETI

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Technical Session XVI

Westin Bonaventure Hotel & Suites, San Francisco Ballroom

MODERATORS: Ryosuke Motani and Gabriel Bever

1:45 **Whatley, R., Behrensmeyer, A., Mcintire, S., Ramezani, J., Parker, W.** FIRST PTEROSAUR DENTARY AND POSTCRANIA FROM THE UPPER TRIASSIC OWL ROCK MEMBER, CHINLE FORMATION, PETRIFIED FOREST NATIONAL PARK, ARIZONA

2:00 **Upchurch, P., Andres, B., Butler, R., Barrett, P.** AN ANALYSIS OF THE BIOGEOGRAPHIC HISTORY OF PTEROSAURS

2:15 **Motani, R., Jiang, D., Tintori, A., Rieppel, O., Chen, G.** HIGH DIVERSITY OF EARLY TRIASSIC ICHTHYOPTERYGIANS REVEALED THROUGH DETAILED EXCAVATION IN CHAOHU, ANHUI, CHINA

2:30 **Schmitz, L., Motani, R., Wainwright, P.** EVOLUTIONARY DRIVERS OF GIANT EYES IN LARGE OCEAN PREDATORS

2:45 **Bever, G., Lyson, T.** CRANIAL EVOLUTION AND THE ORIGIN OF TURTLES: INSIGHTS FROM *EUNOTOSAURUS AFRICANUS*

3:00 **Danilov, I., Obraztsova, E., Syromyatnikova, E., Krasnolutskii, S.** NEW DATA ON A XINJIANGCHELYID TURTLE FROM THE MIDDLE JURASSIC OF SIBERIA, RUSSIA

3:15 **Stayton, C., Cadena, E.** EXCEPTIONAL MECHANICAL PERFORMANCE IN THE SHELLS OF TWO CENOZOIC TURTLES: *STUPENDEMYS* AND *CERREJONEMYS*

3:30 **Parham, J., Wood, R., Salas-Gismondi, R., Thomas, H., Pyenson, N.** NEW ARTICULATED SPECIMENS OF LEATHERBACK SEA TURTLES FROM THE CENOZOIC OF NORTH AND SOUTH AMERICA ELUCIDATE THE PHYLOGENY, DIVERSITY, GLOBAL BIOGEOGRAPHY, AND MAJOR EVOLUTIONARY TRENDS OF DERMOCHELYIDS

3:45 **Modesto, S., Lamb, A., Reisz, R.** RE-APPRAISAL OF THE CAPTORHINID REPTILE *CAPTORHINIKOS VALENSIS* FROM THE LOWER PERMIAN OF TEXAS

4:00 **Tsuji, L., Sidor, C., Smith, R., Angielczyk, K.** THE FIRST PROCOLOPHONID FROM THE MANDA BEDS OF SOUTHERN TANZANIA AND ITS IMPLICATIONS FOR MIDDLE TRIASSIC BIOGEOGRAPHY

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Technical Session XVII

Westin Bonaventure Hotel & Suites, Sacramento Ballroom

MODERATORS: Akinobu Watanabe and Robert Anemone

1:45 **Lovelace, D., Butler, R.** QUANTIFYING TRIASSIC SEDIMENTATION ACROSS THE WESTERN UNITED STATES: PERCEPTION, PRESERVATION, AND PALEONTOLOGY

2:00 **Anemone, R., Emerson, C., Nachman, B.** DOES PREDICTIVE MODELING WORK IN THE SEARCH FOR VERTEBRATE FOSSILS? A CASE STUDY FROM THE EOCENE OF WYOMING.

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Technical Session XVII (CONTINUED)

2:15 **Lloyd, G., Friedman, M.** A NOVEL METHOD FOR TIME-BINNING RATES OF CONTINUOUS CHARACTER EVOLUTION ON A PHYLOGENY

2:30 **Alroy, J.** STILL AROUND OR GONE FOREVER? BAYESIAN CREDIBLE INTERVALS ON TEMPORAL RANGES

2:45 **Sansom, R., Wills, M.** FOSSILIZATION FILTERS RESULT IN SIGNIFICANT LOSS OF PHYLOGENETIC SIGNAL AND CAUSE ORGANISMS TO APPEAR ERRONEOUSLY PRIMITIVE

3:00 **Watanabe, A., Norell, M.** TREE BUILDING FROM NOAH'S ARK: THE IMPACT OF POOR SAMPLING WITHIN SPECIES ON PHYLOGENETIC RECONSTRUCTION

3:15 **Smithson, T., Smithson, T., Clack, J.** NEW TETRAPOD AND FISH FAUNAS FROM THE EARLIEST CARBONIFEROUS OF SCOTLAND

3:30 **Lu, J., Zhu, M., Ahlberg, P., Qiao, T.** CRANIAL STRUCTURE IN THE EARLY DEVONIAN ONYCHODONT *QINGMENODUS YUI* AND ITS IMPLICATIONS FOR THE PHYLOGENETIC POSITION OF ONYCHODONTIFORMES AMONG SARCOPTERYGIANS

3:45 **Chevrinais, M., Cloutier, R., Béchard, I.** PROFILE OF A DEVONIAN KILLER: *EUSTHENOPTERON FOORDI*, TOP-PREDATOR OF THE ESCUMINAC FISH ASSEMBLAGE

4:00 **Wendruff, A., Wilson, M.** MORPHOLOGICAL AND SPECIES DIVERSITY OF COELACANTHS FROM THE LOWER TRIASSIC SULPHUR MOUNTAIN FORMATION OF BRITISH COLUMBIA, CANADA

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Technical Session XIII

Westin Bonaventure Hotel & Suites, San Jose Ballroom

MODERATORS: David Levering and Allistair Evans

1:45 **Pol, D., Carballido, J., Rauhut, O., Rougier, G., Sterli, J.** BIOGEOGRAPHIC DISTRIBUTION PATTERNS OF TETRAPODS DURING THE JURASSIC: NEW INFORMATION FROM THE CAÑADÓN ASFALTO BASIN, PATAGONIA, ARGENTINA

2:00 **Martin, T., Goin, F., Chornogubsky, L., Gelfo, J., Schultz, J.** EARLY LATE CRETACEOUS (CENOMANIAN) MAMMALS AND OTHER VERTEBRATES FROM THE MATA AMARILLA FORMATION OF SOUTHERN PATAGONIA (ARGENTINA)

2:15 **Bercovici, A., Hunter, J., Knauss, G., Wood, J., Pearson, D.** OUT WITH THE OLD, IN WITH THE NEW: VERTEBRATE MICROSTRATIGRAPHY DOCUMENTING THE IMMEDIATE K–PG MASS EXTINCTION RECOVERY

2:30 **Levering, D., Luttbeg, B.** OF MULTITUBERCULATES AND MASS EXTINCTION: EVIDENCE OF SELECTION FOR SMALL BODY SIZE WITHIN THE CIMOLODONTA (MULTITUBERCULATA) ACROSS THE CRETACEOUS-PALEOGENE EXTINCTION BOUNDARY, FOLLOWED BY MORPHOSPACE RECOVERY AND EXPANSION IN THE EARLIEST PALEOGENE

2:45 **Chen, M., Luo, Z., Wilson, G.** MORPHOMETRIC ANALYSIS OF LOCOMOTOR SPECIALIZATION IN THE CRETACEOUS MAMMAL *YANOCONODON*: IMPLICATIONS FOR ECOMORPHOLOGICAL DIVERSIFICATION WITHIN EUTRICONODONT MAMMALS

3:00 **Hoffmann, S., O'Connor, P., Krause, D.** FIRST ENDOCRANIAL RECONSTRUCTION OF A GONDWANATHERIAN MAMMAL

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Technical Session XIII (CONTINUED)

3:15 **Rayfield, E., Gill, P.** A FUNCTIONAL INSIGHT INTO THE EVOLUTION OF THE DEFINITIVE MAMMALIAN MIDDLE EAR

3:30 **Evans, A., Chieu, T., Siu, K., Rich, T.** PREDICTING THE SHAPE OF UNDISCOVERED FOSSILS

3:45 **Grossnickle, D., Polly, P., Luo, Z.** MORPHOLOGICAL DISPARITY OF MESOZOIC MAMMALS THROUGH TIME

4:00 **Oreska, M., Carrano, M.** ADAPTING MODERN COMMUNITY ECOLOGY TECHNIQUES FOR TERRESTRIAL PALEOECOLOGY: INSIGHTS FROM THE EARLY CRETACEOUS CLOVERLY FORMATION

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Poster Session IV

Westin Bonaventure Hotel & Suites, Exhibit Hall
Authors must be present from 4:15 - 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Mitchell, J.** DEAD BIRDS IN THE DIRTY GROUND: HOW TO KNOW WHEN THEY'RE NOT AROUND

2 **Kirchner-Smith, M.** HIND LIMB MORPHOLOGY OF CARNIVOROUS BIRDS: A MORPHOMETRIC ANALYSIS OF PREY PREFERENCE AND PREDATORY TECHNIQUES

3 **Sartin, C.** ASYMMETRY AND VESTIGIAL STRUCTURES IN EXTANT BIRDS

4 **Walsh, S., Milner, A., Bourdon, E.** A REINTERPRETATION OF THE BRAIN MORPHOLOGY OF *CEREBAVIS CENOMANICA* (AVES: INCERTAE SEDIS)

5 **Hu, D., Liu, Y., Li, J., Hou, L., Xu, X.** A NEW LARGE ENANTIORNITHINE BIRD FROM THE LOWER CRETACEOUS OF WESTERN LIAONING, CHINA

6 **Tanaka, T., Kobayashi, Y., Sasaki, K., Chiba, K.** AN ISOLATED FEATHER IN AN AMBER FROM THE LATE CRETACEOUS OF NORTHEAST JAPAN

7 **Hellert, S., Marcot, J.** EVOLUTIONARY DYNAMICS OF THE LIMBS OF BIRDS AND THEROPOD DINOSAURS: TESTING THE INFLUENCE OF FUNCTIONAL CONSTRAINTS

8 **Wang, Y., O'Connor, J., Li, D., You, H.** A NEW ORNITHUROMORPH BIRD FROM THE EARLY CRETACEOUS CHANGMA BASIN OF GANSU PROVINCE, NORTHWESTERN CHINA

9 **Pomeroy, D.** IS *OMNIVOROPTERYX SINOUSAORUM* A SAPEORNITHID BIRD?

10 **Falk, A.** THE PLUMAGE OF *CONFUCIUSORNIS*: PRIMITIVE OR MODERN?

11 **Sclafani, M., Ksepka, D., Smith, A.** EVOLUTIONARY PATTERNS IN BONE THICKNESS AND COMPACTNESS IN DIVING BIRDS

12 **Smith, N., Clarke, J.** OSTEOLOGICAL HISTOLOGY OF THE PAN-ALCIDAE (AVES, CHARADRIIFORMES): CORRELATES OF WING-PROPELLED DIVING AND FLIGHTLESSNESS

13 **Ando, T., Fordyce, R.** BASAL SPHENISCIFORMES DO NOT SUPPORT A SISTER TAXON RELATIONSHIP WITH PLOTOPTERIDS

14 **Biedlingmaier, A., Leavitt, J., Monfette, G., Allan, D., Claessens, L.** DIGITAL SURFACE SCANNING AND ANALYSIS OF A CAVE SPECIMEN OF THE DODO (*RAPHUS CUCULLATUS*)

Corresponding board numbers in left hand column

15 **Torres, C., De Pietri, V., Louchart, A., Van Tuinen, M.** REDESCRIPTION OF THE INTERMEDIATE BILL MORPHOLOGY OF THE OLIGOMIOCENE FLAMINGO *HARRISONAVIS CROIZETI* BASED ON HIGH RESOLUTION X-RAY COMPUTED TOMOGRAPHY

16 **Prassack, K.** WERE HOMININ LIVING SITES FOR THE BIRDS? USING AVIFAUNA TO INTERPRET PLIOCENE HOMININ LAND USE AT OLDUVAI GORGE, TANZANIA

17 **Frigot, R., Palmer, C.** BIOMECHANICAL SIGNIFICANCE OF TRABECULAR ARCHITECTURE IN PTEROSAURS

18 **Bennett, S.** REINTERPRETATION OF THE WINGS OF *PTERODACTYLUS ANTIQUUS* BASED ON THE VIENNA SPECIMEN

19 **Vila Nova, B., Sayão, J., Kellner, A.** REDESCRIPTION OF *CEARADACTYLUS ATROX* (PTEROSAURIA, PTERODACTYLOIDEA) FROM THE EARLY CRETACEOUS ROMUALDO FORMATION (SANTANA GROUP) OF THE ARARIPE BASIN, BRAZIL

20 **Bantim, R., Sayão, J.** THE USE OF GEOMETRIC MORPHOMETRIC DATA TO SOLVE PHYLOGENETIC INCONGRUENCES WITHIN ANHANGUERIDAE (PTEROSAURIA, PTERODACTYLOIDEA)

21 **Carroll, N.** FUNCTIONAL MORPHOLOGY OF THE AZHDARCHID MANUS

22 **Rodrigues, T., Kellner, A.** LITTLE MORPHOLOGICAL VARIATION IN THE PTEROSAUR *ORNITHOCHEIRUS SIMUS*

23 **Kellner, A., Rodrigues Marques Da Silva, T.** ON AN UNUSUAL TAPEJARID PTEROSAUR FROM THE EARLY CRETACEOUS OF BRAZIL AND COMMENTS ON THE PTEROSAUR PALATE

24 **Vremir, M., Naish, D., Dyke, G.** PTEROSAUR SIZE CLASSES IN THE TRANSYLVANIAN LATE CRETACEOUS?

25 **Gierlinski, G., Adach, L., Lockley, M.** FIRST REPORT OF JURASSIC PTEROSAUR TRACKS FROM AFRICA

26 **Peters, D.** A FLIGHTLESS PTEROSAUR

27 **Wu, X., Li, C., Jiang, D., Cheng, L., Rieppel, O.** MORPHOLOGICAL DIVERSITY AND PHYLOGENY OF THE 'TURTLE-LOOKING' SAUROSPHARGIDAE

28 **Jasinski, S.** THE UTILITY OF SOFT-TISSUE CHARACTERS IN UNDERSTANDING THE PHYLOGENETIC RELATIONSHIPS OF FOSSIL TAXA: EVIDENCE FROM THE EVOLUTION OF THE TURTLE FAMILY EMYDIDAE

29 **Hirayama, R., Kon, H., Yoshida, M.** A NEW SPECIMEN OF *CUORA MIYATAI*, A PLEISTOCENE ASIAN BOX TURTLE FROM JAPAN

30 **Bourque, J., Rincon Burbano, A., Wood, A., Bloch, J., Macfadden, B.** NEW TURTLES (REPTILIA, TESTUDINES) FROM THE LAS CASCADAS FORMATION, PANAMA CANAL BASIN, SUGGEST LOW DIVERSITY IN THE EARLY MIOCENE (ARIKAREEAN) NEOTROPICS

31 **Awalt, K., Parham, J., Holroyd, P.** NEW SPECIMENS OF LEATHERBACK SEA TURTLES (DERMOCHELYIDAE) FROM THE MIOCENE OF ORANGE COUNTY SHED LIGHT ON MORPHOLOGICAL TRENDS

Corresponding board numbers in left hand column

SATURDAY AFTERNOON, NOVEMBER 2, 2013

Poster Session IV (CONTINUED)

32 **Luján, À., Delfino, M., Casanovas-Vilar, I., Alba, D.** PTYCHOGASTERINAE (TESTUDINES: GEOEMYDIDAE) IN THE VALLÈS-PENEDÈS BASIN (NE IBERIAN PENINSULA): NEW REMAINS AND TAXONOMIC REVISION

33 **Knell, M.** TAPHONOMIC ANALYSIS OF FOSSIL FRESHWATER TURTLES IN THE UPPER CRETACEOUS (CAMPANIAN) KAIPAROWITS FORMATION OF SOUTHERN UTAH

34 **Suárez, M., Parham, J., Otero, R., Rubilar-Rogers, D., Vargas, A.** A NEW SEA TURTLE SKULL FROM THE LATE CRETACEOUS OF CHILE AND THE BIOGEOGRAPHY OF *EUCLASTES*

35 **Lawver, D.** THE FIRST OCCURRENCE OF FOSSIL EGGS FROM THE UPPER CRETACEOUS (CAMPANIAN) MORONDAVA BASIN, MADAGASCAR

36 **Syromyatnikova, E., Danilov, I.** NEW DATA ON THE MORPHOLOGY OF *ADOCUS BOSTOBENSIS*, AN ADOCID TURTLE FROM THE SANTONIAN–EARLY CAMPANIAN OF KAZAKHSTAN

37 **Pérez-García, A., Ortega, F., Gasulla, J.** NEW DATA ON THE PHYLOGENETIC POSITION AND EVOLUTION OF DORTOKIDAE, THE ONLY PAN-PLEURODIRAN CLADE OF TURTLES RECOGNIZED IN THE EARLY CRETACEOUS OF EUROPE

38 **Beardmore, S., Orr, P., Furrer, H.** THE SIGNIFICANCE OF SPATIAL AND TEMPORAL VARIATION IN THE TAPHONOMY OF ICHTHYOPTERYGIANS

39 **Naish, D., Fischer, V., Liston, J., Godefroit, P.** A BASAL THUNNOSAURIAN FROM IRAQ REVEALS DISPARATE PHYLOGENETIC ORIGINS FOR CRETACEOUS ICHTHYOSAURS

40 **Lawrence, J., Naish, D., Dyke, G.** A FRESH LOOK AT THE GENUS *ICHTHYOSAURUS*: SPECIES CHARACTERISTICS, PHYLOGENY AND EVOLUTIONARY DRIVERS

41 **Yury-Yáñez, R., Soto-Acuña, S., Otero, R., Rojas, O., Vargas, A.** NEW UPPER JURASSIC MARINE VERTEBRATES FROM A BONEBED IN THE ATACAMA DESERT, NORTHERN CHILE

42 **Anderson, K., Druckenmiller, P., Baichtal, J.** NEW MATERIAL OF *TORETOCNEMUS* FROM THE LATE TRIASSIC (NORIAN) OF SOUTHEAST ALASKA

43 **Sansom, I., Sallan, L., Friedman, M., Sansom, R.** HABITAT DIVERSIFICATION IN EARLY VERTEBRATES – A CRITICAL TEST OF MARINE MACROEVOLUTIONARY PATTERNS

44 **Afanassieva, O.** NEW DATA ON THE DEVELOPMENT OF THE EXOSKELETON IN EARLY VERTEBRATES (AGNATHA: OSTEOSTRACI)

45 **Elliott, D., Lassiter, L.** PREDATION OF EARLY VERTEBRATES BY EURYPTERIDS

46 **Arsenault, F., Béchard, I., Cloutier, R., Kerr, J.** NEW METHODOLOGY FOR 3D RECONSTRUCTION OF FOSSIL FISH USING DIGITAL IMAGERY

47 **Matton, O., Cloutier, R., Béchard, I., Caron, A., Arseneault, D.** *ELPISTOSTEGE* AND THE LIGHT AND DARK SIDE OF THE MOON: NEW DATA ON THE PALEOENVIRONMENT OF THE FISH-TO-TETRAPOD TRANSITION

48 **Horner, A., Falkingham, P. L.** MAKING FOOTPRINTS WITHOUT LIMBS: SIMILARITIES BETWEEN TRACES LEFT BY LUNGFISH TERRESTRIAL LOCOMOTION AND PRIMITIVE TETRAPOD TRACKWAYS

49 **Long, J., Young, G., Lee, M.** ORIGINS OF THE PTYCTODONTID PLACODERMS

Corresponding board numbers in left hand column

50 **Vaskaninova, V.** THE LARGEST LOWER DEVONIAN ARTHRODIRE (PLACODERMI) *ANTINEOSTEUS RUFUS* SP. NOV., FROM THE EMSIAN OF THE BARRANDIAN AREA (CZECH REPUBLIC)

51 **Richter, M., Cisneros, J., Kammerer, C., Fröbisch, J., Smith, R.** NEW FOSSIL FISHES FROM THE PERMIAN PEDRA DE FOGO FORMATION, PARNAIBA BASIN, NORTHEASTERN BRAZIL

52 **Criswell, K., Coates, M., Labarbera, M.** DRAG FORCES AND WAKE PRODUCTION IN THE SPINE BRUSH COMPLEX OF STETHACANTHID SHARKS

53 **Itano, W.** REDISCOVERY OF THE HOLOTYPE OF *EDESTUS MINOR* AND A TAXONOMIC REASSESSMENT OF THE *EDESTUS MINOR* SPECIES GROUP

54 **Dzenowski, N., Hasiotis, S., Rasmussen, D.** LARGE- AND MEGA-DIAMETER STRUCTURES OF PROBABLE VERTEBRATE ORIGIN FROM THE LOWER PERMIAN (WOLFCAMPIAN) CEDAR MESA SANDSTONE OF SOUTHEASTERN UTAH, USA

55 **Kriwet, J., Fischer, J., Licht, M., Buchwitz, M., Bartsch, P.** EVOLUTION OF BASAL GNATHOSTOME EGG CAPSULE MORPHOTYPES

56 **Spindler, F.** THE NIEDERHÄSLICH TETRAPOD ASSEMBLAGE (EARLY PERMIAN, DÖHLEN BASIN) FROM GERMANY – NEW INSIGHTS TO ECOLOGY, REPTILIOMORPH DIVERSITY, AND THE BIOLOGY OF *PALAEOHATTERIA LONGICAUDATA* (BASAL SPHENACODONTIA)

57 **Macdougall, M., Meer, T., Reisz, R.** THE FIRST LOOK AT THE RELATIVE ABUNDANCES OF TAXA FROM THE RICHARDS SPUR LOCALITY OF OKLAHOMA, USA

58 **Pardo, J., Anderson, J.** CRANIAL ANATOMY OF THE PROBLEMATIC CARBONIFEROUS-PERMIAN LEPOSPONDYL *BRACHYDECTES NEWBERRYI*: NEW INFORMATION FROM MICRO-CT

59 **Porro, L., Rayfield, E., Clack, J.** COMPUTED TOMOGRAPHY, DIGITAL PREPARATION AND THREE-DIMENSIONAL RECONSTRUCTION OF THE EARLY TETRAPOD LOWER JAW

60 **Mabee, P., Dececchi, A., Ibrahim, N., Sereno, P., Balhoff, J.** AGGREGATION OF MORPHOLOGICAL CHARACTERS ACROSS STUDIES USING AN ONTOLOGY-BASED PHENOTYPE APPROACH

61 **Jones, M., Benson, R.** A NEW APPROACH FOR UNDERSTANDING THE DIVERSITY OF TOOTH ATTACHMENT IN TETRAPODS

62 **Burroughs, R., Morris, Z., Colbert, M.** USE OF A NETWORK ALGORITHM TO RAPIDLY GENERATE ONTOGENETIC SEQUENCES

63 **Colbert, M., Morris, Z.** ACCOUNTING FOR SAMPLE SIZE BIASES IN ANALYSES OF ONTOGENETIC SEQUENCES

64 **Fahlke, J., Mallison, H., Wings, O., Schwarz-Wings, D.** ONE FITS ALL: USING PHOTOGRAMMETRY TO SOLVE DIVERSE PROBLEMS WITH LARGE-SIZED PALEONTOLOGICAL OBJECTS

65 **Katz, E., Tambusso, P., Farlow, J.** ESTIMATING BASAL METABOLIC RATE OF EXTANT AND EXTINCT VERTEBRATES FROM NASAL CROSS SECTIONAL AREA AND BODY MASS

66 **Prothero, D.** SPECIES LONGEVITY IN NORTH AMERICAN FOSSIL MAMMALS

67 **Smits, P.** PREDICTING TEMPORAL BINS FROM CENOZOIC MAMMAL COMMUNITY COMPOSITION

Corresponding board numbers in left hand column

68 **Morgan, M., Barry, J., Flynn, L., Pilbeam, D.** TIME SLICE ANALYSIS OF MAMMALIAN FAUNAL STABILITY AND CHANGE IN THE LATE MIDDLE AND EARLY LATE MIOCENE SIWALIKS OF PAKISTAN

69 **Polly, P., Schnitzler, J., Lawing, A., Eronen, J.** MORPHOLOGICAL ADAPTATION, RANGE SHIFTS, OR EXTINCTION? MODELING OF MORPHOLOGICAL RESPONSES OF SPECIES AND COMMUNITIES TO ENVIRONMENTAL CHANGE IN A GEOGRAPHICALLY AND TEMPORALLY EXPLICIT CONTEXT

70 **Theodor, J.** MAXIMUM BODY SIZE EVOLUTION OF CENOZOIC MAMMALIAN HERBIVORES

71 **Thomson, M., Curran, S.** NOT BY SIZE ALONE: INVESTIGATIONS OF SHAPE, ALLOMETRY, AND PHYLOGENY IN CERVID ECOMORPHOLOGY

72 **Janis, C., Figueirido, B.** THE ELBOW JOINT OF THE MARSUPIAL LION, *THYLACOLEO CARNIFEX*: IMPLICATIONS FOR PREDATORY BEHAVIOR

73 **Damuth, J., Janis, C., Travouillon, K., Figueirido, B.** STHENURINES — WHY THE SHORT FACE? CRANIODENTAL MORPHOLOGY IN RELATION TO DIET IN LIVING AND FOSSIL KANGAROOS

74 **Fujiwara, S.** OPTIMUM SCAPULAR POSITION TO SUPPORT AND STABILIZE THE BODY ON A FORELIMB IN QUADRUPEDAL TETRAPODS

75 **Mallison, H.** COMBINED SIMULTANEOUS VERTEBRATE MUSCULOSKELETAL 3D MODEL CREATION IN SIMM AND CAD - IS IT WORTH THE EFFORT?

76 **Sansalone, G., Teresi, L., Cox, T., Moscato, M., Kotsakis, T.** UNVEILING THE DIGGING ADAPTATIONS IN PROSCALOPIDAE HUMERUS BY MEANS OF COMPARATIVE 3D FINITE ELEMENT ANALYSIS

77 **Blumenthal, S., Cerling, T., Chritz, K., Bromage, T., Valley, J.** OXYGEN ISOTOPES FROM MAMMALIAN TEETH: SAMPLING GUIDED BY THE GEOMETRY OF ENAMEL MINERALIZATION

78 **Keller, J., Fox, D., Bagley, B.** DENTAL MORPHOMETRICS PREDICT SPECIFIC TROPHIC CATEGORIES IN RODENTS

79 **Schulz, E., Kaiser, T.** HOW TO CHOOSE AND USE 3D SURFACE TEXTURE PARAMETER TO RECONSTRUCT FEEDING ECOLOGY AND CHEWING MECHANICS: PARAMETER RUSH AND BASIC PRINCIPLES OF 3D TRIBOLOGY

80 **Greshko, M., Desantis, L., Hulbert, R.** EVOLUTIONARY AND ECOLOGIC IMPLICATIONS OF DIETARY VARIATION AT INDIVIDUAL AND POPULATION LEVELS IN HERBIVOROUS MAMMALS

81 **Karme, A., Saarinen, J.** A NEW ANGLE ON MESOWEAR - ANGULAR CRITERIA FOR FAST AND CONSISTENT RECORDING OF MESOWEAR DATA

82 **Vizcaíno, S., Kay, R., Fernicola, J., Bargo, M., Cuitiño, J.** REDISCOVERING AMEGHINO'S FOSSIL LOCALITIES OF THE SANTA CRUZ FORMATION (EARLY MIOCENE) IN THE SANTA CRUZ RIVER VALLEY, SANTA CRUZ PROVINCE, ARGENTINA

83 **Kelloway, T., Croft, D., Prybyla, A., Semprebon, G., Townsend, K.** DIETS OF LATE EARLY MIOCENE LITOPTERNS FROM SANTA CRUZ, ARGENTINA, BASED ON MESOWEAR AND ENAMEL MICROWEAR

84 **Perez, N., Croft, D., Kelloway, T., Prybyla, A., Townsend, K.** USING MESOWEAR AND MICROWEAR TO INFER THE DIET OF *ASTRAPOTHERIUM* FROM THE LATE EARLY MIOCENE OF SANTA CRUZ, ARGENTINA

Corresponding board numbers in left hand column

85 **Drew, N., Croft, D., Anaya, F.** DESCRIPTION OF A NEW MIOCENE HEGETOTHERIID NOTOUNGULATE FROM CERDAS, BOLIVIA

86 **Ferrusquia-Villafranca, I., Ruiz-Gonzalez, J.** THE MIOCENE MAMMAL FAUNA OF SOUTHEASTERN MEXICO: AN UPDATING OVERVIEW

87 **Baldvins, T., Secord, R.** THE DEVELOPMENT OF C_3 GRASSLANDS IN THE MIOCENE INFERRED FROM MESOWEAR IN GREAT PLAINS UNGULATES FROM NEBRASKA

88 **Kingston, J., Maclatchy, L., Kiyemba, J.** ISOTOPIC VARIABILITY IN EARLY MIOCENE C_3 DOMINATED ECOSYSTEMS IN UGANDA

89 **Villaseñor, A.** DOES ECOLOGY OR TAPHONOMIC BIAS DESCRIBE THE DIFFERENCES IN MAMMALIAN COMMUNITIES IN THE PLIOCENE HADAR AND TURKANA BASINS, ETHIOPIA AND KENYA? A QUANTITATIVE APPROACH

90 **Bernor, R., Mittmann, H., Munk, W., Semprebon, G., Wolf, D.** NEW INSIGHTS FROM THE EXCAVATIONS OF THE HÖWENEGG LAGERSTÄTTE, HEGAU, GERMANY (MN9, 10.3 MA)

91 **Nyborg, T., Nurmi, N., Jansen, B.** RECONSTRUCTING AN ANCIENT PLAYA MUDFLAT USING HIGH-DYNAMIC-RANGE IMAGING ALONG AN EXPOSED SECTION OF THE FLUVIAL-LACUSTRINE DEPOSITS OF THE COPPER CANYON FORMATION, DEATH VALLEY NATIONAL PARK, CALIFORNIA

92 **Holbrook, L.** REEVALUATION OF HYPOTHESES OF PERISSODACTYL (MAMMALIA) ORIGINS AND THE PROBLEM OF "UNGULATE" PHYLOGENY

93 **Jones, K., Wood, A.** LUMBAR MORPHOLOGY OF *ARENAHIPPUS* AND *MESOHIPPUS* WITH IMPLICATIONS FOR THE EVOLUTION OF EQUID LOCOMOTION

94 **Bai, B., Wang, Y.** POSTCRANIAL MORPHOLOGY OF THE EARLY EOCENE CHALICOTHERE *LITOLOPHUS GOBIENSIS* (MAMMALIA, PERISSODACTYLA)

95 **Miyata, K., Okazaki, Y., Sakai, H., Ohashi, T., Tomida, Y.** FIRST RECORD OF A PRIMITIVE RHINOCEROTOID *HYRACHYUS* FROM THE MIDDLE EOCENE OF JAPAN

96 **Wyss, A., Bright, J., Tiffney, B.** A MIDDLE OLIGOCENE (WHITNEYAN) RHINOCEROTID FROM NORTH-EASTERN CALIFORNIA

97 **Stilson, K., Hopkins, S., Davis, E.** USING AN EVOLUTIONARY MODEL TO INVESTIGATE THE ORIGINS OF WIDESPREAD ARTHRITIS IN RHINOCEROTIDAE (MAMMALIA, PERISSODACTYLA)

99 **Coillot, T., Bernor, R., Boisserie, J.** CONTRIBUTION OF THE SHUNGURA FORMATION (3.6 MA - 1.05 MA) TO EASTERN AFRICAN EQUID EVOLUTION AND PALEODIET

100 **Campbell, D., Ghani, I., Mihlbachler, M.** INTRATOOTH HETEROGENEITY IN THE DENTAL MICROWEAR OF ARTIODACTYLS AND PERISSODACTYLS: IMPLICATIONS FOR INTERPRETING PALEODIET IN EXTINCT UNGULATES

101 **Boardman, G., Secord, R.** APPLYING DENTAL MICROWEAR TEXTURE ANALYSIS TO EXTANT AND FOSSIL PERISSODACTYLS AND NON-RUMINANT ARTIODACTYLS

102 **Lutz, C., Scott, E.** TESTING MOLECULAR HYPOTHESES OF LATE PLEISTOCENE EQUID ABUNDANCE IN NORTH AMERICA: HORSES FROM GYPSUM CAVE, NEVADA

Corresponding board numbers in left hand column

103 **Spencer, L., Scott, E.** RESOURCE PARTITIONING AMONG LATE PLEISTOCENE HERBIVORES OF NATURAL TRAP CAVE, WYOMING

104 **Ghani, I., Campbell, D., Barron-Ortiz, C., Mihlbachler, M.** TESTING CLIMATE CHANGE AND OVERKILL EXTINCTION HYPOTHESES FOR PLEISTOCENE EQUIDS WITH DENTAL MESOWEAR

105 **Scott, E., Springer, K., Manker, C.** *EQUUS SCOTTI* FROM THE TULE SPRINGS LOCAL FAUNA, SOUTHERN NEVADA: IMPLICATIONS FOR THE DIVERSITY AND BIOGEOGRAPHY OF LATE PLEISTOCENE EQUIDS IN WESTERN NORTH AMERICA

106 **Nakaya, H., Suwa, G., Ode, S., Asfaw, B., Beyene, Y.** A NEAR-COMPLETE SKULL OF *EQUUS* (EQUIDAE, PERISSODACTYLA, MAMMALIA) FROM THE EARLY PLEISTOCENE KONSO FORMATION, SOUTHERN ETHIOPIA.

107 **Widlansky, S., Manz, C., Bloch, J.** PALEOCENE-EOCENE RODENTS (ISCHYROMYIDAE, REITHROPARAMYINAE) FROM FRESHWATER LIMESTONE IN THE CLARKS FORK BASIN, WYOMING

108 **Bertrand, O., Silcox, M.** *ISCHYROMYS TYPUS* (RODENTIA, ISCHYROMYIDAE): ENCEPHALIZATION QUOTIENT ESTIMATION AND THE ECOLOGICAL HABITS OF EARLY RODENTS

109 **Coster, P., Beard, K., Chaimanee, Y., Salem, M., Jaeger, J.** HYSTRICOGNATHOUS RODENT ASSEMBLAGE FROM A NEW EARLY OLIGOCENE VERTEBRATE LOCALITY: ZALLAH 7, SIRT BASIN, LIBYA

110 **Tanabe, Y., Nakatsukasa, M., Kunimatsu, Y., Onodera, M., Nakaya, H.** THE LATE MIOCENE RODENT FAUNA FROM NAKALI FORMATION, NORTHERN KENYA.

111 **Olroyd, S., Hopkins, S.** VARIATION THROUGH TOOTH WEAR OBSCURES THE DIFFERENTIAL DIAGNOSES OF THE HEMPHILLIAN CASTORIDS *DIPOIDES STIRTONI* AND *DIPOIDES SMITHI*

112 **Casanovas-Vilar, I., García-Paredes, I., Van Dam, J.** CHANGES IN DIVERSITY AND STRUCTURE OF THE VALLESIAN (LATE MIOCENE) RODENT RECORD FROM THE VALLÈS-PENEDÈS BASIN (CATALONIA, SPAIN)

113 **Grossman, A., Flynn, L., Manthi, F.** RODENTS FROM THE LOTHIDOK FORMATION, EARLY MIOCENE, WEST TURKANA, KENYA

114 **Browne, I., Smith, K.** SPECIES RELATIONSHIPS OF *COPEMYS* (RODENTIA, CRICETIDAE) SPECIMENS RECOVERED FROM THE MIDDLE MIOCENE BARSTOW FORMATION

115 **Biedron, E., Hopkins, S., Mclaughlin, W.** RESOLVING MORPHOLOGICAL/MOLECULAR CONFLICT IN MARMOTINI (MAMMALIA, RODENTIA, SCIURIDAE) THROUGH DIAGNOSTIC DENTAL CHARACTERISTICS

116 **Blois, J., Li, C., Hadly, E.** THE INFLUENCE OF LATE QUATERNARY CLIMATES ON SPECIES DISTRIBUTION, ABUNDANCE, AND GENETIC DIVERSITY OF NORTHERN CALIFORNIA POCKET GOPHERS

117 **Haveles, A., Fox, D.** RECONSTRUCTING QUATERNARY PALEOENVIRONMENTS IN THE GREAT PLAINS USING GEOGRAPHIC RANGES OF EXTANT SPECIES

118 **Lightner, E., Fraser, D., Minckley, T., Clementz, M.** BUSHY-TAILED WOODRAT (*NEOTOMA CINEREA*) RESPONSE TO LATE PLEISTOCENE CLIMATE CHANGE

Corresponding board numbers in left hand column

119 **Hsu, J., Lacey, E., Hadly, E.** ASSESSING GENOMIC VARIATION IN PATAGONIAN SOCIAL TUCO-TUCOS (*CTENOMYS SOCIABILIS*) USING ANCIENT DNA

120 **Marcy, A., Desantis, L., Hadly, E.** MORPHOMETRICS AND MICROWEAR ANALYSES SUGGEST TOOTH-DIGGING POCKET GOPHERS (*THOMOMYS* SPP.) CLAIMED CLIMATE-HARDENED SOILS THROUGH INCREASED INCISOR PROCUMBENCY

121 **Townsend, K., Croft, D.** AN EXPANDED ANALYSIS OF DENTAL MICROWEAR IN CAVIOMORPH RODENTS

122 **López-Antoñanzas, R., Flynn, L., Knoll, F.** BIODIVERSITY CRISES IN THE HISTORY OF RHIZOMYINE RODENTS

123 **Mori, H., Druckenmiller, P., Erickson, G., Prieto-Márquez, A.** CRANIAL ONTOGENY OF *EDMONTOSAURUS*: IMPLICATIONS FOR THE TAXONOMIC STATUS OF THE PRINCE CREEK FORMATION SPECIES (LOWER MAASTRICHTIAN, NORTHERN ALASKA)

Corresponding board numbers in left hand column

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW DATA ON THE DEVELOPMENT OF THE EXOSKELETON IN EARLY VERTEBRATES (AGNATHA: OSTEOSTRACI)

AFANASSIEVA, Olga, Paleontological Institute of Russian Academy of Sciences, Moscow, Russia

Osteostracans (Osteostraci) are among the most ancient extinct jawless vertebrates (Agnatha), known from the early Silurian to the late Devonian. The external skeleton of osteostracans is composed of three layers typical of the vertebrate exoskeleton: the layer of dentine (mesodentine), the middle layer of cellular bone and the basal layer of laminar bone (isopedine). The sculpture and the histological structure of the shields of *Timanaspis kossovoii* and *Thyestes verrucosus* (order Trematraspidiformes) were investigated based on well-preserved material. The remains come from the Lower Silurian deposits of Saaremaa, Estonia (*Thyestes*) and Upper Silurian deposits of North Timan, Russia (*Timanaspis*). The surface of the shield of *Thyestes* is covered with numerous tubercles of different sizes: large tubercles with curved dentine tips arranged in longitudinal rows, and small ribbed tubercles. The sculpture of the dorsal side of the shield of *Timanaspis* is characterized by separate longitudinal ridges and elongated tubercles (relatively large elements the upper part of which is composed of dense mesodentine of a specific type) and numerous small projections between them (composed of bone tissue; dentine tissue is absent or poorly developed). It is assumed that, during ontogenesis, the large tubercles of the longitudinal rows (along the ribs of rigidity of the shield) emerged first. Paleohistological study of the shields shows that the species under investigation have different characteristic features in the tissue structure and degree of development of the exoskeletal layers. New information on the processes of ontogenetic development of the osteostracan exoskeleton was analyzed and compared with previous data on the external skeleton of another species of osteostracan. Analysis of the data on the osteostracan exoskeleton suggests that diversity in the exoskeletal structure, as well as the ability to form various shields (tessellated or consolidated), was achieved primarily by combining the types of initiation of tissues (dentine and bone) and modes of their development.

Technical Session XIII (Friday, November 1, 2013, 2:00 PM)

OSTEOLOGY AND MORPHOLOGY OF THE PROBABLE STEM-GROUP OSTEICHTHYAN *LOPHOSTEUS SUPERBUS* PANDER, FROM THE SILURIAN OF ESTONIA

AHLBERG, Per, Uppsala University, Uppsala, Sweden; BLOM, Henning, Uppsala University, Uppsala, Sweden; ZHU, Min, IVPP Academia Sinica, Beijing, China; MÄRSS, Tiiu, Tallin University of Technology, Tallinn, Estonia; SANCHEZ, Sophie, Uppsala University, Uppsala, Sweden

Lophosteus superbus from the Pridoli (latest Silurian) of Saaremaa, Estonia, has long been known from scales and isolated bone fragments. It has been variously interpreted as showing actinopterygian, placoderm or acanthodian affinities. A large-scale collection program at the Ohessaare Cliff locality has allowed us to amass several hundred specimens including complete dermal plates, bone fragments and scales, which together begin to characterize this enigmatic taxon. A distinctive histology with numerous large and closely spaced cell lacunae allows bones to be attributed to *Lophosteus* with confidence, while the dermal ornament has distinct anteroposterior polarity that allows even bones of unknown identity to be oriented correctly. *Lophosteus* resembles an osteichthyan in possessing marginal dermal jaw bones, though recent discoveries from China show that such bones also occur in derived stem gnathostomes. The inner dental arcade consists of numerous identical “tooth cushions”. The skull roof includes placoderm-like elements such as rostral and central plates, as well as numerous smaller bones suggesting areas of sarcopterygian-like bone mosaic. Multiple examples of the same bone often have quite variable outlines, suggesting some individual variation in the pattern. Longitudinal sensory lines are generally carried in open grooves whereas transverse lines take the form of rows of isolated pits. The braincase appears to have had only perichondral ossification. The shoulder girdle is placoderm-like with a large spinal plate. A dermal pelvic girdle is present. Numerous ridge scutes have been recovered, including both symmetrical examples from the dorsal midline and asymmetrical ones from the flanks. Scales are rhombic. All odontodes lack enamel. Despite some continuing uncertainties, in particular regarding the skull roof pattern, *Lophosteus* clearly shows a combination of what have traditionally been termed “osteichthyan” and “placoderm” characteristics. The recognition of placoderm paraphyly, along with recent discoveries of fossils from China combining “placoderm” and “osteichthyan” characters, have blurred the distinction between these two groups and paradoxically made the phylogenetic position of *Lophosteus* less easy to determine. It is most probably a primitive stem osteichthyan, but despite its “osteichthyan look” it could possibly be a derived stem gnathostome.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

FOOT POSTURE IN EARLY EOCENE HYAENODONTIDAE AND OXYAENIDAE FROM WYOMING

AHRENS, Heather E., Johns Hopkins University School of Medicine, Baltimore, MD, United States, 21205

Early workers on ″Creodonta″ concluded that both Hyaenodontidae and Oxyaenidae possessed a plantigrade foot posture based on qualitative comparisons with the morphology present in Carnivora. However, later workers found evidence for subdigitigrady and digitigrady, particularly in later hyaenodontids. Metrics correlated with foot posture have recently been proposed and can be used to test hypotheses of hyaenodontid and oxyaenid foot posture generated by qualitative comparisons. The calcaneal gear ratio (CGR) significantly correlates with foot posture in extant carnivorans and is applied for the first time to Eocene creodonts. The CGR is the length of the calcaneus divided by the length of the in-lever (sustentacular process to the medial tubercle), with larger values representing increased digitigrady. Here, I test for differences in the calcaneal gear ratio between 1) Hyaenodontidae and Oxyaenidae and 2) earlier (Wasatchian) and later (Bridgerian) hyaenodontids. Seven genera were sampled that represent Early Eocene hyaenodontids and oxyaenids from Wyoming. Prior to examining familial and temporal differences, I tested for an allometric relationship between CGR and total calcaneal length using ordinary least squares regression. Size was not significantly correlated with CGR (r^2 = 0.03363, p-value = 0.4523) suggesting allometry does not drive differences between groups. Student′s t-tests were used to test for differences in the CGR between families and Early Eocene North American land mammal ages. There was no difference in the CGR between the sampled Wasatchian hyaenodontids and oxyaenids (p-value = 0.5796). There is, however, a significant increase in the CGR from the Wasatchian to the Bridgerian hyaenodontids (p-value = 1.683×10^{-05}). These results indicate an increase in digitigrady within Hyaenodontidae through the Early Eocene. This shift in foot posture may also reflect a shift in locomotor style towards increased terrestriality, which is exemplified by later cursorial hyaenodontids. Understanding the variation in locomotor habits of ″Creodonta″ is crucial to understanding the functional and ecological diversity of Paleogene carnivores.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE ASPHALTO/MCKITTRICK COMPLEX: QUATERNARY FOSSILS ASSOCIATED WITH ASPHALT DEPOSITS FROM THE SOUTHWESTERN MARGIN OF THE SAN JOAQUIN VALLEY, 23 KM NORTHEAST OF TAFT, KERN COUNTY, CALIFORNIA

AKERSTEN, William , Idaho State University, Pocatello, ID, United States, 83204; JEFFERSON, George, Anza Borrego Desert Paleonological Society, Borrego Springs, CA, United States

During 1977-78, we conducted field and literature surveys of the area for an environmental impact statement (EIS) on paleontologic resources but only collected voucher specimens. Outcrops included diatomitic shales of the petroliferous marine Miocene Monterey Formation - intensively folded and faulted, the overlying less distorted clastic terrestrial Blancan Tulare ormation, and undistorted surficial Pleistocene to modern alluvium. In the immediate area, a large slab of Monterey was thrust over the Tulare. Asphalt deposits formed when dikes and seams of nearly pure asphalt intruded along fractures into the weakly consolidated Tulare and overlying units. As asphalt surfaced, it flowed out to form a variety of traps, primarily shallow seeps with a occasional deeper pools. Much asphaltic material was subsequently removed by erosion and mining. Minor entrapment of insects, arachnids, and small vertebrates continues today in seeps at the base of the thrust between the Monterey and the Tulare and along Route 33 southeast of the town of McKittrick. Remaining records regarding Asphalto are fragmentary and often contradictory but the site is certainly related to or identical with McKittrick. Variable width dikes of nearly pure asphalt within the Tulare were mined in the late 19th century using hard rock methods. Surviving photographs of timbered shafts indicate that the mines were wider than recorded widths of the dikes and that considerable amounts of the host rock had been removed. The two Blancan carnivore specimens at University of California Museum of Paleontology (UCMP) reported from Asphalto bear no evidence of asphalt; their preservation is typical of Tulare specimens. They evidently were recovered from the Tulare during mining of the intruding asphalt dikes and indicate the age of the host rock, not of the intrusive dike. Major collections of McKittrick Pleistocene megafauna are reposited at UCMP (locality 4096) and the Los Angeles County Museum [LACM(CIT) locality 7139], different portions of the same La Brea-like bone deposit. Fossil deposits also include asphaltic mudstones (asphaltic earthy sediments), in the remnant of a dike, and a unique locality which seems to have developed when water saturated weathered asphaltic diatomite created a quicksand-like bog. While faunal differences between Rancho La Brea and McKittrick can partially be attributed to environmental conditions, others (such as abundant aquatic insects and aquatic birds in the latter) appear to result from temporal discontinuities or selective entrapment.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

OLDEST JOINT RECORD OF *MACACA* AND *MESOPITHECUS* (PRIMATES, CERCOPITHECIDAE) BASED ON MATERIAL FROM THE LATEST MIOCENE OF MONCUCCO TORINESE (ITALY)

ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; DELSON, Eric, Department of Anthropology, Lehman College, CUNY and Department of Vertebrate Paleontology & NYCEP, New York, NY, United States; COLOMBERO, Simone, Università degli Studi di Torino, Torino, Italy; DELFINO, Massimo, Università degli Studi di Torino, Torino, Italy; PAVIA, Marco, Università degli Studi di Torino, Torino, Italy

The final Miocene site of Moncucco Torinese is located in the Moncucco gypsum quarry (Tertiary Piedmont Basin, NW Italy), which exposes a Messinian lithostratigraphic succession ranging from the pre-evaporitic Messinian up to the Miocene-Pliocene boundary. On the basis of both litho- and biostratigraphic data, the vertebrate-bearing fossiliferous horizons of Moncucco are correlated to the upper post-evaporitic unit of the Messinian, with an estimated age of 5.40–5.33 Ma (MN13, late Turolian, late Miocene). Here we report dental and postcranial fossil remains of Old World monkeys (Primates: Cercopithecidae) from Moncucco, including a distal fragment of a proximal phalanx, a complete middle phalanx, a lateral upper incisor, a male lower canine, a lower third molar, a talus and a proximal fragment of ulna. Although some of these remains cannot be allocated to either cercopithecines or colobines, the typical papionin occlusal morphology of the lower molar enables an unambiguous attribution to the genus *Macaca*. In contrast, both the talus and the ulna are attributable on morphologic and morphometric grounds to the colobine *Mesopithecus pentelicus*, whose postcranial morphology is well known based on material from its type locality.

The record of *Mesopithecus* at Moncucco agrees well with the previously-known range of this species in Italy and elsewhere in Europe. That of *Macaca*, however, constitutes only the second record of macaques in the Miocene of Europe—the other one derives from the roughly coeval Spanish locality of Almenara-Casablanca M, with an estimated age of 5.9–5.3 Ma. Although the co-occurrence of *Mesopithecus* and *Macaca* in the same locality had been previously recorded, Moncucco is the first known instance in which a macaque is recorded together with the late Miocene species *Mesopithecus pentelicus* instead of *Mesopithecus monspessulanus*. The presence of such opportunistic and semi-terrestrial monkeys at Moncucco fits well with previous paleoenvironmental reconstructions based on the remaining fauna, which indicates a relatively warm and humid, densely-forested environment with more open and dryer habitats nearby. From a paleobiogeographic viewpoint, the record of *Macaca* at Moncucco further reinforces the hypothesis, based on the previous citation of this genus from the latest Miocene of Spain, that macaques dispersed from Africa into Europe sometime between 5.9 and 5.3 Ma, due to the sea level drop associated with the Messinian Salinity Crisis.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE LAST FOSSIL PRIMATE IN NORTH AMERICA: NEW MATERIAL OF THE ENIGMATIC *EKGMOWECHASHALA* FROM THE ARIKAREEAN OF OREGON

ALBRIGHT, L. Barry, University of North Florida, Jacksonville, FL, United States, 32224; SAMUELS, Joshua, John Day Fossil Beds National Monument, Kimberly, OR, United States; FREMD, Theodore, University of Oregon, Eugene, OR, United States

In North America, fossil primates and the primate-like Plesiadapiformes are known from the earliest Paleocene through the late Oligocene. Although primates vanish in North America in the Chadronian, approximately 37 million years ago, the tiny, enigmatic *Ekgmowechashala* shows up 9 million years later, in the Arikareean of South Dakota and Oregon. The phylogenetic position of this taxon has been debated, with various authors placing *Ekgmowechashala* in the Plagiomenidae (Dermoptera) and Omomyidae (Primates), and most recently Adapiformes (Primates). *Ekgmowechashala* was previously known from five dentary specimens from the upper Sharps Formation of South Dakota, plus a maxilla fragment with teeth assigned to the genus from the John Day Formation of Oregon. Here we note three additional teeth of *Ekgmowechashala*, likely from a single dentary, from unit H in the Turtle Cove Member of the John Day Formation. The reversed magnetic polarity of Unit H together with its position between the overlying Deep Creek Tuff (27.89 Ma) and the underlying Picture Gorge Ignimbrite (28.7 Ma) provide a refined age of these specimens within magnetochron C9R. These teeth very closely resemble those of the South Dakota specimens of *E. philotau*, and help to confirm the presence of this taxon in Oregon and refine the age of these occurrences.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW *MINOTAURASAURUS* MATERIAL FROM THE DJODOKTA FORMATION ESTABLISHES NEW TAXONOMIC AND STRATIGRAPHIC CRITERIA FOR THE TAXON

ALICEA, Justy, American Museum of Natural History , New York, NY, United States, 10027; LOEWEN, Mark, Univ of Utah, Salt Lake City, UT, United States

Minotaurasaurus ramachandrani was named from an illegally acquired specimen that was available at the Tuscon Gem and Mineral show. As with most specimens of uncertain provenance, the stratigraphy of the specimen was assigned to “Gobi Desert of either Mongolia or China.” A previously described specimen from the Huiquanpu Formation of China, Shanxia, is indistinguishable from *Minotaurasaurus*; however the age of this formation is listed as “Late Cretaceous”.

Ongoing scientific research by the American Museum of Natural History, in cooperation with the Mongolian Academy of Sciences has produced a second specimen with some postcranial elements from the Xanadu site of the Uhkaa Tolgod locality within the Late Campanian Djodokta Formation (76.5-70.5 Ma). This new specimen is referable to *Minotaurasaurus* based on its autapomorphic anteriorly facing nares rimmed with a ring scale; a large presquamosal unfused, free-floating osteoderm; and an elongated, highly-rugose squamosal horn with a sub-circular cross-section. In addition, a unique suite of characters separate *Minotaurasaurus* from all other ankylosaurids including: a well-developed premaxillary buttress; a peaked, bulbous scale pattern on the nasal and frontal region; forward facing orbits; a circumorbital scale; and a mandibular osteoderm that extends forward to the anterior end of the tooth row. Additionally, the new specimen includes the axis and the complete first cervical ring, with a small, laterally oriented spike on the lateral-most plate. The entire specimen has been modified by 1 cm diameter borings which lead to large excavations within the skull roof and cervical ring. These burrows continued in a Medusa-like pattern into the matrix surrounding the skull, and are filled with bone fragments, suggesting insect utilization of bone similar to the unique pattern currently only known from Late Cretaceous Gobi deposits.

This new specimen places *Minotaurasaurus* in stratigraphic and geographic context and adds to our knowledge about the crania and postcrania of this taxon.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ENDOCAST SHAPE EVOLUTION IN PRIMATES

ALLEN, Kari, Duke University, Durham, NC, United States, 27705

The endocrania of early anthropoid primates have been described as being relatively small, with a mixture of strepsirrhine and anthropoid-like qualities. These qualitative differences have yet to be quantified in both the fossil and living primates. It is therefore unknown the degree to which the fossil specimens differ from extant groups.

This project uses geometric morphometric shape analyses to explore endocranial shape change over time. Fossil specimens under consideration include Oligocene early anthropoid (*Parapithecus*), stem catarrhine (*Aegyptopithecus*), and Miocene stem platyrrhine primates (*Homunculus*, *Tremacebus*). 3D landmarks were collected on virtual surface renderings of endocasts, segmented from micro-CT scans of primate crania. The sample includes thirty-one extant primate species and the four fossil taxa. Endocast shape was explored via Principal Components Analysis of General Procrustes-aligned variables.

The first principal component (PC1), accounting for 25% of the variance in the analysis, separates extant strepsirrhines and tarsiers from anthropoids. Shape changes on this axis include the rostral projection of the olfactory fossa, endovertex height, flexion of the endocast base, and the position of the foramen magnum and cerebellar hemispheres relative to the cerebrum. Among the extant sample, PC1 scores were found to co-vary with phylogenetic distance (Pagel’s lambda = 0.98), and are correlated with residual endocranial volume when phylogenetic generalize least squares regressions (PGLS) techniques are applied ($p<0.001$).

The fossil representatives of anthropoid subclades show a trend towards modern anthropoid-like endocast shape. Along PC1, the Oligocene early anthropoid *Parapithecus* is intermediate between extant strepsirrhine and anthropoid primates, while the stem catarrhine *Aegyptopithecus* falls within the lower limit of the extant anthropoid distribution. Early platyrrhines *Homunculus* and *Tremacebus* fit comfortably within the extant anthropoid distribution on PC1, and towards the center of the extant platyrrhine group on PC2. Despite the correlation between residual endocranial volume and endocast shape among modern primates, the fossil representatives demonstrate a disconnect between these two factors in having anthropoid-like endocranial form at a relatively small brain size. These results suggest that a reorganization of the endocranium, which may reflect brain proportions, occurred relatively early in anthropoid evolution, prior to encephalization.

Technical Session XVII (Saturday, November 2, 2013, 2:30 PM)

STILL AROUND OR GONE FOREVER? BAYESIAN CREDIBLE INTERVALS ON TEMPORAL RANGES

ALROY, John, Macquarie University, Sydney, Australia

Estimating the chance that a taxon has gone extinct is one of the most basic problems in analytical paleobiology. There are many published equations for computing confidence intervals on temporal ranges, but all of them yield the wrong statistic: the chance a taxon has not been found again by now given that it is still alive. We instead simply want to know the chance it is still alive. Bayesian methods do produce such numbers, i.e., posterior probabilities that are used to define "credible intervals." I describe a new "creeping shadow of a doubt" algorithm for computing posteriors. It depends on knowing the prior chance of extinction per unit of time (E0); the chance of failing to sample the taxon given that it is alive (q); and the number of sampling events. E0 is estimated by finding a value for it that would produce the observed range's length 50% of the time (with a correction for undersampling), whereas q is computed from the frequency of observations within the range. The values for the first interval after the range endpoint are plugged into Bayes' theorem and the extinction chance is recomputed iteratively going forwards, which yields a posterior (or "shadow value") at each step. The few previously described Bayesian methods were ignored because (1) no good ideas were offered for setting the prior and (2) the proposed algorithms weren't iterative, so they wrongly treated sampling events as independent. Simulations show that the shadow values are highly accurate unless sampling is very poor or sampling deteriorates very rapidly. Although the values are conservative when mass extinctions occur, the same is true of all related methods. When sampling is erratic, as with all fossil data, the method is best applied by using records of a taphonomic control group to define failed sampling events. Analysis of the classic Ward and Marshall ammonite data set shows that the shadow values and conventional confidence intervals flag the same species as likely to have gone extinct below the K-Pg boundary, but in ambiguous cases the shadow values are consistently low while the conventional values are broadly distributed. An analysis of fossil occurrence data decisively rejects the idea that penguins, which first appeared in the Paleocene, were present before the Maastrichtian. This result does not depend on whether the control group is defined as all marine macrofossils or all marine tetrapods. Although caution is warranted, similar analyses could be used to improve calibration of molecular clocks. No rigorous method for setting priors in this context has been proposed previously.

Technical Session I (Wednesday, October 30, 2013, 9:00 AM)

THREE DIMENSIONAL MICRO-CT STUDY OF THE AÏSTOPOD CRANIUM REVEALS HIDDEN MORPHOLOGICAL DIVERSITY AMONG THE EARLY TETRAPOD RADIATION

ANDERSON, Jason, University of Calgary, Calgary, AB, Canada, T2N 4n1; PARDO, Jason, University of Calgary, Calgary, AB, Canada; GERMAIN, Damien, MNHN, Paris, France; AHLBERG, Per, Uppsala Univ, Uppsala, Sweden

Recent studies have suggested that the braincase preferentially preserves a phylogenetic signal against selective pressures (i.e., locomotor, feeding) that strongly modify the rest of the skull and that neurocranial characters can resolve otherwise intractable phylogenetic problems. Neurocranial morphology revealed by micro-Computed Tomography (micro-CT) has been found to be particularly promising in resolving the phylogenetic relationships of recumbirostran lepospondyls, but resolution of broader relationships among lepospondyl orders will not be realized until a more comprehensive sample is built across all early tetrapods.

In order to understand the range of braincase morphology in lepospondyls, we volumized a previously acquired dataset of the earliest aïstopod, *Lethiscus*, from the Viséan of Scotland, and new scans of the oestocephalid aïstopod *Coloraderpeton*, from the Kasimovian of Colorado. The entire skull of *Lethiscus* has been reconstructed except for details of the skull roof. It is demonstrated for the first time to be a lightly built, strut-like skull, reminiscent in construction of *Phlegethontia*. The premaxilla is relatively short but the skull is elongate, especially in the postorbital region that is dominated by a large

temporal fenestra but retains a complete lower temporal bar. The braincase is extremely primitive in its construction, in stark contrast with other lepospondyls, with a previously recognized notochordal occiput, persistent ventral cranial fissure, prominent basal tubera, and a pronounced dorsal inflection supported ventrally by a tall dorsal lamina of the parasphenoid. The occiput plus opisthotic ossification is completely separated from the prootic ossification, but the prootic and sphenethmoid ossifications articulate dorsally. The sphenethmoid braincase is elongate and solidly walled, although perforated laterally by a foramen for the optic nerve and rostrally for the olfactory tract. The braincase of *Coloraderpeton* is more completely ossified, but largely conforms to this pattern, and the peculiar morphology of a previously described anterior braincase of *Phlegethontia* is confirmed by these scans. The lower jaws of both taxa are completely reconstructed and retain most primitively present bones, including an adsymphyseal. When analyzed using parsimony in a matrix of lower jaws of early tetrapods, *Lethiscus* and *Coloraderpeton* fall stemward, near *Crassigyrinus*. These results strongly question the monophyly of Lepospondyli as currently conceived.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW MATERIAL OF *TORETOCNEMUS* FROM THE LATE TRIASSIC (NORIAN) OF SOUTHEAST ALASKA

ANDERSON, Katherine L., University of Alaska Museum, Fairbanks, AK, United States, 99709; DRUCKENMILLER, Patrick, University of Alaska Museum, Fairbanks, AK, United States; BAICHTAL, James, Tongass National Forest, Thorne Bay, AK, United States

The Late Triassic was a crucial period in the evolution of the ichthyosaur body plan. During this interval, ichthyosaurs exhibited the greatest size disparity known from their entire geological history; however, relatively little is known about the diversity and morphology of small-bodied (1-2 m) forms, especially when compared to the much larger and better known Late Triassic taxa. In 2003, a small-bodied (< 1.5 m total length) ichthyosaur was collected from rocks exposed in an intertidal zone on Gravina Island in Southeast Alaska. The specimen was found in a calcareous shale from the lower unit of the Nehenta Formation, which is early to middle Norian in age based on biostratigraphic evidence. These rocks are in turn part of the Alexander terrane, a displaced crustal fragment that was accreted to North America during the Mesozoic and Cenozoic. The new ichthyosaur consists of bone fragments and external molds of an incomplete but largely articulated postcranial skeleton. Surface peels were used to better interpret the skeleton, which includes two dorsal and 18 articulated caudal vertebrae, a partial pelvic girdle, an articulated hind limb and a second femur. The distinctive hind limb morphology, including a strongly constricted femoral shaft that is distally expanded both pre- and postaxially, as well as elongate epipodials separated by an epipodial foramen, permits referral of the specimen to the poorly-known, small-bodied ichthyosaur *Toretocnemus*. As currently known, *Toretocnemus* is restricted to Carnian-aged strata of California and possibly Sonora, Mexico. The new Alaskan specimen is significant in that it extends the stratigraphic range of the genus into the Norian. In addition, it is important in being the first record of the genus in northwestern North America, although the reconstructed paleogeographic position of the Alexander terrane in the Triassic was approximately 20° N. It is also the first specimen of *Toretocnemus* to preserve apical vertebrae, providing insight into the evolution of the tail bend in Late Triassic, small-bodied ichthyosaurs.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

BASAL SPHENISCIFORMES DO NOT SUPPORT A SISTER TAXON RELATIONSHIP WITH PLOTOPTERIDS

ANDO, Tatsuro, Ashoro Museum of Paleontology, Ashoro, Japan; FORDYCE, Robert Ewan, University of Otago, Dunedin, New Zealand

Phylogenetic relationships between penguins (Sphenisciformes) and Plotopteridae (Suliformes) have been considered mostly in terms of the high-level taxa Sphenisciformes and traditional Pelecaniformes, rather than by direct phylogenetic analysis including both penguins and plotopterids. Here, cladistic analyses that include the most-basal Sphenisciformes, *Waimanu*, suggest that Sphenisciformes and Plotopteridae are not related closely.

Plotopterids, which are extinct wing-propelled diving birds, possess pelecaniform characters (e.g., absence of nasal gland fossa on dorsal frontal, elongate acromion of scapula, simple procoracoid process), as seen in *Phalacrocorax* and *Anhinga*. Accordingly, plotopterids have been placed in Suliformes within the traditional Pelecaniformes. Phylogenetic analyses for water bird relationships have been performed widely on morphology- and molecular-based studies, generally indicating that Sphenisciformes and Pelecaniformes are not sister taxa. Rather, in morphology-based studies, most of which lack basal sphenisciforms and plotopterids, Sphenisciformes is closely related to Procellariiformes or to the clade Gaviiformes + Podicipediformes. Such results imply that similarities between penguins and plotopterids, especially in the pectoral skeletons, are homoplasious. Two previous morphology-based analyses which included extinct plotopterids showed contradictory results in terms of the phylogenetic position of penguins and the interpretation of the morphological similarities in the wing (in turn, related to the wing-propelled diving). One analysis made penguins and plotopterids sister taxa interpreting the similarity as synapomorphic while the other rejected that. These analyses lacked basal Sphenisciformes, making the results questionable. Because basal members of a taxon tend to retain less-specialized and/or "transitional" morphologies which may provide powerful phylogenetic signals, we tested the phylogenetic relationship between penguins and plotopterids by adding the most basal Sphenisciformes *Waimanu* to the published analyses and reanalyzing with the software package TNT. The results from both analyses do not support the sister taxon relationship between penguins and plotopterids. The characters cited in support of a sister taxon relationship (e.g., thin, broad scapula, wide and flattened ulna and radius) are demonstrated to be homoplasious.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DESCRIPTIVE PALEOHISTOLOGY ON *GUARINISUCHUS MUNIZI* (DYROSAURIDAE, CROCODYLOMORPHA) LONG BONES AND THEIR INFERENCES ON ITS LIFESTYLE

ANDRADE, Rafael, Universidade Federal de Pernambuco, Recife, Brazil; SAYÃO, Juliana, Universidade Federal de Pernambuco, Vitória de Santo Antãoo, Brazil

Dyrosaurids are among the few vertebrates that survived the mass extinction event documented at the Cretaceous–Paleocene boundary. *Guarinisuchus munizi* remains were collected from the deposits of the Maria Farinha Formation, Danian, Paraíba Basin in fieldwork carried out in a limestone quarry located close to Recife in northeastern Brazil. The good preservation of the microstructures of bones allows, besides simple morphological description, the only way to obtain information about the biology of extinct animals such as ecology, growth rate, and life history strategies. There is little information on the bone histology of this group; the only exception is a section from a *Dyrosaurus phosphaticus* vertebra. For this work, thin sections of the right femur and left tibia have been used to produce the histological slides. On the left tibia, the cortex (1119.65 µm thick) consists of lamellar-zonal bone (LZB) with five lines of arrested growth (LAGs). A few to medium organized vascular network of both simple vascular canals and primary osteons that increase towards the inner cortex and vary in its size from 52.55 µm to 176.77 µm. The femur shows a similar histological pattern with the same number of LAGs and the space between them varying up to 2 µm and few exceptions such as a thicker cortex with 1.997,49 µm. The vascular canals range from 22.12 µm to 85.92 µm. Secondary osteons occur in the deep cortex in average, from 150.95 µm to 292.94 µm near and inside the spongiosa as a result of remodeling, in both bones. This type of osseous tissue is fairly common among medium to large-sized poikilothermic tetrapods. As proposed before it is noteworthy that it should be restricted to adult and subadult individuals. The presence of cyclic growth marks indicates that somatic growth in this specimen was not steady, but presented a cyclic pattern, like that of most of marine reptiles. The LZB tissue, which indicates a high growth rate has also been considered to indicate a high body temperature and, possibly, a relatively rapid metabolism in these taxa. An 'osteoporotic-like' pattern corresponding to a spongy inner organization of the bone with large cavities occurs in active swimmers requiring high speed and manoeuvrability.

Symposium 4 (Saturday, November 2, 2013, 8:45 AM)

THE FIRST PTEROSAUR FROM ANTARCTICA

ANDRES, Brian, University of South Florida, Tampa, FL, United States, 33620; SMITH, Nathan, Howard University, Washington, DC, United States

Pterosaurs are considered one of the most successful groups of flying organisms due in part to their achieving a global distribution soon after their appearance. This achievement is largely based on a single fossil, an isolated humerus from the Early Jurassic Hanson Formation in the Central Transantarctic Mountains of Antarctica. However, this is the least diverse time known for pterosaurs. It is a possibility that there was period in time in which this was the only pterosaur specimen known to exist, but this cannot be confirmed by the dating resolution of the specimens from this time. Comprehensive phylogenetic analysis of this specimen and the Pterosauria supports low diversity during this time by recovering a single pterosaur lineage surviving into the Early Jurassic on which this specimen is a basal member. This phylogenetic bottleneck is also during a time of record low oxygen levels in the atmosphere. Lower atmospheric oxygen levels hinder powered flight by providing less oxygen for this aerobically expensive activity and creating a less dense atmosphere in which to fly. This phylogenetic bottleneck may represent the survival of pterosaurs through an oxygen crisis, and the Antarctic may have been a refugium with relatively colder, denser air in which flight was easier.

Use of diversity estimates to test evolutionary scenarios has recently been debated, and pterosaurs have become a focal point of this debate. Studies that support a strongly biased record attribute a significant correlation between species richness and sampling proxies such as number of pterosaur formations over time to the causation of diversity patterns. This correlation has also been attributed to diversity and sampling estimates being at least partially redundant. The third possibility, that pterosaur diversity and sampling share a common cause, has not been studied in as much detail. Pterosaur fossils are found worldwide in both marine and terrestrial environments and biases that would affect their diversity patterns would be planetary in scope and may have affected their evolution. The number of pterosaur formations is not significantly correlated with phylogenetically corrected diversity estimates based on the comprehensive phylogeny but is correlated with atmospheric oxygen levels over time. The correlation between pterosaur diversity estimates and sampling proxies may be due the combined effect of oxygen on pterosaur evolution and geological processes such as sediment production.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW ALVAREZSAURID MATERIAL FROM THE HELL CREEK FORMATION, MONTANA

ANDUZA, Danny, Montana State University, Museum of the Rockies, Bozeman, MT, United States, 59717; FOWLER, Denver, Montana State University, Museum of the Rockies, Bozeman, MT, United States; NOTO, Christopher, Univ of Wisconsin-Parkside, Kenosha, WI, United States; HORNER, John, Montana State University, Museum of the Rockies, Bozeman, MT, United States

The Alvarezsauridae are an enigmatic family of theropod dinosaurs, characterized by derived forms that possess extremely short forelimbs with a single functional digit bearing a large robust ungual. Alvarezsauridae are first recorded from the Late Jurassic

Shishugou Formation of China (*Haplocheirus*), but are otherwise known only from the Late Cretaceous, particularly of South America (*Alnashetri*, *Alvarezsaurus*, *Patagonykus*) and Asia (*Xixianykus*, *Linhenykus*, *Parvicursor*, *Shuvuuia*, *Mononykus*), including a number of relatively complete skeletons. In contrast, the North American Late Cretaceous has yielded only limited material, comprising an ulna, manual ungual, tibiae, metatarsals and phalanges (*Albertonykus*) from the Lower Maastrichtian part of the Horseshoe Canyon Formation, Alberta; and a pubis, partial ischium, and metatarsal from the Upper Maastrichtian Hell Creek Formation, Montana, and Lance Formation, Wyoming. Here we describe new alvarezsaurid material from the Hell Creek Formation, Montana, comprising a metatarsal III (Museum of the Rockies specimen MOR 2920), and two unassociated manual unguals from digit I (MOR 3098, 6622). These are of particular interest as manual unguals undergo a number of changes through basal to derived members of the clade, including gradual enclosure of the ventral blood vessel groove, development of a ventral sulcus, and increased robusticity and rugosity. The largest ungual (MOR 6622; reconstructed length 4.4cm) is nearly complete and is ~10% larger than that of *Mononykus* (Geological Institute, Mongolian Academy of Sciences specimen GI N107/6), whereas MOR 3098 is smaller (reconstructed length 2.6cm) and more comparable in size to *Albertonykus* (Royal Tyrrell Museum of Palaeontology TMP 2000.45.86). MOR 6622 differs from MOR 3098 in exhibiting a more rugose surface texture, ventral foramina that are more deeply enclosed, and a deeper and more developed ventral sulcus. Due to the size disparity, morphological differences between MOR 6622 and 3098 most likely represent either variation (allometric or ontogenetic) within the same taxon, or taxonomic distinction. This may have implications for characters currently used to diagnose other alvarezsaurid taxa. New and revised stratigraphic data demonstrate that alvarezsaurids occur through most of the ~85m thick Hell Creek Formation, with the lowermost specimen occurring ~25m above the formational base, and the uppermost specimen ~10m below the upper contact with the Fort Union Formation. As such these are the youngest known alvarezsaurid remains and demonstrate that the clade survived at least until ~200 k.y. before the Cretaceous-Paleogene extinction.

Technical Session XVII (Saturday, November 2, 2013, 2:00 PM)

DOES PREDICTIVE MODELING WORK IN THE SEARCH FOR VERTEBRATE FOSSILS? A CASE STUDY FROM THE EOCENE OF WYOMING.

ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, United States, 49008; EMERSON, Charles, Western Michigan University, Kalamazoo, MI, United States; NACHMAN, Brett, University of Texas, Austin, TX, United States

Remote sensing and other tools and methods from the geographic information sciences (GIS) have the potential to revolutionize how fieldwork in vertebrate paleontology is conducted. We trained an artificial neural network to analyze remotely sensed Landsat imagery and multiple GIS data and analytical layers in order to recognize different land cover classes, including productive localities, in Eocene deposits of the Great Divide Basin of southwestern Wyoming. *Post hoc* testing of the model indicated that it was able to recognize the spectral signatures of productive localities and other land cover classes with a high degree of accuracy (84% correctly classified pixels). Our predictive model was constrained by geology (limited to outcrops mapped as Wasatch formation), by topography (minimum required slope was 5%), and was limited to pixels which resembled known localities at the 98% probability level. The question we ask today is, how well did the model work in the field? During the 2012 field season, we surveyed two areas in the northern part of the Great Divide Basin that our predictive model suggested would have a high probability of being fossiliferous. Neither of these areas had ever been prospected or surveyed by our field crews in previous field seasons. The first area we surveyed yielded no terrestrial mammals, but we did recover numerous characteristic Eocene vertebrate fossils (e.g., turtle, fish, crocodile, gastropod, bivalve) in deposits whose lithology (oil shales, limestones, and stromatolites) suggested a lacustrine origin. We confirmed that these deposits have been mistakenly mapped as Wasatch formation and should be attributed to the Green River formation. In the second area, the lithology was clearly fluvial and the rocks were typical of the Wasatch formation (gray sandstones and mudstones). The area indicated by our model as having a high priority of being fossiliferous was in fact an extensive outcrop of heavily eroded sandstone that yielded typical Eocene terrestrial mammals, including *Hyracotherium* and *Hyopsodus*. While the fauna collected from this new locality was not particularly rich or diverse (even by Great Divide Basin standards), it highlights the enormous potential that predictive modeling approaches hold for vertebrate paleontologists and paleoanthropologists.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW VERTEBRATES FROM THE PERMIAN PEDRA DE FOGO FORMATION, PARNAIBA BASIN, NORTHEASTERN BRAZIL

ANGIELCZYK, Kenneth, Field Museum of Natural History, Chicago, IL, United States, 60605; CISNEROS, Juan Carlos, Universidade Federal do Piaui, Ininga, Teresina, Brazil; MARSICANO, Claudia, Universidad de Buenos Aries, Buenos Aires, Argentina; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa; GOSTLING, Neil, University of Southapmton, Southampton, United Kingdom

Permian fossils, including petrified wood, fish, and a temnospondyl amphibian, were first discovered in the Pedra de Fogo Formation (PFF) of the Parnaiba Basin in the first half of the 20th century. Their precise age is uncertain, with estimates spanning most of the Permian. In 2011-2013 our team conducted fieldwork in the PFF to determine its age, depositional environments, and vertebrate fauna. The PFF accumulated in a large shallow intra-continental sag basin. With progressive climatic drying paleoenvironments changed from a large shallow epeiric sea to an expansive alluvial plain culminating in isolated playas between extensive aeolian dune fields. An ash bed discovered in 2011 is currently being radiometrically dated, offering the possibility of a numerical age for the PFF for the first time. We discovered several new fossil sites on both sides of the Parnaiba River, which cluster in three main areas: the far south of the basin, the central basin, and the eastern edge near the city of Teresina. Chondrichthyians and osteichthyians are the most abundant vertebrate fossils in the PFF. Tetrapods are so far only recorded in the central and eastern portions of the basin. The archegosaurid *Prionosuchus* is the only tetrapod previously known from the PFF. We collected additional temnospondyls from two areas in the basin, representing at least three new taxa. Specimens from the eastern edge of the basin occur in low energy lake facies and resemble tupilakosaurids and rhinesuchids, whereas those from the central basin may represent rhytidosteids and the archegosaurid *Prionosuchus*. At least one specimen may preserve soft tissue impressions. In the Permian, the Parnaiba Basin was located in equatorial Pangaea, at a similar latitude as the Moradi Formation of Niger. Like the Moradi, the PFF includes an anachronistic mixture of taxa, suggesting that such faunas may have been common in central Pangaea. Yet, the PFF appears to include a mix of clades best known from the Early Permian and Mesozoic, whereas the Moradi includes a mix of Early and Late Permian taxa. Further research will be necessary to better establish the number of distinct time horizons in the PFF, and their correlations within the basin and with other basins. The PFF shows great potential to provide new insight into Permian biogeography and potentially the end-Permian mass extinction.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

SYNCHROTRON ANALYSIS OF PATHOLOGIC BONE: CHEMISTRY AND MORPHOLOGY IN EXTINCT AND EXTANT ARCHOSAUR BONE

ANNE, Jennifer, University of Manchester, Manchester, United Kingdom; WOGELIUS, Roy, University of Manchester, Manchester, United Kingdom; EDWARDS, Nicholas, University of Manchester, Manchester, United Kingdom; SELLERS, William, University of Manchester, Manchester, United Kingdom; MANNING, Phillip L., Univ of Manchester, Manchester, United Kingdom

Bone histology has historically been a structure-based technique, with the bulk of analysis accomplished through the study and interpretation of histological thin sections. More recently, the use of chemical techniques such as rare earth element (REE) and isotope analysis have begun to aid the interpretation of bone histology and taphonomy by incorporating chemical information. However, both traditional histological thin sections and destructive chemical analyses are limited with respect to mapping bone chemistry in high resolution. Synchrotron Rapid Scanning X-Ray Fluorescence (SRS-XRF) allows elemental mapping at low concentrations (parts per million) over large surface areas in a relatively short period of time (~3000 times faster than standard mapping techniques). The distribution of dilute elemental concentrations within discrete biological structures allows us to correlate specific chemistry within identifiable tissue types in both extant and extinct samples, and has allowed us to identify biomarkers for specific biomolecules (e.g. eumelanin).

Here we use SRS-XRF to analyze variations in the trace element inventory of pathologic and normal bone in a theropod (*Allosaurus fragilis*) pedal phalanx. Evidence for bone infection and fracture healing (callus formation) is mapped in cross section and combined with detailed thin section analysis. Diagenetic incorporation of trace elements can be correlated within the different tissue types present between pathologic and normal bone. These include differences between woven and lamellar bone, areas of resorption, and areas of remodeling (of callus). SRS-XRF mapping reveals both chemical variations within different bone tissues and previously unobserved histological structures not seen in thin section. Comparing these results to SRS-XRF maps from avian and crocodilian pathologic bone will allow us to further investigate both the chemical compositions of bone through time as well as the evolution of fracture healing within the Archosauria.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

COMPARATIVE ANATOMY OF THE FRONTAL SINUSES OF THE SCIMITAR-TOOTHED FELID </I>MACHAIRODUS APHANISTUS *(FELIDAE, CARNIVORA) FROM THE LATE MIOCENE SITES OF BATALLONES-1 AND BATALLONES-3 (MADRID, SPAIN)*

ANTON, Mauricio, Museo Nacional de ciencias Naturales, Madrid, Spain; SILICEO, Gema, Museo Nacional de ciencias Naturales, Madrid, Spain; SALESA CALVO, Manuel, Museo Nacional de ciencias Naturales, Madrid, Spain; MORALES, Jorge, Museo Nacional de ciencias Naturales, Madrid, Spain

Frontal sinuses are air-filled spaces in the frontal bone formed through a pneumatization process when the mucous epithelial tissue from the nasal cavity expands into the adjacent frontal bones. The need to keep a biomechanically stable structure despite pneumatization results in the development of bony struts. There are several hypotheses about the function of frontal sinuses (e.g., olfactory, respiratory, thermoregulatory), whilst some authors see them as functionless by products of the bone remodeling process.

We studied the frontal sinuses in the saber-toothed felid Machairodus aphanistus from the sites of Batallones-1 and 3, comparing them with those of the extant felines Acinonyx jubatus, Puma concolor, Panthera pardus and Panthera tigris, and the saber-toothed felid Promegantereon ogygia. We obtained 3D reconstructions of the sinuses through virtual filling of the cavities after CT scans of skulls. As in other felids, frontal sinuses in M. aphanistus are limited rostrally by the naso-frontal suture and caudally by the fronto-parietal suture. They show a reduced rostral portion, a broader medial one and an elongated caudal part, which narrows with the postorbital constriction. Several struts were found inside the sinus, but few were in their original position. Among extant felids, P. pardus and P. tigris show simpler, rostro-caudally shorter sinuses, whilst P. concolor and A. jubatus had relatively more complex and larger ones, with inflated caudal portions having more struts; the dome-shaped sinus of A. jubatus was proportionally the largest. The sinuses of P. ogygia resembled those of P. concolor, but less inflated and less caudally constricted. Machairodus aphanistus showed the most elongated sinuses, with an even greater postorbital constriction than in P. concolor but not inflated. Some of the

struts are in the medial and caudal part, reinforcing the sinuses. Whilst the presence of these struts could relate to a need to avoid the collapse of the cavity, or even dissipate biomechanical stresses produced during the "canine shear-bite" (the killing technique of saber-toothed cats), the extension and constriction of the sinuses are difficult to explain. In some hyaenids, the caudally elongated frontal sinuses and domed skulls have been related to dissipation of stresses produced when cracking bones, but their sinuses surpass the level of the fronto-parietal suture, which is not the case in M. aphanistus. Some other explanations, such as the frontal sinuses acting as thermal insulators of the brain are also possible, but not strongly supported.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EVOLUTIONARY PATTERNS AND MORPHOLOGICAL DISPARITY OF SAUROPODOMORPHS OVER THE TRIASSIC–JURASSIC BOUNDARY

APALDETTI, Cecilia, Conicet - Museo Paleontológico Egidio Feruglio, Trelew, Argentina; POL, Diego, Conicet - Museo Paleontologico Egidio Feruglio, Trelew, Argentina; MARTINEZ, Ricardo, Universidad Nacional de San Juan, San Juan, Argentina

Sauropodomorpha was a diverse and abundant group of herbivorous dinosaurs that dominated most continental ecosystems of the Mesozoic era. The sauropodomorph fossil record reveals the Late Triassic–Early Jurassic was a key period of time in the evolution and diversification of this group, including the origin of Sauropoda. Here we present a morphological disparity study to evaluate the regions of the morphospace occupied by Sauropodomorpha from the Late Triassic to the Early Jurassic. Morphological disparity was approximated using multivariate analyses applied to different versions of a recently published phylogenetic matrix, in which taxon and character sampling was altered in different ways. The results show the most basal and oldest sauropodomorphs (Carnian) forming a group that occupies a small and well-differentiated region of the morphospace. During the Norian this group diversified notably both taxonomically and ecologically, which is reflected in that they occupy a different and much broader region of the morphospace. The boundaries of this region of the morphospace are mostly determined by robust basal sauropodomorphs from the Southern Hemisphere. During the Lower Jurassic, the region of the morphospace occupied by Sauropodomorpha is markedly expanded with respect to that of the Norian. This is expanded toward two news regions where some of the most conspicuous sauropodomorphs of that period are positioned: the gracile forms known as massospondylids and the derived and giant forms of basal sauropods. This result evidences that the increase in taxonomic diversity was paralleled by a rise in the morphological disparity of Sauropodomorpha during the Late Triassic. After the Triassic-Jurassic boundary, the disparity increases notably, but the taxonomic diversity is not altered significantly. These marked steps in the changes and expansions of the morphospace regions occupied by basal sauropodomorphs is to a large degree dominated by the signal coming from taxa known from the southern hemisphere.

Technical Session V (Wednesday, October 30, 2013, 1:45 PM)

THE RETURN OF *NAJASH*: NEW, BETTER PRESERVED SPECIMENS CHANGE THE FACE OF THE BASALMOST SNAKE

APESTEGUIA, Sebastian, Universidad Maimonides, Buenos Aires, Argentina; GARBEROGLIO, Fernando, Universidad Maimonides, Buenos Aires, Argentina

La Buitrera is a fossiliferous locality from northern Patagonia, Argentina. It preserves superb small to mid-sized skeletons in a Gobi style, but evidencing subaereal exposure, scavenging, dissolution and shallow disarticulation. Skeletons are commonly well-defined and clearly separated from other. Lag deposits are present too, but as consequence of disarticulation of complete skeletons. *Najash rionegrina* is the only snake found in this locality. The phylogenetic approach positioned this species as the basalmost snake, bringing it into the large debate of snake origins. The species was primarily described based on one specimen consisting of a largely complete vertebral sequence of 122 vertebrae from axis to caudals, including pelvis, limbs and a dentary. As frequent in La Buitrera style, this specimen was largely articulated except for some displaced vertebrae (isolated within the jacket), the dentary some millimeters in front of the axis, and the fibula at less than one centimeter from the tibia. A recent work discussing the position of *Najash* proposed the exclusion of these elements for not being in anatomical contact. We reject this opinion. Full anatomical contact is rare in vertebrate paleontology. Concerning other elements, found isolated and at about 3 km (i.e., an isolated partial skull, a quadrate, an additional dentary and several vertebrae), included as referred material, debate is understandable. A recent visit to the locality resulted in the finding of two additional specimens, both provided with skull and bearing vertebrae that are indistinguishable from those described for the holotype. One of them bears an incomplete skull preserved almost exactly as the published one. The second skull, although still unprepared, bears an "anilioid" general aspect and preserves premaxilla, nasal, vomer, prefrontal, frontal, maxilla, jugal and postfrontal (both clearly differentiated), ectopterygoid, parietal, prootic, otoccipital, supraoccipital, supratemporal and quadrate. The lower jaw includes compound bone, angular and a dentary with two foramina. This new specimen makes a substantial contribution to make *Najash rionegrina* one of the better known basal snakes.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PHYLOGENY AND PAEDOMORPHISM IN ANGOLAN MAASTRICHTIAN ELASMOSAURIDS

ARAUJO, Ricardo, SMU-Museu da Lourinha, Dallas, TX, United States, 75205; LINDGREN, Johan, Lund University, Lund, Sweden; JACOBS, Louis, Southern Methodist Univ, Dallas, TX, United States; Polcyn, Mike, , Dallas, TX, United States; SCHULP, Anne, Natuurhistorisch Museum Maastricht, Naastnicht, Netherlands

Plesiosaur humeri from Angola are pachyosteosclerotic to osteosclerotic, have secondary osteons that extend to near the external surface of the bone, and exhibit three lines of arrested growth. These traits are indicative of an 'adult' condition. However, the external morphology of the bones is 'juvenile'; i.e., unfaceted propodials and the tubercles of the propodials unseparated by an isthmus. This paradox can be explained by paedomorphism. A database of ontogenetic stages of nearly 400 plesiosaur specimens arranged by geologic age shows an average 31% (SD=0.16) of 'immature' specimens, if the Maastrichtian time bin is excluded. The Maastrichtian record is composed mainly of elasmosaurids (~90%) and Southern Hemisphere (Weddelian) plesiosaurs (~80%). Within the Weddelian elasmosaurid fauna, 'immature' specimens are 2.7 times more abundant than 'mature'. A phylogenetic morphometrics analysis using 31 operational taxonomic units and 6 landmark configurations based on postcranial material shows biogeographical and stratigraphic congruence, and retrieval of the Maastrichtian forms within the same clade.

Technical Session III (Wednesday, October 30, 2013, 2:30 PM)

THE ORIGIN OF THE ANKYLOSAURID TAIL CLUB

ARBOUR, Victoria, University of Alberta, Edmonton, AB, Canada, T6G2E9; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

The tail club is one of the most distinctive features of ankylosaurid dinosaurs, and is composed of elongated, interlocking distal caudal vertebrae (the 'handle'), and enlarged, fused osteoderms that envelop the tip of the tail (the 'knob'). It has previously been suggested that the tail club was present only in ankylosaurine ankylosaurids. *Zhongyuansaurus*, from the early Late Cretaceous of Henan, China, was originally described as a nodosaurid ankylosaur; we suggest instead that this taxon is a junior synonym of *Gobisaurus*, a 'shamosaurine'-grade ankylosaurid, based on cranial morphology. Previous authors have interpreted the absence of enlarged distal caudal osteoderms in the holotype of *Zhongyuansaurus* (*Gobisaurus*) as evidence for the absence of a tail club in 'shamosaurine' ankylosaurids. Although *Gobisaurus* does not preserve enlarged distal caudal osteoderms, it does have elongated, interlocking distal caudal vertebrae indistinguishable from those typical of the tail club handle of ankylosaurine ankylosaurids. A systematic review of Chinese ankylosaurids was undertaken in order to update a revised phylogenetic analysis of the ankylosaurid dinosaurs and thereby investigate the evolution of the tail club in ankylosaurids. *Shanxia* is a junior synonym of *Tianzhenosaurus*, and *Bienosaurus*, *Tianchisaurus*, and *Zhejiangosaurus* are nomina dubia. *Crichtonsaurus bohlini* is a nomen dubium, but "*Crichtonsaurus*" *benxiensis* is a valid species. A phylogenetic analysis recovered a derived clade of North American species as the sister group to a derived clade of Mongolian species. Outside these clades, *Tianzhenosaurus*, *Pinacosaurus*, and *Crichtonsaurus* formed successive outgroups. *Gobisaurus* and *Shamosaurus* were recovered as basal ankylosaurids. *Gobisaurus* is the phylogenetically most basal ankylosaurid known to have possessed a tail club handle, and *Pinacosaurus* is the most basal species where a tail club knob has been preserved. "*Crichtonsaurus*" *benxiensis* was recovered as more derived than *Gobisaurus*, but is known from older sediments; *Gobisaurus* is from the Turonian, whereas "*Crichtonsaurus*" *benxiensis* is from the Albian. This analysis shows that the tail club appeared first in 'shamosaurine'-grade ankylosaurids, and that the ankylosaurid tail club handle had evolved by at least the Turonian, but may have been present as early as the Albian.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A NEW CROCODYLOMORPH FROM THE MORRISON FORMATION (LATE JURASSIC: KIMMERIDGIAN - EARLY TITHONIAN?) FROM THE FRUITA PALEONTOLOGICAL AREA, WESTERN COLORADO, USA

ARCUCCI, Andrea, Universidad Nacional de San Luis, San Luis, Argentina; ORTEGA, Francisco, Universidad Nacional de Educacion a Distancia, Madrid, Spain; POL, Diego, Museo Paleontologico Egidio Feruglio, Trelew, Argentina; CHIAPPE, Luis, Natural History Museum of LA County, Los Angeles, CA, United States

The Morrison Formation is one of the most prolific geological units for vertebrate fossils of Late Jurassic age. One of its localities, the Fruita Paleontological Area (FPA, Mesa County, Colorado), has yielded a peculiar assemblage of small vertebrates including a variety of archosaurians (e.g., the shartegosuchid crocodyliform *Fruitachampsa*, the heterodontosaurid ornithischian *Fruitadens*), lepidosaurs (sphenodontids and squamates) and mammals (triconodontids, multituberculates, dryolestids), among other vertebrate clades. Previous records of basal crocodylomorphs from the FPA were limited to fragmentary remains of *Macelognathus vagans*, a medium to small size "sphenosuchian", considered to be one of the latest representatives of non-crocodyliform crocodylomorphs. Here we present a much smaller specimen of a basal crocodylomorph (less than 1 m total body length) that can be clearly differentiated from *Macelognathus* on the basis of its vertebral morphology. Despite the fact that the specimen is missing the skull, it constitutes one of the most completely known "sphenosuchian" postcranial skeletons due to its exquisite preservation and articulated remains. It includes much of the vertebral column (first cervical to proximal caudals), ribs, scapula and coracoid, ischium and pubis, and forelimb and hind limbs. The rod-like ventrally projected coracoid process, elongated carpals, slender limbs and the morphology of the calcaneal tuber present in the FPA specimen suggest a close relationship with basal crocodylomorphs such as the Laurasian *Terrestrisuchus*, *Dibothrosuchus*, *Hesperosuchus*, and the Gondwanan *Sphenosuchus* and *Almadasuchus*. Among basal crocodylomorphs, the presence of procoelous vertebrae is unique to this new FPA specimen and *Junggarsuchus* (late Middle Jurassic of China), which is considered one of the closest relatives of Crocodyliformes. Other noteworthy derived characters, including extremely long carpals that are 40% of the length of the femur, indicate that the new FPA specimen represents a new minute "sphenosuchian" taxon. This discovery increases the taxonomic diversity and morphological disparity developed by the latest known basal crocodylomorphs. The remarkable elongation of the carpals

documents an extreme specialization for cursoriality, far beyond what was previously known for the group.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

FISH DIVERSITY AND PALEOENVIRONMENTS FROM THE LATE MIOCENE OF SAHABI, LIBYA

ARGYRIOU, Thodoris, University of Alberta, Edmonton, AB, Canada, T6G 2E9; MURRAY, Alison, University of Alberta, Edmonton, AB, Canada

Decades of excavations at the late Miocene (Messinian) fossiliferous deposits exposed in Sahabi, in northeastern Libya, have uncovered a greatly diverse vertebrate assemblage. The known diversity includes terrestrial (e.g., large proboscideans, carnivores, bovids, equids, and primates) and aquatic mammals (e.g., dolphins and sea cows), crocodylians, turtles, birds, and both bony and cartilaginous fish. The previous works on fish fossils have provided useful information about the composition of the Sahabi ichthyofauna but were either focused on elasmobranchs or based on a limited sample size. Recent excavations conducted in 2010 by the East Libya Neogene Research Project (ELNRP), and focused on the U1 member of the Sahabi Formation, allowed the collection of a sizable sample of fossil fish that includes at least 18 different actinopterygian taxa of both marine and freshwater affinities. Both recent and fossil comparative material were used to assess similarities. The recognized taxa, some of which were previously unreported from Sahabi, are the following: *Polypterus* sp. (Polypteridae); cf. *Labeo* sp. (Cyprinidae); *Hydrocynus* sp. (Alestidae); *Carlarius* sp. (Ariidae); *Bagrus* sp. (Bagridae); *Clarotes* sp. and *Auchenoglanis* sp. (both Claroteidae); *Clarias* or *Heterobranchus* sp. (Clariidae); *Synodontis* spp. (Mochokidae, at least two different species); Mugilidae indet.; *Semlikiichthys rhachirhinchus* (incertae sedis); *Lates niloticus* (Latidae); Sparidae indet.; *Argyrosomus* sp. (Sciaenidae); two unidentified perciforms and an unidentified tetraodontiform. Most taxa are of freshwater affinities and can be considered as typical members of the Neogene Nilosudanian ichthyoprovince. Their presence indicates that both fast flowing–pelagic and more marginal or stagnant freshwater habitats coexisted. However, the mugilids, sparids, sciaenids, and likely the two unidentified perciforms represent marine or euryhaline taxa whose modern relatives are known to invade estuaries. This diverse fish assemblage corresponds to the estuaries or the terminal part of the channel–delta of a large riverine system active during the Messinian.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW METHODOLOGY FOR 3D RECONSTRUCTION OF FOSSIL FISH USING DIGITAL IMAGERY

ARSENAULT, Félix, Centre de Développement et de Recherche en Imagerie Numérique, Matane, QC, Canada, G4W 0E1; BÉCHARD, Isabelle, Université du Québec à Rimouski, Rimouski, QC, Canada; CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QC, Canada; KERR, Johanne, Parc national de Miguasha, Nouvelle, QC, Canada

*Non-invasive technologies, such as CT-scan, traditional and synchrotron-based micro-CT-scan, are gaining in popularity for quantitative visualization of fossilized anatomical structures and ultrastructures. However, most studies in virtual paleontology are performed on a limited number of specimens owing to the cost of utilisation and the time required for image acquisition, processing, and interpretation. Usage of such technologies can also be limited by the taphonomic condition and size of the fossils, as well as the type of matrix surrounding the specimens. However, three-dimensional reconstruction (3D) of taxon does not necessarily require histological and ultrastructural investigation. Non-invasive 3D laser surface scanner provides the possibility to acquire high-definition surface-scanned images of prepared specimens without the potential limitations imposed by other technologies. Results are rapid and easy to use for research purpose and collection management. A new and precise method to 3D-reconstruct fossilized taxon was developed using a 3D laser surface scanner combined with cutting-edge digital imagery tools. Nineteen well-preserved and articulated specimens of the Late Devonian placoderm *Bothriolepis canadensis* (Miguasha, eastern Canada) were scanned at maximum resolution. Digital data were cleaned in an acquisition and processing software. Using a digital sculpting software, superposition of multiple 3D meshed models allows for size and shape corrections and taphonomical corrections providing an unbiased and accurate reconstruction of *B. canadensis*. This new digital reconstruction highlights previous anatomical misinterpretations on the morphology, size and shape, and articulation of this placoderm; most of the modifications would not have been possible without the usage of the digital 3D model.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

DISSECTING DINOSAURS: THE USE OF RESEARCH SPECIMENS IN HIGH SCHOOL BIOLOGY CLASSROOMS TO ENGAGE STUDENTS AS CITIZEN SCIENTISTS AND PROMOTE SCIENTIFIC LITERACY

ATTERHOLT, Jessie, University of California, Berkeley, CA, United States, 92720-4780

Community Resources for Science is a northern California non-profit organization that connects K-12 educators with local scientists through their Bay Area Scientists in Schools (BASIS) volunteer program. BASIS scientists visit primary and secondary school classrooms to conduct one-hour science lessons for which they provide materials and expertise otherwise unavailable to teachers, at no cost to the school. A lesson entitled ″Dissecting Dinosaurs,″ which involves students in an exploration of avian evolution and anatomy through bird dissections, has recently been designed and implemented in five high school biology classrooms in Oakland, California. The primary goals of this lesson are: 1) to excite students about science; and 2) to promote the use of critical thinking skills, such as inductive and deductive reasoning, analysis, and synthesis.

The specimens provided for this exercise are bird carcasses of a wide variety of native California taxa (among them, hawks, owls, pelicans, and grebes), collected for doctoral dissertation research at the University of California (UC), Berkeley and accessioned as specimens in the University's Museum of Vertebrate Zoology (MVZ). Main themes of the lesson are: the dinosaurian ancestry of birds, evidence of this relationship, and understanding basic avian anatomy and biology. Students also act as citizen scientists, collecting real data for the MVZ (including tissue samples, gonad identification and measurements, and notes on stomach contents). This lesson not only provides students with a unique opportunity to dissect wild birds, but also gives them an appreciation for local wildlife and helps to instill a critical-thinking toolkit fundamental to becoming scientifically literate citizens. During times of severe budget crisis, when underprivileged schools suffer from dwindling financial support, decreased access to teaching resources, and growing class sizes, action from outside of schools to improve education becomes critical. This exercise is an example of how research scientists from institutions such as UC Berkeley and the MVZ can combat the further degradation of our primary and secondary education system and improve scientific literacy in the United States.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW EVIDENCE THAT OMOMYID DIET, NOT BODY SIZE, WAS AFFECTED BY GLOBAL CLIMATE CHANGE

ATWATER, Amy, University of Oregon, Eugene, OR, United States, 97405; HOLROYD, Patricia, Univ of California Berkeley, Berkeley, CA, United States; DAVIS, Edward, Univ of California Berkeley, Eugene, OR, United States

The North American Eocene fossil record contains both the diversification and extinction of lineages of early mammals through a period of climatic changes that include fluctuations in temperature and precipitation. Omomyid primates have a well-documented evolutionary history, diversifying and subsequently disappearing in the context of regional climate change. Our study investigates possible drivers of omomyid evolution and extinction. We tested whether the evolutionary trajectories of body mass and inferred feeding ecologies in omomyid clades match our predictions for the effects of climate change and biological interactions. We gathered measurements of lower m1 area from 1092 specimens representing 24 genera and 45 species ranging from earliest Eocene to late Middle Eocene in age (55 to 43 Ma) as a proxy for body mass and added diet data from published literature in the form of shearing ratio based on tooth area of the lower m2. These body size and diet proxy data were then analyzed in a phylogenetic framework to reconstruct the ancestral state of these characters and document their changes through time. Our results indicate that taxonomic diversity and biological interactions were the main drivers of omomyid body size, while climate played a major role in diversification of omomyid feeding ecologies. These results highlight the importance of understanding and considering multiple factors in developing models for diversification and extinction. The details of omomyid extinction can be used to inform a model for extinction, which should help conservation efforts for extant organisms that share similar ecological niche spaces with these Eocene primates.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW SPECIMENS OF LEATHERBACK SEA TURTLES (DERMOCHELYIDAE) FROM THE MIOCENE OF ORANGE COUNTY SHED LIGHT ON MORPHOLOGICAL TRENDS

AWALT, Katrina, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States, 92834-6850; PARHAM, James, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States; HOLROYD, Patricia, Univ of California Berkeley, Berkeley, CA, United States

The Miocene is a key time in the evolutionary history of leatherback sea turtles, because it marks the last appearance of archaic thick-shelled forms (*Psephophorus* spp.). Current knowledge about Miocene dermochelyids is limited, and mainly based on specimens from Europe and the eastern USA. Recent studies have raised questions about the taxonomic diversity and biogeographic distribution of Miocene dermochelyids, and so the description of new specimens from this time, especially from new areas, is key. Although dermochelyid fossils are known from a few Miocene sites in California, the only published record is a single femur that was mentioned over 75 years ago (and misidentified as a cheloniid). Many important specimens from California have been unstudied in museum collections. Over the past decade, paleontological mitigation at three sites in Orange County resulted in the collection of new, relatively complete dermochelyid specimens from the middle Miocene Topanga Formation and late Miocene Monterey Formation. These specimens, in combination with more fragmentary specimens from other California sites, provide new data on the diversity, distribution, and morphology of dermochelyids in the eastern Pacific. We compare the morphology and stratigraphic position of these specimens to other Miocene dermochelyids in order to refine the temporal and geographic patterns associated with this important time in the evolutionary history of leatherbacks. The data show that the transition from archaic thick-shelled forms to the more thin-shelled forms includes intermediate morphotypes that appear sequentially within the Miocene marine formations of California.

Technical Session XI (Friday, November 1, 2013, 4:00 PM)

THREE BIOGEOGRAPHIC MODES OF CHANGE IN MIOCENE MAMMAL DIVERSITY FROM THE SIWALIK SEQUENCE OF THE INDIAN SUBCONTINENT

BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States, 48109-1079; DOMINGO, Soledad, University of Michigan, Ann Arbor, MI, United States; BARRY, John, Harvard Univ , Cambridge, MA, United States; FLYNN, Lawrence, Harvard Univ, Cambridge, MA, United States; MORGAN, Michele, Harvard Univ, Cambridge, MA, United States

The Siwalik fossil record of the Indian subcontinent documents ecosystem changes under different configurations of geodynamically controlled barriers and climatic change. Over the Neogene, the Siwalik faunal province, which extended from Pakistan to Myanmar, was either isolated or connected to Eurasia depending on sea level and montane barriers. Four biogeographic modes result from the interaction of permeable versus impermeable barriers and changing versus stable climates. Each mode corresponds to a unique set of macroevolutionary predictions for vertebrate faunas. For example, the combination of permeable barriers and climatic stability should result in low rates of immigration, speciation, and extinction, and stable ecological structure of Siwalik vertebrate faunas. Three of the four modes are present within the Siwalik sequence. We analyzed the diversification history of Siwalik mammals from 18.0 to 5.0 Ma based on fossil collections from northern Pakistan and evaluated whether periods of faunal change or stability correspond to the predictions for three biogeographic modes. We calculated confidence intervals on stratigraphic ranges and then analyzed per-capita rates of origination, extinction, diversification, and turnover per 0.5-myr intervals for small mammals (<1 kg) and large mammals separately. During two intervals of permeable barriers and changing climatic conditions, both small mammals and large mammals showed similar patterns of diversification, with a middle Miocene interval dominated by high origination rates and positive diversification and a late Miocene interval dominated by high extinction rates and negative diversification. During a middle Miocene interval of impermeable barriers and stable climate, large mammals exhibited stable diversity and small mammals showed modest turnover without significant change in diversity. During a late Miocene interval of permeable boundaries and stable climate, large mammals showed significant turnover but little change in diversity, whereas small mammals exhibited stable diversity. These patterns suggest that changing climatic conditions affect small mammals and large mammals in a similar manner via geographic-range shifts. In contrast, under stable climatic conditions, small mammals and large mammals showed non-synchronous turnovers and stable diversity. These contrasting patterns of faunal change and stability support the concept of multiple biogeographic modes of biotic change.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

POSTCRANIAL MORPHOLOGY OF THE EARLY EOCENE CHALICOTHERE *LITOLOPHUS GOBIENSIS* (MAMMALIA, PERISSODACTYLA)

BAI, Bin, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; WANG, Yuan-Qing, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Preliminary study of a large amount of postcranial material of the basal chalicothere *Litolophus gobiensis* recently collected from the early Arshantan deposits in the Erlian Basin, Inner Mongolia, China shows great potential in understanding the phylogenetic position of chalicotheres in the order Perissodactyla. The postcranial skeleton of *Litolophus* is generally similar to that of other early perissodactyls (e.g. *Hyracotherium*, *Homogalax*, *Heptodon*, and *Hyrachyus*) in having the following features: a deep scapular notch, a weak crest of thegreater tubercle and a weak deltoid tuberosity of the humerus, a quadrangular proximal articulation crossed by a sagittal ridge on the head of the radius, a long and posterodorsally extending olecranon tuber of the ulna, four metacarpals of the manus, a high and narrow trochlea of the femur, a shallow and wide extensor groove of the tibia, navicular and cuboid facets on a distal trochlea of the talus, three metatarsals of the pes, and a hoof-like ungual. The manus of *Litolophus* is more similar to that of *Lophiodon* than to other perissodactyls, supporting a close phylogenetic relationship between chalicotheres and lophiodonts. Their similarities include two aspects: (1) a scaphoid with a large distal lunar facet on the medial side extending anteroventrally to posterodorsally, while the proximal lunar facet is rather small; (2) an unciform with a prominent boundary between Mc III and Mc IV facets. The first character is also present in *Eomoropus amarorum* and *Anisodon grande*. By contrast, other early perissodactyls have equally developed proximal and distal lunar facets on scaphoids, and a curved and indistinct boundary between Mc III and Mc IV facets on unciforms. Furthermore, *Litolophus* displays a number of autapomorphies that distinguish it from other early perissodactyls examined in this study, such as the posterior thoracic vertebrae characterized by swollen mammillary processes, the last thoracic vertebra with prominent accessory processes, and a ridge-like anteromedial border of the cuboid being projecting medially. A comprehensive phylogenetic analysis of early perissodactyls based on both craniodental and postcranial characters will be conducted in the further study, which will shed new light on the early evolution of perissodactyls.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ONTOGENY OF CRANIAL SUTURES IN *ALLIGATOR MISSISSIPPIENSIS*: IMPLICATIONS FOR MATURITY ASSESSMENT IN NON-AVIAN DINOSAURS

BAILLEUL, Alida, Montana State University - Museum of the Rockies, Bozeman, MT, United States, 59717; SCANNELLA, John, Montana State University - Museum of the Rockies , Bozeman, MT, United States; HORNER, John, Montana State University - Museum of the Rockies, Bozeman, MT, United States

The degree of cranial suture obliteration has been used as a maturity indicator in non-avian dinosaurs. This hypothesis is based on patterns observed in some mammalian species, however a sequence of cranial suture closure is unknown in the extant phylogenetic bracket of the Dinosauria. This study shows (1) the sequence and timing of sutural closure and (2) the external sutural morphology during ontogeny in the skull of *Alligator mississippiensis* (Archosauria: Crocodylia). Cladistic methodology (in which immature character states were coded as zeroes, analogous to the plesiomorphic condition in phylogenetic analyses) was employed to determine the sequence of fusion in a sample of both sexually immature and mature specimens (n=6). Within the 25 sutures examined in each skull, only the metopic (interfrontal) and sagittal (interparietal) sutures fuse, the others stay open until well after sexual maturity is attained. In immature specimens the sutures appear externally more closed than those of more mature specimens, however this may reflect taphonomical effects rather than ontogeny. There is variation in timing between mature specimens. Interdigitation of sutures tends to increase through ontogeny. These preliminary results show that in *Alligator mississippiensis*: (1) the (simplistic) sequence of sutural closure exhibits variation and does not indicate maturity, (2) the observable degree of sutural closure might be due to taphonomy and should be taken into account when studying dried specimens, and (3) the shape of the sutures (straight versus interdigitated) may be a better maturity indicator than suture patency. This does not fit the typical mammalian model (where sutures stay open until sexual maturity is reached) that has been used for decades to attribute ontogenetic stages in non-avian dinosaurs. Thus it appears that the degree of sutural fusion may not be used as a maturity indicator in non-avian dinosaurs without further investigation, including examination of suture microstructure in both fossil and extant archosaurs.

Technical Session IX (Friday, November 1, 2013, 9:45 AM)

THE RELATIONSHIPS OF OVIRAPTOROSAUR DINOSAURS AND ENDOCRANIAL EVOLUTION ALONG A MORPHOLOGICALLY BIZARRE LINEAGE

BALANOFF, Amy, American Museum of Natural History, New York, NY, United States, 10024; BEVER, Gabe, New York Institute of Technology, Old Westbury, NY, United States; NORELL, Mark, American Museum of Natural History, New York, NY, United States

Oviraptorosaur dinosaurs include some of the most morphologically unique dinosaurs known. Although this unusual morphology makes their monophyly relatively clear, the relationships of species within the clade continue to be highly enigmatic. We attempted to clarify the phylogenetic relationships within Oviraptorosauria by sampling a number of new taxa and character systems. Many of the topological details recovered by previous studies were conserved in our analyses. This includes the basal position of tooth-bearing taxa such as *Incisivosaurus gauthieri* and *Caudipteryx zoui*. The more exclusive group Oviraptoridae, however, does not maintain its traditional topology. A stark example is that the 'crested' and 'crestless' oviraptorids no longer represent a basal divergence within the group, being replaced by a hypothesis in which the crested morphology evolved multiple times. We used the novel tree topology recovered from our phylogenetic analysis to study the evolutionary history of the oviraptorosaur endocranial space and brain. Previous studies have recognized morphological similarity between the cranial endocasts of oviraptorosaurs and birds, and concluded that this similarity is the homologous product of a close phylogenetic history. One way our study differs from these earlier works is that we bracket the entirety of known oviraptorosaur diversity by including the cranial endocast of the basally divergent *Incisivosaurus*, as well as those of several oviraptorids. We also significantly expand sampling within avialans and non-avialan maniraptorans. Our results indicate that characters shared with avialans, such as shortened olfactory tracts and an expanded cerebrum, are better explained as either convergent or plesiomorphic for Maniraptora. The oviraptorid endocranial morphology supports a surprising degree of evolutionary plasticity, possessing not only these "bird-like" characters but also features otherwise known only in basal coelurosaurs. Our study thus makes an important contribution to what is an increasingly complex history of theropod neuroanatomical evolution.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE DEVELOPMENT OF C_3 GRASSLANDS IN THE MIOCENE INFERRED FROM MESOWEAR IN GREAT PLAINS UNGULATES FROM NEBRASKA

BALDVINS, Tom, University of Nebraska-Lincoln, Lincoln, NE, United States, 68583; SECORD, Ross, Univ of Nebraska Lincoln, Lincoln, NE, United States

The spread of grasslands in the Miocene and Pliocene is considered a driving force behind the evolution of hypsodonty and other important faunal and ecological changes in the Neogene. However, although the late Miocene expansion of C_4 grasses can be readily documented using stable isotopes, the spread of C_3 grasses is more problematic. The phytolith record suggests expansion of C_3 grasses in the early Miocene while other proxies suggest a middle or late Miocene expansion. Here, we use mesowear analysis of ungulate mammals to infer vegetation change from the early Miocene (late Arikareean) through the late Miocene (Hemphillian). Diets were determined using factor analysis with a set of 27 typical extant herbivores. Of four late Arikareean taxa, our analysis indicates that one was a grazer (*Stenomylus hitchcoki*), two were mixed C_3 feeders (*Menoceras* sp., *Desmatchoerus* sp.), and one was a dicot browser (*Promerycochoerus* sp.). For Early Hemingfordian ungulates three were grazers (*Parahippus* sp., *Oxydactylus longirostris* , and *Protolabis* sp.) and three were mixed feeders (*Merychoerus* sp., *Aletomeryx gracilis*, and *Michenia* sp.). In the medial Barstovian three were grazers (*Calippus francisi*, *Merychippus* sp., and *Teleoceras* sp.) and two were mixed feeders (*Protohippus* sp. and *Ramoceros osborni*). The horse, *Neohipparion republicanus* was a grazer at one medial Barstovian locality and a mixed feeder at another. Four late Barstovian taxa (*Calippus placidus*, *Protohippus perditus*, *Merycodus* sp., and *Procamelus occidentalis*) were mixed feeders or grazers. *Merycodu* sp. was the only browser sampled during the late Barstovian. In the Clarendonian, two horses were grazers (*Neohipparion* sp. and

Nannihippus lenticularis) and one rhino was a mixed feeder (*Teleoceras major*). For the Hemphillian *Neohipparion eurystyle* was a grazer and *Calippus* sp. a mixed feeder. These results suggest a predominance of medium to large-bodied grazers and mixed feeders for most of the Miocene, and differ from hypsodonty proxies that suggest a much larger browsing component for the early and middle Miocene. The presence of several ungulates occupying a mixed feeder or grazer niche during the late Arikareean and Hemingfordian suggests that the expansion of C_3 grasslands was underway by the early Miocene. This is most consistent with the phytolith record that suggests an early Miocene patchwork of grasses and forests. Future work will focus on analyzing larger mesowear samples from a broader range of taxa to test these preliminary findings.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

WHAT CAN PALEOPATHOLOGY TELL US ABOUT HUNTING MODES?

BALISI, Mairin, University of California, Los Angeles, Los Angeles, CA, United States, 90095; BROWN, Caitlin, University of California, Los Angeles, Los Angeles, CA, United States; VAN VALKENBURGH, Blaire, Univ of California Los Angeles, Los Angeles, CA, United States; SHAW, Christopher, George C Page Museum, Los Angeles, CA, United States

Living mammalian predators sustain injuries from hunting that can be preserved after death in pathological lesions of the skeletal elements. Consequently, the location of such injuries on a skeleton might reflect the hunting mode of the animal in life. In this study, we quantified osteological pathologies in the two most abundant mammalian predators from the late Pleistocene La Brea Tar Pits in Los Angeles, CA, USA –*Canis dirus*, the dire wolf, and *Smilodon fatalis*, the saber-tooth cat – the former inferred to hunt by pursuit and the latter by ambush. We surveyed specimens from Pit 61/67, the most recent and most chronologically constrained deposit (11,581 ± 3768 years). *S. fatalis* exhibited pathologies attributed to trauma more often in the ribs and thoracic and lumbar vertebrae, and also demonstrated more vertebral fusion and sternal injuries than *C. dirus*. The preponderance of *C. dirus* injuries occurred in the limbs rather than in the post-cranial axial skeleton, but *C. dirus* exhibited more injuries to the skull (cranium + mandible) than *S. fatalis*. Both species showed equal injury frequency between left and right sides. Preservational bias is unlikely to account for the interspecific differences in injury frequency, as Pit 61/67 preserves comparable numbers of *C. dirus* and *S. fatalis* individuals. Rather, these differences suggest that *C. dirus* was a pursuit hunter similar to gray wolves today, suffering injuries to the skull and distal limbs from contact with the hooves of prey. Unlike the putative pursuit predator *C. dirus*, *S. fatalis* has a lower frequency of distal limb and facial trauma and appears to have sustained injuries during forceful grappling with large prey, suggesting ambush predation. Paleopathology can supplement traditional morphometric and biomechanical methods in inferring hunting modes of extinct predators. This study provides a starting point for inferring hunting mode from bone injuries in other predator traps, such as the Talara tar seeps in Peru, which, like La Brea, is likely to have a significant number of predators with skeletal pathologies.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE USE OF GEOMETRIC MORPHOMETRIC DATA TO SOLVE PHYLOGENETIC INCONGRUENCES WITHIN ANHANGUERIDAE (PTEROSAURIA, PTERODACTYLOIDEA)

BANTIM, Renan, Universidade Federal de Pernambuco , Recife, Brazil; SAYÃO, Juliana, Universidade Federal de Pernambuco, Vitória de Santo Antão, Brazil

The most distinctive characteristic of anhanguerid pterosaurs is the presence of a premaxillary and dentary sagittal crests confined to the anterior portion of the skull. This structure shows great variation in size, and may be a potential feature to solve systematic incongruences. This work compares geometric morphometric landmarks of six anhanguerid species from Brazil with phylogenetic data in order to resolve the polytomy composed of the *Anhanguera* species on known phylogenies. Twenty eight landmarks were defined in the right lateral view of the skull, positioned in specific regions, of those 13 landmarks were positioned at the ends of the skull (quadrate, quadratojugal, opisthotic, supraorbital and premaxilla) and the remaining 15 landmarks were marked on the premaxillary sagittal crest as a curve function. The graphic resulting from the Principal Component Analysis (PCA) identified three distinct clusters, where PC1 represents the height of the crest and PC2 the length of the sagittal premaxillary crest. The first one united the species *Tropeognathus mesembrinus* and *Anhanguera spielbergi*. The second group is composed of *Anhanguera blittersdorffi* and *Anhanguera araripensis*. The third contains *Anhanguera piscator* and *Anhanguera santanae*. The main morphological characteristics that separate the groups are the form, proportion and position of the premaxillary crest in the skull, which is similar within the taxa in the same cluster. Thus the features of the premaxillary crest showed a good source of data to solve the polytomy within the *Anhanguera* in the pterosaur phylogenies known to date. Thus, this result demonstrates the importance of morphometric characters as a support for the systematic studies of pterosaurs.

Technical Session IV (Wednesday, October 30, 2013, 3:45 PM)

ESTABLISHING THE CHRONOLOGY OF QUATERNARY MEGAFAUNAL EXTINCTION IN SOUTH AMERICA

BARNOSKY, Anthony, University of California, Berkeley, CA, United States, 94720; LINDSEY, Emily, University of California, Berkeley, CA, United States; VILLAVECENCIO, Natalia, University of California, Berkeley, CA, United States; MARSHALL, Charles, University of California, Berkeley, CA, United States

South America lost more genera and species of large mammals than did any other continent during the Late Quaternary Megafaunal Extinction (LQE), yet less is known about the chronology, causes, and consequences of the extinction in South America than elsewhere. Here we report initial results of an international, multidisciplinary effort to assess the timing of the LQE in South America and how it coincides (or not) with major climatic changes and human settlement on a region-by-region basis. Dated megafaunal remains are now known from the northern tropics and subtropics; central Argentina; eastern and northern Brazil; northern Chile, Peru, and vicinity; and Patagonia. Available information suggests megafaunal extinction, human settlement, and climatic change were more or less simultaneous in Patagonia, but that extinctions began before, and finished long after, initial human presence in Brazil. In central Argentina, extinctions may have began near the time of first abundant human presence, which was also coincident with a major climatic fluctuation, but several taxa persisted for thousands of years afterwards. At least three genera in central Argentina and Brazil have what appear to be good radiocarbon dates that place them well into the Holocene. Brazil may exhibit a pulse of extinction that coincides with both initial human occupation and end-Pleistocene climatic fluctuations, but the small number of radiocarbon dates per taxon so far precludes a statistically robust conclusion. Extinction patterns in northern Chile and the northern subtropics and tropics have not yet emerged due to paucity of dates, but additional dating efforts are presently underway. Overall, the chronology that is coming to light suggests a synergy of human impacts plus climatically-caused environmental change may have resulted in a more rapid, temporally constrained extinction event in Patagonia compared to Brazil and central Argentina, where extinctions may have been protracted over several thousand years. At the continental scale, the LQE event in South America seems to have spanned more time than it did in North America. Intensive radiocarbon-dating efforts are now in progress in order to test these initial impressions.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DINOSAUR INTEGUMENT: WHAT DO WE REALLY KNOW?

BARRETT, Paul, The Natural History Museum, London, United Kingdom; EVANS, David, Univ of Toronto at Mississauga, Toronto, ON, Canada

Osteoderms and scaly skin impressions are historically well known in non-avian dinosaurs. Recent discoveries have demonstrated that in addition to these structures, many dinosaur taxa possessed other integumentary features, including a range of 'quills,' filaments, and feathers in non-avian theropods and ornithischians. Feathers and their homologs are commonly regarded as a synapomorphy of either coelurosaurian or tetanuran theropods, but some authors have gone further, using the presence of ornithischian feather-like structures to suggest that these structures are plesiomorphic for Dinosauria. This inference has wide-ranging implications for dinosaur biology and evolution.

However, to date, no studies have attempted to assess rigorously the evolution of dinosaur integumentary structures within a broad phylogenetic context. We compiled a complete database of all epidermal integumentary structures reported in dinosaurs, by major body region, in order to investigate the origin of feather homologs and the evolution of integumentary structures in the clade. Scales are definitively present in virtually all major ornithischian clades. This, and the presence of extensive armour in thyreophorans suggests that genasaurian skins were primitively scaly. Similarly, sauropodomorphs lack evidence for anything other than scales or osteoderms. Fitch optimization of integument types on dinosaur phylogenies shows that there is no unequivocal support for inferring a deep origin of feather-like structures, a result supported by maximum likelihood ancestral state reconstructions for these characters. The structures in *Tianyulong* and *Psittacosaurus* are best regarded as autapomorphic integumentary modifications, and there is currently no strong evidence that these features are feather homologs. Further work on the chemical composition of these structures, and those in several non-coelurosaurian theropods, is needed. Although ornithodirans exhibit a range of integumentary novelties that may be related to the origin of feathers, theropods are currently the only dinosaurs that display unequivocal evidence of feathers and their direct homologs.

Technical Session II (Wednesday, October 30, 2013, 9:00 AM)

INVESTIGATING THE APPLICABILITY OF OUTLINE-BASED GEOMETRIC MORPHOMETRIC TECHNIQUES TO THE STUDY OF UNGULATE MESOWEAR

BARRON-ORTIZ, Christian, University of Calgary, Calgary, AB, Canada, T2N 1N4; MIHLBACHLER, Matthew, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States; RANKIN, Brian, University of Calgary, Calgary, AB, Canada; THEODOR, Jessica, University of Calgary, Calgary, AB, Canada

Traditional mesowear analyses are invaluable for inferring the diets of extant and, more commonly, extinct ungulate mammals; however, subjectivity in assessing variables relating to cusp sharpness and relief has resulted in the inability to provide a comprehensive description and characterization of molar cusp shape. Detailed outline-based geometric morphometric techniques offer a more quantitative approach for describing and analyzing cusp morphology and the application of this work was examined here. The study sample consisted of 340 wild-shot ungulates representing 37 extant species including eleven grazers, twelve mixed feeders, eight leaf browsers, and six fruit-dominated browsers belonging to the genus *Cephalophus*. Mesowear was quantified on the metacone cusp of the second upper molar by digitizing a series of semilandmarks along the cusp outline using digital photographs of teeth taken at a standardized angle. Average cusp shape was calculated for every species and the resulting coordinates were analyzed using two different methodologies: sliding semilandmarks and eigenshape analysis. In both analyses, the first two components explain over 60 percent of the variation in the data and each dietary group tends to occupy a different region of the morphospace. Notably, the first axis of the eigenshape analysis describes variation in cusp relief and apex orientation, in which leaf browsers plot opposite to grazers, whereas mixed feeders and fruit-dominated browsers occupy intermediate positions. Multivariate analysis of variance (MANOVA) tests and post-hoc

pairwise comparisons identify significant differences between dietary groups in the two analyses, except between fruit-dominated browsers and grazers as well as between fruit-dominated browsers and mixed feeders. These results corroborate previous observations that small fruit-dominated browsers tend to have lower cusps, unlike those reported for leaf browsers. Examination of the relationship between cusp shape and tooth size via multivariate regression reveals that mesowear varies independently of tooth size, indicating the mesowear signal is not offset by size differences between taxa. Outline-based geometric morphometric techniques offer a consistent, less subjective approach to analyzing cusp shape. Expansion of the extant ungulate dataset will better elucidate the extent and applicability of this novel approach to reconstructing ungulate diets.

Preparators' Session (Thursday, October 31, 2013, 9:30 AM)

PREPARATION OF A CROCODYLIFORM AND SAUROPOD DINOSAUR FROM MONTANA: SOLUTIONS TO COMPLEX MOLDING PROBLEMS

BAZIAK, Brian, Museum of the Rockies, Bozeman, MT, United States, 59717

An articulated marine crocodyliform and a partially articulated sauropod skull and cervical series were collected from Montana and prepared at the Museum of the Rockies. Both specimens posed unique problems for molding. The 2.2m long crocodyliform (~50% complete) specimen is to remain in articulation for display, but a cast of the skull and cervical series needed to be available for researchers. Therefore it was necessary to mold these elements while still in articulation because they likely could not be replaced if they were removed. This was a challenge because of the size and fragility of the specimen. A silicone rubber mold (Smooth-On Mold Max 20) and plaster mother mold (Hydrocal FGR 95 with fiberglass filter media) was applied to the dorsal surface, with the posterior most cervical vertebrae acting as the pour spout. A partial plaster cradle to cover the unmolded dorsal areas of the specimen was then added. This allowed the specimen to be rolled so the ventral side of the mold could be completed using the same procedure without damaging the specimen. After removing the ventral side of the mold, the full ventral cradle was replaced so the specimen could be rolled and the dorsal side of the mold removed.

The partially articulated sauropod skull and cervical series presented molding challenges as well. Prior to removing each element it was necessary to mold the entire specimen within the matrix to preserve a record of the taphonomy. Photogrammetry was attempted, but did not provide adequate detail. The left lateral side of the skull and neck were exposed, and as much matrix was removed as possible while still leaving the neck in articulation. Molding was complicated by the fact that the specimen is quite large (2.1m long), and the right lateral side of the specimen still needed to be prepared. The left lateral side was molded using the same procedure as the crocodyliform. Loops of plastic mesh were incorporated into the silicone and passed through slots made in the plaster. During casting rods were placed in the loops to hold the silicone tight against the plaster to prevent loss of shape. The plaster mother mold was created in two parts enabling easier removal later. Rebar was also added along the length of the mother mold for additional support as it also functioned as a cradle when the specimen was rolled to prepare the other side. Once the specimen was rolled, much of the remaining matrix was removed and the molding process was repeated.

The molding of both of these specimens helped develop new techniques, as well as improving old ones, and will help in future molding procedures.

Technical Session VI (Thursday, October 31, 2013, 11:00 AM)

A NEW EARLY OLIGOCENE VERTEBRATE FAUNA FROM ZALLAH OASIS, SIRT BASIN, LIBYA YIELDS THE OLDEST KNOWN AFRICAN CARNIVORAN

BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, United States, 15213; COSTER, Pauline, Carnegie Museum of Natural History, Pittsburgh, PA, United States; SALEM, Mustafa, University of Tripoli, Tripoli, Libya; CHAIMANEE, Yaowalak, Universite de Poitiers, Poitiers, France; JAEGER, Jean-Jacques, Universite de Poitiers, Poitiers, France

Fieldwork during January 2013 in Paleogene strata exposed near Zallah Oasis in the Sirt Basin of central Libya has yielded the first diverse vertebrate fauna of early Oligocene age known from that country. The new site, known as the Incision Locality or Zallah 7, occurs in a rock unit provisionally mapped as Oligocene ″Continental and Transitional Marine Deposits.″ Fossil vertebrates occur at the base of a fluvial channel comprised of fine-grained sandstone. As currently understood, the Incision local fauna includes sharks, rays, bony fishes, crocodilians, sirenians, hyracoids, hystricognathous rodents, the anthracothere *Bothriogenys*, the anthropoid primate *Apidium*, and a ″miacoid″ stem carnivoran. The Incision local fauna can be compared with the sequence of later Paleogene faunas known from the Fayum region of northern Egypt, where the closest resemblance to the new Libyan fauna lies with the assemblage known from Fayum Quarry V. If this correlation proves to be accurate, the Incision local fauna would date to ~31-32 Ma based on current correlation of the Fayum sequence to the GPTS. The *Apidium* specimens from the Incision Locality are the first Oligocene anthropoids to be discovered in Libya, but the most unexpected faunal element from the new site is the miacoid carnivoran. The Zallah miacoid is the first record of a stem carnivoran from Africa and the oldest record of an undoubted carnivoran from that continent by a wide margin (the next oldest record being from the late Oligocene of northern Kenya, ~6-7 Ma later). Prior to the discovery of the Zallah miacoid, it was widely assumed that the only predatory mammals inhabiting the island continent of Africa during the Paleogene were creodonts, which are recorded in considerable diversity in the Fayum sequence in Egypt and other broadly contemporaneous faunas such as Taqah in Oman. The discovery of the Zallah miacoid suggests the development of at least a moderate degree of faunal provincialism across the northern part of Afro-Arabia during the early Oligocene, possibly related to habitat fragmentation caused by the cooler, drier conditions of that interval. Biogeographically, the Zallah miacoid apparently signals the successful colonization of Africa by yet another Asian mammal clade prior to the tectonic collision between Africa and Eurasia near the Oligo-Miocene boundary. Miacoids are unknown from Europe after the middle Eocene, but they range up to the end of the Eocene in southeastern Asia, as documented by *Miacis thailandicus* from the late Eocene Krabi fauna of peninsular Thailand.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE SIGNIFICANCE OF SPATIAL AND TEMPORAL VARIATION IN THE TAPHONOMY OF ICHTHYOPTERYGIANS

BEARDMORE, Susan, School of Geological Science, University College Dublin, Dublin, Ireland; ORR, Patrick, School of Geological Science, University College Dublin, Dublin, Ireland; FURRER, Heinz, Palaontologisches Institut und Museum der Universitat Zurich, Karl Schmid-Strasse 4, Zurich, Switzerland

Ichthyopterygia is a group of extinct Mesozoic reptiles with a highly resolved phylogeny, conservative morphology, a wide paleogeographic distribution and, relative to many other vertebrates, an abundant fossil record. Syntheses of the skeletal taphonomy of ichthyopterygians over extended spatial and temporal intervals are an opportunity to investigate what, if any, trends in the fidelity of preservation exist in response to regional-scale variation in environmental conditions. For various vertebrate taxa, such trends have been shown to correlate with environmental gradients that impact the rate of decay of non-biomineralized tissues and fidelity of skeletal preservation. An investigation of the taphonomy of selected ichthyopterygian datasets, representing the Besano (Middle Triassic, Switzerland), Posidonienschiefer (Lower Jurassic, Germany) and Blue Lias (Lower Jurassic, UK) formations, was undertaken using a semi-quantitative method that divides a tetrapod skeleton into nine anatomical units and assesses the completeness and articulation of each. Individual specimens exhibit variable loss of articulation that tends to be focused in peripheral, rather than medial, regions and is strongly decoupled from loss of completeness. Limbs repeatedly disarticulate first, and often only, at the proximal (shoulder/hip) joint; the presence of elements distal to this point in fossilized specimens implies carcasses arrived at the sediment shortly after death and intact, disarticulating subsequently as soft tissue decay progressed. The T-value, a single value defining the overall state of preservation for specimens in each dataset, is 78% for Besano, 66% for Posidonienschiefer, and 35% for Blue Lias formation specimens, suggesting there is significant variation in preservation between the datasets despite markedly similar host lithologies. The above patterns and features infer that the underlying biology of ichthyopterygians was unlikely to have been the primary cause of variation in their taphonomy. Instead, variation between the datasets can be confidently attributed to subtle environmental differences in the interval between deposition of the carcass at the sediment-water interface and final burial at each locality investigated.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE SUBTLE HETERODONTY OF ODONTOCETES

BEATTY, Brian, NYIT College of Osteopathic Medicine, Old Westbury, NY, United States, 11568

Fossil odontocete paleoecology studies are challenging because many methods (stable isotopes, dental microwear) rely on teeth. Such studies require decent sample sizes to be statistically reliable, though identifiable skulls from single localities are uncommon. Isolated teeth are more common, but difficult to identify. A careful analysis of odontocete dentitions is needed, so I qualitatively and morphometrically described the teeth of 15 species of modern odontocetes and many fossil taxa of the West Atlantic coast's largest Miocene faunas, the Calvert Cliffs (MD) and Lee Creek Mine (NC). This includes the squalodontid *Squalodon calvertensis*, the squalodephid *Phocageneus*, kentriodontids *Delphinodon dividum* and *D. mento*, the eurhinodelphinid *Schizodelphis morckhoviensis*, and the platanistid *Pomatodelphis bobengi*. Odontocete teeth are not all the same, but each successive tooth along the tooth row is slightly different from the adjacent teeth, amounting to major differences between the teeth found at the most mesial and distal ends. This continuum is challenging to account for without measuring and describing each and every tooth. But, often teeth are missing, too worn, or merely differ from adjacent teeth in ways that are not greater than the range of observer error. To simplify this, I measured and described these teeth in categories of mesial (M), intermediate (I), and distal (D). Squalodontid M teeth are elongate and narrow, D teeth are multicusped and serrated. *Phocageneus* crowns have large distal carinae that wear to a shearing facet. *Phocageneus* enamel is rough and includes cuspules from the cingulum that are generally smaller, numerous, and found on labial and lingual sides of all teeth, unlike *Delphinodon* and other kentriodontids that have such cuspules only on D teeth. Eurhinodelphinids generally have labiolingually flattened, slender M teeth that form carinae along the mesiodistal rims of the apical half. Kentriodontid teeth have slender, smooth enameled I teeth with a round cross section and are a little flat mesiodistally, slight curved, and have a crown in line with root. The D teeth are rounder in cross section, with crowns that are swollen and round with crown base lingual cuspules. The differences between *Delphinodon mento* and other kentriodontids are mostly the larger size and fewer number of cuspules of *D. mento*. Platanistids M teeth have curved crowns typically oriented >45° to the long axis of the root, with mesial and distal carinae near the base of the crown.

Technical Session XIII (Friday, November 1, 2013, 2:45 PM)

EXTERNAL MORPHOLOGY OF THE DEVONIAN PLACODERM *BOTHRIOLEPIS CANADENSIS* REVISITED IN 3D

BÉCHARD, Isabelle, Université du Québec à Rimouski, Rimouski, QC, Canada, G5L 3A1; ARSENAULT, Félix, Centre de Développement et de Recherche en Imagerie Numérique, Matane, QC, Canada; CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QC, Canada; KERR, Johanne, Parc national de Miguasha, Nouvelle, QC, Canada

The external morphology of the well-known, middle Frasnian *Bothriolepis canadensis* from the Escuminac Formation (Miguasha, Canada) is revised using cutting-edge technology in three-dimensional (3D) digital imagery. Nineteen well-preserved and articulated specimens of *B. canadensis* were used to reconstruct a 3D digital model of the dermal armor (cephalic and thoracic parts covering 35.6% of the total length), whereas four specimens were used to reconstruct the posterior part of the body. The 3D model representing a large adult specimen (44 cm total length) allows us to investigate some biomechanical aspects and constraints. Mobility of the cephalic armor, submarginal plates ("opercular plates") and pectoral fins has been previously hypothesized based on inaccurate reconstructions. In contrast to previous reconstructions, there is no indication of mobility between the cephalic and thoracic armors. The submarginal plate is fixed upon the cephalic armor; a gill opening is located between the submarginal plate and the anterior ventrolateral plate of the thoracic armor. The median dorsal ridge of the thoracic armor forms a hydrodynamic dorsal crest with its maximum height along the posterior median dorsal plate. In contrast to previous interpretations, the fully retracted and protracted (70º) position of the pectoral fin allows only for restricted movement. Maximum of mobility is reached in a protracted angle of 16º which allows a rotation of 30º around the brachial process and 20º in an up-and-down movement. The 3D model of *B. canadensis* brings out some unexpected novelties on a supposedly well-known Devonian fish.

Technical Session X (Friday, November 1, 2013, 11:00 AM)

OLDEST DIRECT EVIDENCE OF DENTAL DEVELOPMENTAL DELAY AND ENCEPHALIZATION IN A LATE MIOCENE HOMININE.

BEGUN, David, University of Toronto, Toronto, ON, Canada, M5S2S2

Rudabánya is a late Miocene locality in central Hungary with a rich vertebrate fauna that includes one of the largest and best preserved samples of an early hominine, *Rudapithecus hungaricus*. The sample includes two partial crania sufficiently well preserved to provide the basis for an estimate of cranial capacity. One of these specimens, RUD 200, has a complete upper and lower dentition with very little occlusal wear. Synchrotron images of RUD 200 reveal a periodicity of seven days, which is consistent with extant hominid dental developmental rates and is significantly slower than in other catarrhines. RUD 200 and another specimen, RUD 77, preserve intact cranial lengths, which allow for a reliable estimate of cranial capacity. In both cases they are well within the range of extant chimpanzees. A sub-adult mandible, RUD 14, preserves a pattern of dental development identical to that of extant hominids regarding eruption sequence and timing. Taken together, these data provide the oldest evidence of the well-known correlation in extant hominids of a life history slow-down and brain size increase. While there is evidence that *Sivapithecus*, a late Miocene pongine from South Asia, also experienced a slowing of life history (age of M1 emergence), brain size is not known in this taxon. In contrast, age of M1 emergence and brain size in *Proconsul*, an early Miocene ape, suggest a cercopithecoid-like pattern of life history. Finally, *Rudapithecus*, especially RUD 200, is smaller than any extant hominid, suggesting that brain size increase in great apes is causally related to developmental delay and not a simple by-product of an increase in body mass. Research funded by grants from NGS, NSERC, Alexander von Humboldt Stiftung, and the University of Toronto

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW BASAL STEREOSPONDYL (TEMNOSPONDYLI) FROM THE LOWER TRIASSIC FREMOUW FORMATION OF ANTARCTICA

BEIGHTOL V, Charles, University of Washington, Seattle, WA, United States, 98103; HUTTENLOCKER, Adam K., University of Washington, Seattle, WA, United States; PEECOOK, Brandon, University of Washington, Seattle, WA, United States; SIDOR, Christian, University of Washington, Seattle, WA, United States; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa

The first vertebrate fossil recovered from Antarctica was Austrobrachyops, a temnospondyl from Graphite Peak in the central Transantarctic Mountains. Five temnospondyl taxa have been described from the Triassic of Antarctica (Austrobrachyops, Cryobatrachus, Kryostega, Parotosuchus, and another large paracyclotosaur). We describe a new stereospondyl from the Lower Triassic lower Fremouw Formation based on new material collected at Graphite Peak in 2011. The new taxon is a partial skull preserved in a green fissile sandy siltstone bed about 50 m above the Permo-Triassic boundary. This taxon has an estimated basal skull length of 42 mm and is characterized by a posteriorly convex prefrontal, a large ventral process on the palatine ramus of the pterygoid, a small infraorbital bar, and a ridge on the quadratojugal that parallels the marginal tooth row. The skull also has a relatively large cheek that lacks sensory sulci, which suggests a terrestrial habit. The new specimen was included in a phylogenetic analysis, with a matrix consisting of 121 characters and 37 taxa, spanning Temnospondyli. The new Antarctic taxon falls basally within Stereospondyli. It is placed as the sister group to the Lower Triassic family Lapillopsidae in the most parsimonious tree, but with weak support, forming a polytomy with lapillopsids and lydekkerinids among basal stereospondyls in the bootstrap tree. Lapillopsids are semiterrestrial stereospondyls unique to southeastern Gondwana, and have been found only in Australia and India, with the new species being the first putative occurrence in Antarctica. Each of the known lapillopsid species is endemic to its respective basin and the new Antarctic taxon reinforces this pattern of endemism. Early Triassic temnospondyls in southern Pangea are generally more provincial than contemporaneous terrestrial amniotes (e.g. Thrinaxodon, Lystrosaurus, Prolacerta, Procolophon; the dicynodont Kombuisia is a possible exception), which were found throughout the Beacon Basin and the more northerly Karoo Basin of South Africa. All known temnospondyls from both the Lower and Middle Triassic of Antarctica are endemic with the exception of the genus Parotosuchus. It is possible that endemism arose in temnospondyls as the climate shifted from cool and seasonally wet-dry during late Permian times to drier and warmer in the Early Triassic.

Technical Session VII (Thursday, October 31, 2013, 3:45 PM)

USING THE CHARACTER COMPLETENESS METRIC TO EXAMINE COMPLETENESS OF MESOZOIC DINOSAURS: A MAASTRICHTIAN HIGH AND A PALEOEQUATORIAL LOW

BELL, Mark, University College London, London, United Kingdom; UPCHURCH, Paul, Univ College London, London, United Kingdom; MANNION, Philip, Imperial College London, London, United Kingdom; LLOYD, Graeme, Univ of Oxford, Oxford, United Kingdom

A recently proposed metric for quantifying the completeness of fossil taxa is applied to Mesozoic dinosaurs; the Character Completeness Metric (CCM) measures the percentage of morphological characters available for scoring in phylogenetic data matrices. Calculating completeness is important for our understanding of the quality of the rock record and for any interpretations we may make of the resultant patterns. This method has previously been applied to both sauropodomorph dinosaurs and Mesozoic birds. Here, we expand this to include all Mesozoic dinosaurs as a case study for the application of a new computerized technique.

The source of data for this study is a compilation of over 500 published character matrices. New code written in R calculates the mean CCM of taxa across all matrices. The mean CCM value for each stratigraphic stage was calculated through rarefaction of all species means for that interval. One important caveat is the bias against species not incorporated in a phylogenetic analysis; in order to assess the effect of this, a comparison is made with a previous study of sauropodomorphs using both scored and unscored species. Both datasets show a trend of decreasing completeness with time and therefore supports the use of the new method.

Spearman-rank correlations were conducted between mean CCM and dinosaur diversity (using both raw taxic and subsampled species diversity) as well as estimates of worker effort. Comparisons were made between two broad groupings: theropods (including birds) and ornithischians + sauropodomorphs. Lastly, we examined the relationship between paleolatitude and completeness in the Cretaceous.

Dinosaurs show a decreasing trend in completeness between the Carnian and Cenomanian followed by a rapid increase until their highest mean value in the Maastrichtian. This Maastrichtian peak is shown most strongly in theropods and ornithischians. Significant positive relationships were recovered with taxic diversity and worker effort with no relationship recovered with subsampled diversity. The palaeolatitudinal completeness of dinosaurs shows a similar trend to that documented for their diversity, with peaks in paleotemperate regions, and the lowest values near the paleoequator. This pattern is most prominent in theropods and ornithischians. This study demonstrates that although dinosaur completeness varied throughout their evolutionary history, the decoupling from sample-corrected diversity suggests that patterns of dinosaur diversity are not controlled by the quality of their fossil record.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ON THE APPENDICULAR ANATOMY OF *MARILIASUCHUS AMARALI* (CROCODYLIFORMES: NOTOSUCHIA) FROM THE UPPER CRETACEOUS (BAURU GROUP) OF BRAZIL

BELMONTE, Simone, Museu Nacional, Rio de Janeiro, Brazil; FIGUEIREDO, Rodrigo, Museu Nacional, Rio de Janeiro, Brazil; CARVALHO, Luciana, Museu Nacional, Rio de Janeiro, Brazil; AZEVEDO, Sergio, Museu Nacional, Rio de Janeiro, Brazil; ROMANO, Pedro, Universidade Federal de Vicosa, Vicosa, Brazil

Crocodyliforms were remarkably diverse during the Cretaceous of Gondwana. The Notosuchia was the most representative taxon from the southern landmasses, a group that encompasses several different clades of terrestrial animals with oreinirostral skulls and very specialized dentition. The fossil record of the Bauru Group (Upper Cretaceous) of Brazil is rich in such fossil crocodyliforms and it is the geological unit from which all material of *Mariliasuchus amarali* was recovered to date. The relative large number of well-preserved specimens makes it one of the best-studied Brazilian notosuchians. Nevertheless, the postcranial anatomy of this species has not been the object of a detailed study. Here we describe the appendicular skeleton of *Mariliasuchus amarali* based both on juvenile (Museu Nacional [MN] 6298-V) and adult specimens (MN 6751-V). CT-scans and rapid prototyping technologies were used in order to recover important morphological data due the fragile nature of these fossils. *Mariliasuchus* has long and robust limbs with a radius and ulna subequal in size. The femur lacks the well-marked constriction between the proximal end and the axis. The supracetabular crest has a restricted pattern of grooves located on its posterior-most region. There is a posterodorsal hook on the scapular blade, as observed in *Simosuchus* and some protosuchians. *Mariliasuchus* also shows features regarded as synapomorphies of Notosuchia, such as the presence of a deep circular depression on the posterior surface of the proximal humerus and the horizontally directed ventral margin of the postacetabular iliac process. Furthermore, there are several unique traits that can be used to diagnose this taxon: the large reniform fossa on the lateroposterior surface of the humerus, the presence of three large subcircular depressions on dorsal surface of the ilium, and the metatarsals II and IV, which are subequal in length. Ontogenetic variation in cranial morphology was previously known, and is also present in the shoulder girdle. The posterior margin of the scapula is straight in juveniles (MN 6298-V) and become concave in mature specimens (MN 6751-V). The observed osteological landmarks (e.g. scars, fossae and grooves) suggest that *Mariliasuchus amarali* had a well-developed musculature, especially on the forelimbs.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A PATHOLOGICAL TIMBER WOLF (*CANIS LUPUS*) FEMUR INDICATES EXTENDED SURVIVAL AFTER TRAUMATIC AMPUTATION INJURY

BENNETT, Bryan, California State University San Bernardino, San Bernardino, CA, United States, 92407; SCOTT, Kim, California State Univ San Bernardino, Ontario, CA, United States; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States; REGA, Elizabeth, Western University of Health Sciences, Pomona, CA, United States; SUMIDA, Stuart, California State Univ San Bernardino, San Bernardino, CA, United States

The proximal portion of a pathological right femur of a timber wolf (*Canis lupus*) from the (late Pleistocene) Rancho La Brea asphalt deposits of Los Angeles, California demonstrates advanced healing along the entire distal fragment surface, in a plane distal and oblique to the greater trochanter. No evidence of a fused or articulating distal femur remains. Two possiblities arise: a pseudarthrosis (false joint) resulted from osseous non-union or a complete amputation event occurred with subsequent healing of the remaining bony shaft. Either case indicates that the animal survived for a significant amount of time after the traumatic injury was inflicted. The angle of the break in the damaged femur suggests it broke as a result of an extremely violent event, such as a fall from great height, or violent snapping of the limb by another, larger predator. The fact that the proximal femoral segment had adequate time to heal means the violent event could not have been the cause of death. Further, that the individual lived for a significant amount of time post-injury means it must have retained adequate hunting and/or scavenging ability to survive. Alternatively if it was a member of a pack or other social group, that group may have facilitated, or minimally tolerated, the inclusion of the injured individual. Because there is no functional connection to the more distal limb elements, the individual must have had either a useless lower right leg, or may have adopted a completely tripodal lifestyle.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

REINTERPRETATION OF THE WINGS OF *PTERODACTYLUS ANTIQUUS* BASED ON THE VIENNA SPECIMEN

BENNETT, S. Christopher, Fort Hays State Univ, Hays, KS, United States, 67601-4099

The Vienna specimen of *Pterodactylus antiquus* (Natural History Museum, Vienna specimen NHMW 1975/1756/0000) is complete, fully articulated, and preserves propatagial and brachiopatagial soft tissues on part and counterpart slabs. When first described, linear features in the patagia were interpreted as widely spaced cylindrical internal elastic actinofibrils present throughout the brachiopatagium, a projection into the suboval window framed by trailing edge behind the right elbow was interpreted as the result of bunching of actinofibrils originating at the carpus, and it was suggested that the appearance that the brachiopatagium attached to the distal femur might be misleading because *Desmodus* can present a similar appearance with wings folded at rest. The recent discovery of closely spaced broad flat keratinous actinofibrils and distinct fold lines in the wings of *Rhamphorhynchus muensteri* (e.g., Zittel wing, Marsh specimen) prompted a reevaluation of the Vienna specimen. It was found that linear features in the patagia include: 1) closely spaced broad flat structures subparallel to wing phalanges, lightly permineralized with calcite on the upper slab, interpreted as keratinous actinofibrils of folded dactylopatagium; 2) clumped straight structures originating behind the metacarpophalangeal joint and resisting longitudinal compression to project into the window on the right and a like distance behind the elbow on the left, interpreted as actinofibrils associated with fold A; and 3) often curving structures that parallel the leading edge of the propatagium and the trailing edge of the brachiopatagium medial to the window, interpreted as collagen fibers bearing tensile loads in tenopatagial patagia. The suggestions as to the appearance of trailing edge attachment to the thigh is accepted. The absence of uropatagial impressions indicates they were less resistant to decay than propatagia and plagiopatagia, probably because their tensile fibers were smaller and/or fewer. The new information permits a new reconstruction of *Pterodactylus* wings.

Technical Session VII (Thursday, October 31, 2013, 4:00 PM)

RATES OF DINOSAUR LIMB EVOLUTION PROVIDE EVIDENCE FOR EXCEPTIONAL RADIATION IN MESOZOIC BIRDS

BENSON, Roger, University of Oxford, Oxford, United Kingdom; CHONIERE, Jonah, University of the Witwatersrand, Johannesburg, South Africa

Birds are the most diverse living tetrapod group and are a model of large-scale adaptive radiation, providing key data on the origins of extant vertebrate diversity. Neontological studies suggest a radiation within the avian crown group, long after the origin of flight. However, deep time patterns of bird evolution remain obscure because only limited fossil data have been considered. We analyse cladogenesis and limb evolution on the entire tree of Mesozoic theropod dinosaurs, documenting the dinosaur-bird transition and immediate origins of powered flight. Surprisingly, Mesozoic birds inherited constraints on forelimb evolution from non-flying dinosaur ancestors, and species diversification rates did not accelerate in the earliest flying taxa. However, Early Cretaceous short-tailed birds exhibit both phenotypic release of the hindlimb and increased diversification rates, unparalleled at any other time in the first 155 million years of theropod evolution. Thus, a Mesozoic adaptive radiation of stem group birds was enabled by restructuring of the terrestrial locomotor module, which may therefore represent a key innovation. Our results suggest two phases of radiation in Avialae, with the Cretaceous diversification overwritten by extinctions of stem-group birds at the Cretaceous-Palaeogene boundary and subsequent re-diversification of the crown group. We emphasize the importance of paleontological data to understanding the origins of modern biodiversity.

Technical Session XVIII (Saturday, November 2, 2013, 2:15 PM)

OUT WITH THE OLD, IN WITH THE NEW: VERTEBRATE MICROSTRATIGRAPHY DOCUMENTING THE IMMEDIATE K–PG MASS EXTINCTION RECOVERY

BERCOVICI, Antoine, Lund University, Lund, Sweden; HUNTER, John, Ohio State Univ, Newark, OH, United States; KNAUSS, Georgia, Univ of Iowa, Sheridan, WY, United States; WOOD, Jacqueline, Delgado Community College, New Orleans, LA, United States; PEARSON, Dean, Pioneer Trails Regional Museum, Bowman, ND, United States

The Cretaceous–Paleogene (K–Pg) mass extinction event triggered major faunistic and floristic re-arrangements within devastated terrestrial ecosystems caused by the Chicxulub asteroid impact. Radiation and evolution of some vertebrates, including mammals, is conventionally thought to originate from the freeing of ecological niches and the release of pressure as a result of the extinction of the non-avian dinosaurs, allowing for taxonomic turnover within many ecological niches. Here we present new results from an extensive excavation of sediments located immediately above the K–Pg boundary in southwestern North Dakota. The excavation was stratigraphically controlled at a centimeter scale allowing for the description of a succession of individual depositional environments associated to their characteristic faunas and floras. On the basis of 2742 vertebrate fossil remains recovered from 5162 kg of screen-washed material across 20 distinct lithological units, we demonstrate that the recovery of terrestrial ecosystems was underway by 83 cm above the palynologically defined K–Pg boundary. Immediately following the K–Pg boundary, which lies above the Hell Creek–Fort Union formation contact coal at this locality, is an interval of dark, massive mudstone which is interpreted as a ponding event based on the presence of fish, aquatic plants, freshwater aquatic palynomorphs, crocodilians, salamander, and absence of terrestrial taxa. The first terrestrial sediments occur 83 cm above the palynologically defined boundary, and document the earliest Paleogene vertebrates on land. Vertebrate assemblages recovered are dominated by fish, but also include a full range of semi-aquatic and terrestrial taxa, however the typical Hell Creek fauna are entirely absent. The first mammals to appear in the Paleocene are multituberculates, cimolestans, and condylarths, and co-occur with the first appearance of typical low diversity Paleocene (FU1) macrofloral assemblages. The overwhelming occurrence of lizards/salamanders and mammals (more specifically multituberculates) indicates that these were opportunists with broad tolerances and presumably rapid reproductive potential, whose populations rebounded and expanded quickly in post-impact disturbed habitats.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW INSIGHTS FROM THE EXCAVATIONS OF THE HÖWENEGG LAGERSTÄTTE, HEGAU, GERMANY (MN9, 10.3 MA)

BERNOR, Raymond, Howard University, Washington, DC, United States, 20059; MITTMANN, Hans-Walter, Staatliches Museum für Naturkunde, Karlsruhe, Germany; MUNK, Wolfgang, Staatliches Museum für Naturkunde, Karlsruhe, Germany; SEMPREBON, Gina, Baypath College, Enfield, MA, United States; WOLF, Dominik, Forschungsinstitut Senckenberg, Frankfurt, Germany

Höwenegg (Hegau, southern Germany) is a late Miocene locality (MN 9) exceptional for the abundance and completeness of its paleobiological record. Original excavations were undertaken by Tobien and Jörg in the 1950s and 1960s. Test excavations headed by Karlsruhe scientists between 1985 and 1992 confirmed that complete vertebrate material could still be recovered at the site. Subsequent dating of Höwenegg volcanics yielded a secure single crystal argon age of 10.3 Ma. A 24 meter drill core was made on the western border of the quarry in 2007 and established the unconformity between the earlier Miocene Obere Süßwassermolasse and Höwenegg lake bed deposits at this depth. The latest paleontologic work extended the quarry westward. Since 2001, we have collected diverse biota including limnic and terrestrial gastropods, pollen, seeds, fruits and whole leaves, amphibians, reptiles, and mammals. Höwenegg is most renowned for its production of mammalian skeletons and our efforts have secured an increase in the total number of mammalian skeletons from 29 to 47. The two most abundant mammalian taxa are the primitive boselaphine antelope *Miotragocerus pannoniae* (24 skeletons) and the basal Old World hipparionine equid *Hippotherium primigenium* (16 skeletons). The current project has also increased the taxonomic diversity of other mammals (*Trogontherium, Machairodus, Amphicyon, Thalassictis, Tragulus, Micromeryx, "Dicerorhinus", Aceratherium*), non-mammalian tetrapods (*Testudo, Trionyx*), and fish (*Leuciscus, Silurus, Tinca*). We provide a visual reconstruction of the drill core, a 2-dimensional reconstruction of mammalian skeletal occurrences in the Tobien and Jörg quarry excavated between 1951 and 1959 as well as in those excavated by our team between 2003 and 2012. We further provide a reconstructed 3-dimensional block of all skeletal occurrences using 3D coordinates for spatial and stratigraphic depth distribution. We find that there are four main stratigraphic levels and that stratigraphic level 11 (correlates with level 20 of Joerg and Tobien) has the greatest abundance and diversity of all biotic elements. We also present new information on the ecology and paleodiet of the Höwenegg ungulate community characterized as being lakeside subtropical to warm temperate forest browsers with limited grazing. This international project has been funded by the National Science Foundation (BCS-0321893 and EAR0125009), LSB Leakey Foundation, the Karlsruhe and Stuttgart Museums of Natural History, and the Town of Immendingen.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ISCHYROMYS TYPUS (RODENTIA, ISCHYROMYIDAE): ENCEPHALIZATION QUOTIENT ESTIMATION AND THE ECOLOGICAL HABITS OF EARLY RODENTS

BERTRAND, Ornella, University of Toronto, Toronto, ON, Canada, M5S 2S2; SILCOX, Mary, University of Toronto Scarborough, Scarborough, ON, Canada

The study of brain evolution among early rodents could lead to a more accurate picture of the ancestral condition of the brain for early euarchontans and Glires. Ischyromyidae is one of the oldest rodent families (late Paleocene to late Oligocene), either at the base of Rodentia, or the ancestor to some modern families such as Sciuridae and Aplodontidae. The genus *Ischyromys* is one of the better represented rodents of the North American Oligocene, known from post-cranial and cranial material.

A critical element to understanding brain size evolution is the accurate reconstruction of body mass. No equations exist for estimating this parameter in Glires from cranial remains. 192 specimens of Glires (20 Lagomorpha [nine species], one Anomaluroidea, 12 Castoridae, nine Geomyoidea [eight species], 26 Hystricognathi [21 species], 51 Myodonta [42 species], and 73 Sciuromorpha with two Aplodontidae, one Gliridae, and 70 Sciuridae [17 species]) were used to generate regression equations based on ten cranial measurements. One of the advantages of estimating regression equations from multiple measurements is that they allow for the reconstruction of body mass for very fragmentary specimens when only one of those dimensions is available. A sample of 361 Glires specimens (14 Lagomorpha and 347 Rodentia) was used to estimate brain mass. These equations generated a range of estimates for EQ between 0.34 and 0.87 in *Ischryomys typus* (middle Orellan, early Oligocene).

These estimates were compared with values from extant members of the closely related rodent suborder Sciuromorpha, which exhibit a large range of ecological habits from terrestrial to arboreal. *Ischyromys typus* had an EQ similar to terrestrial and lower than arboreal and glider Sciuromorpha. Principal Components Analysis of cranial measurements allows for clear separation between arboreal and terrestrial taxa and results for *I. typus* are consistent with postcranial reconstructions of it as terrestrial, clustering close in morphospace to *Aplodontia* and *Cynomys*. This suggests that this EQ for *I. typus* could reflect its ecological circumstance. However, cranial measurements for the terrestrial *Rhombomylus* (Early Eocene Glires) reveals even a lower EQ (between 0.32 and 0.46). Thus the low estimates of EQ for the fossil taxa likely relate to a combination of ecological circumstance, and a temporal effect on brain size. Both therefore need to be taken into consideration in interpreting fossil brain masses.

Technical Session XVI (Saturday, November 2, 2013, 2:45 PM)

CRANIAL EVOLUTION AND THE ORIGIN OF TURTLES: INSIGHTS FROM _EUNOTOSAURUS AFRICANUS_

BEVER, Gabriel, New York Institute of Technology, Old Westbury, NY, United States, 11568; LYSON, Tyler, Smithsonian Institution, Washington D.C., DC, United States

The reemergence of the Middle Permian amniote *Eunotosaurus africanus* as a potential early stem turtle is based on a number of striking postcranial synapomorphies, many of which are related directly to the evolutionary origin of the iconic turtle shell. These data demand that the long enigmatic cranial morphology of this animal be elucidated and placed within the broader context of amniote cranial evolution and the problem of turtle origins. We undertook this task using high-resolution computed tomography of the relatively few skulls reported in the literature, as well as a previously undescribed skull in the collections of the Council for Geosciences, Pretoria. Our data reveal a cranial morphology characterized by a large number of plesiomorphic features that suggest *Eunotosaurus* lies near the base of Panreptilia and outside the early radiation of pandiapsid forms. A good example is the large supratemporal bone that sweeps forward to broadly contact the postorbital – a character essentially unknown in Pandiapsida. The cranial characters of *Eunotosaurus* that are derived within Panreptilia are variously shared with an interesting taxonomic mix of turtles, parareptiles, and relatively derived diapsids (crownward stem diapsids and crown diapsids). One character that exemplifies this distribution is the slender, vertically oriented quadratojugal. This is a feature present in the early stem turtle *Proganochelys quenstedti*, a handful of parareptile forms, and as a derived character within Panarchosauria. Almost none of these derived features are shared with those taxa more nearly contemporaneous with *Eunotosaurus* and that constitute the early portions of the diapsid stem. *Eunotosaurus* also shares a number of characters with *Proganochelys* that are not established as present in other parareptiles. Examples include ossification of the anterolateral wall of the braincase and presence of a tall quadrate process of the pterygoid. We articulate and compare the models of cranial evolution as dictated by the currently competing hypotheses for the origin of turtles. The cranial evidence supporting a close relationship between *Eunotosaurus* and turtles amplifies the apparent conflict between the seemingly plesiomorphic morphology of the turtle stem and the seemingly derived molecular signature of the turtle crown.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PALEOECOLOGIES AND PALEOCLIMATES OF MIOCENE SHARK TAXA FROM CALVERT CLIFFS, MARYLAND, USA: EVIDENCE FROM STABLE CARBON AND OXYGEN ISOTOPES

BIASATTI, Dana, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD, United States, 20688; GODFREY, Stephen, Calvert Marine Museum, Solomons, MD, United States; COOPER, Lee, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD, United States

We determined the carbon and oxygen isotopic compositions of shark teeth collected from 12 beds spanning the three Miocene formations along Calvert Cliffs (Maryland, USA) in order to evaluate paleodiet and habitat preference for two species of fossil sharks, *Cosmopolitodus hastalis* (Lamnidae) and *Hemipristis serra* (Hemigaleidae), in the context of long-term regional climate change. These two species co-existed throughout the Miocene in the shallow Atlantic sea that occupied the Salisbury Embayment episodically. The oxygen isotope results reveal significant oceanographic changes from ~18 until ~10 Ma and support previous hypotheses regarding paleo-bathymetry and dating of the sequence inferred from faunal and sedimentological studies of Calvert Cliffs. The oxygen isotope compositions of both species support previous studies which demonstrated an increase in ocean $\delta^{18}O$ values by ~3-4 per mil (V-SMOW) from the Middle Miocene Climate Optimum to the Late Miocene with the expansion of the East Antarctic ice sheet, a resulting decrease in ocean volume, and a corresponding increase in ocean salinity. The $\delta^{18}O$ values of the *Cosmopolitodus* specimens were consistently ~2-3 per mil lower than the $\delta^{18}O$ values of *Hemipristis*, suggesting that *Cosmopolitodus* likely inhabited shallower waters and/or waters closer to the shoreline than did *Hemipristis*. The $\delta^{13}C$ compositions of both genera are consistent with a carnivorous diet and with $\delta^{13}C$ values of tooth enamel from previous studies of modern sharks. The $\delta^{13}C$ values of *Cosmopolitodus* were also ~2-3 per mil lower than the $\delta^{13}C$ values of *Hemipristis*, indicating that the Miocene *Cosmopolitodus* occupied a more near-shore ecological niche than did *Hemipristis*. In addition, the $\delta^{18}O$ and $\delta^{13}C$ values of *Cosmopolitodus* tooth enamel are negatively correlated, whereas the $\delta^{18}O$ and $\delta^{13}C$ values of *Hemipristis* show no significant correlation. This is consistent with *Hemipristis serra* dwelling in waters further offshore than those inhabited by *Cosmopolitodus hastalis*. This is an unexpected inference because the closely related modern makos, *Isurus oxyrinchus* and *I. paucus*, are inhabitants of the open ocean whereas the extant snaggletooth, *Hemipristis elongatus*, occupies tropical continental and insular shelf waters.

Technical Session VI (Thursday, October 31, 2013, 11:45 AM)

THE IMPORTANCE OF THE FOSSIL RECORD FOR MOLECULAR PHYLOGENETICS: THE CASE OF BOVIDAE (ARTIODACTYLA, RUMINANTIA)

BIBI, Faysal, American Museum of Natural History, New York, NY, United States, 10024

Genomes provide an extremely powerful tool for the construction of highly resolved phylogenies of extant species, but no evolutionary history could ever be complete without consideration of the fossil record. One group that has received a lot of attention from molecular phylogenetics is Bovidae (antelopes and relatives), being the most diverse clade of living large mammals, and the largest component of Pecora, Ruminantia, and Artiodactyla (= Cetartiodactyla). Important evolutionary events within these clades have benefited from molecular age estimation, particularly at nodes where the fossil record has been ambiguous or absent. However, most analyses to date have relied on only a single or a few (often poorly applied) fossil calibration points with which to calibrate rates of genomic evolution.

I identify 16 fossil calibration points of relevance to the phylogeny of Bovidae and Ruminantia and use these in a bayesian re-analysis of the full mitochondrial genome of over 100 ruminant species. The new multi-calibrated tree provides ages that are younger than found in previous studies. Among these are young (late Eocene-early Oligocene) ages for the origin of crown Ruminantia, and a ca.17–15 Ma age of origin for crown Bovidae, which may be reasonable hypotheses given the fossil record. Areas of age conflict with the fossil record remain, however, especially with regard to the base of the rapid Pecoran radiation, and the sister relationship of Moschidae to Bovidae. The use of a large number of vetted fossil calibration points (with soft bounds) is promoted as a better approach than using just one or a few calibrations, or using internal-congruency metrics to discard good fossil data. The densely calibrated tree produced here exhibits smaller age error ranges and better reflects the fossil record than the wide variety of ages found by using a single calibration alone. The tree also highlights particular regions of conflict between molecular and morphological approaches to taxonomic classification arising from conflicting topologies or branch lengths. I also provide examples of interesting phylogeographic and paleoenvironmental hypotheses that may be inferred from a tree containing only extant taxa but that are not supported when the fossil record is brought into the picture. Increasing the contribution of the fossil record to the phylogeny of Bovidae is a necessary step toward the reconstruction of the evolutionary history of this clade.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

FOSSIL MARINE FISHES FROM THE CODELL SANDSTONE MEMBER OF THE UPPER CRETACEOUS CARLILE SHALE IN NORTH-CENTRAL KANSAS, U.S.A.

BICE, Kelly, DePaul University, Chicago, IL, United States, 60614; SHIMADA, Kenshu, DePaul Univ, Chicago, IL, United States; DECKER, Ramo, 1348 North 50th Road, Sylvan Grove, KS, United States

The Codell Sandstone Member of the Carlile Shale in Kansas, U.S.A., is an Upper Cretaceous rock unit deposited during the Turonian in the Western Interior Seaway, an epicontinental sea in North America. It was deposited during a regression of the Western Interior Seaway, representing a relatively shallow, near-shore environment. We here report the first collective description of a marine fish assemblage from the Codell Sandstone in Jewell County, Kansas. The collection contains larger specimens that were surface collected and smaller specimens washed from sediments, and they are represented by isolated teeth, vertebrae, and other skeletal elements. The fauna consists of at least 24 fish taxa, including 16 elasmobranchs (*Meristodonoides* sp., *Ptychodus mortoni*, *Ptychodus whipplei*, *Cretoxyrhina mantelli*, *Cretodus crassidens*, *Cretolamna appendiculata*, *Carcharias tenuiplicatus*, *Scapanorhynchus raphiodon*, *Paranomotodon* sp., *Squalicorax* cf. *S. falcatus*, *Squalicorax* cf. *S. pawpawensis*, *Squalicorax* sp., *Pseudocorax laevis*, *Rhinobatos incertus*, *Ptychotrygon* sp., and *Ischyrhiza* sp.) and eight bony fishes (*Micropycnodon kansasensis*, *Belonostomus* sp., *Protosphyraena* sp.,

Xiphactinus audax, *Pachyrhizodus minimus*, *Enchodus gladiolus*, *Enchodus petrosus*, and *Enchodus shumardi*). These taxa are represented by a variety of ecological roles, including benthic batoids (*Rhinobatos*), durophagous sharks (*Ptychodus*), large pelagic sharks (*Cretoxyrhina* and *Cretodus*), medium-sized opportunistic sharks (*Squalicorax*), as well as bony fishes from small (*Enchodus*) to large (*Xiphactinus*). The most abundant taxa are *Squalicorax* cf. *S. falcatus* and *Scapanorhynchus raphiodon*. This collection contains the stratigraphically oldest record of *Ptychodus mortoni* in the United States and this report is only the second report of *Paranomotodon* from Kansas. The fish fauna reported here is important because it provides insights into the paleoecology of vertebrates during a major regression of the Western Interior Seaway.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DIGITAL SURFACE SCANNING AND ANALYSIS OF A CAVE SPECIMEN OF THE DODO (*RAPHUS CUCULLATUS*)

BIEDLINGMAIER, Andrew, College of the Holy Cross, Worcester, MA, United States, 01610; LEAVITT, Jennifer, College of the Holy Cross, Worcester, MA, United States; MONFETTE, Gregory, College of the Holy Cross, Worcester, MA, United States; ALLAN, David G., Durban Natural Science Museum, Durban, South Africa; CLAESSENS, Leon P.A.M., College of the Holy Cross, Worcester, MA, United States; and Naturalis Biodiversity Center, Leiden, Netherlands

The dodo (*Raphus cucullatus*) is a recently extinct large flightless columbid bird that was endemic to the island of Mauritius. Only a handful of fragmentary physical remains of the dodo collected before its extinction in the late 17th century are still in existence. The majority of currently known skeletal remains from the dodo have been recovered from the Mare aux Songes (MAS), a Holocene fossil concentration Lagerstätte in southeast Mauritius first discovered in 1865. Recent excavations indicate that the MAS deposits do not contain articulated dodo skeletal material and the skeletons reconstructed from MAS bones thus represent composites. Here, we report on the anatomy of a partially associated and nearly complete dodo skeleton recovered from a cave, collected at the end of the 19th century by Etienne Thirioux, now housed at the Durban Natural Science Museum (DNSM Ornithology 2366). We scanned the mounted skeleton with a Konica Minolta Range7 non-contact laser surface scanner at a resolution of approximately 100 microns. Our examination has revealed that the skeleton was remounted in 1919 and that a cervical vertebra at the base of the neck (approximately C10) has been removed and likely discarded at this time. The braincase and portions of the sternum of the specimen are reconstructed, and possibly some of the pedal phalanges. Although the specimen appears to be a composite of at least two individuals, some parts of the skeleton, including the pectoral girdle, appear to belong to a single individual and thus provide relative skeletal dimensions for a dodo, unlike the composite skeletons from the MAS. Rare or previously unknown elements, including the pygostyle, distal manual phalanges, patellae and tarsal sesamoids, are preserved. We digitally reconstructed the skeleton in the 3-D editing software Rapidform, which allowed us to correct the sacrothoracic angle, limb and rib positions without having to disarticulate the mounted specimen. Together with one other cave dodo specimen collected by Thirioux, the (digital) Durban dodo is one of the most complete dodo skeletons in existence and forms an excellent basis for studies into the paleobiology of this iconic bird. The digital scan data of DNSM Ornithology 2366 will be deposited in the online repository Aves 3D (http://Aves3D.org).

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

RESOLVING MORPHOLOGICAL/MOLECULAR CONFLICT IN MARMOTINI (MAMMALIA, RODENTIA, SCIURIDAE) THROUGH DIAGNOSTIC DENTAL CHARACTERISTICS

BIEDRON, Eva, Univ of Oregon, Eugene, OR, United States, 97403; Hopkins, Samantha, Univ of Oregon, Eugene, OR, United States; McLaughlin, Win, Univ of Oregon, Eugene, OR, United States

The proliferation of rapid, inexpensive molecular sequencing has led to the discovery of a number of conflicts between morphological and molecular data. In many cases, these conflicts have led to greater scrutiny of character choice and analytical methods, resulting in an improved understanding of phylogenetic relationships. Morphological systematics based on paleontological evidence place the Barstovian genus *Miospermophilus* as the direct ancestor of the *Spermophilus, Cynomys,* and *Ammospermophilus* lines, while *Protospermophilus* has been hypothesized to give rise to the genus *Marmota*. However, molecular data showed that *Spermophilus* was polyphyletic, giving rise to both *Cynomys* and *Marmota*, and the most current molecular resolutions are incompatible with the phylogeny suggested by paleontological studies. A recent revision of genus-level taxonomy of ground squirrels called for re-examination of the paleontological evidence for the origins of ground squirrels, a task we begin here.

Currently, identification of *Protospermophilus* and *Miospermophilus* is based predominantly on size, with *Miospermophilus* distinctly smaller on average. The diagnosis of *Protospermophilus* also depends heavily on skull characters, although there are no described skulls of *Miospermophilus*. There are also a small number of dental characters that distinguish the two; however, these characters have not been reconsidered in light of the new taxonomy of ground squirrels. By examining the dental characteristics of early ground squirrels, we find that the only character consistent between taxonomy of living ground squirrels and that of fossil *Marmotini* is crown height. However, some of the characters that distinguish living ground squirrel clades can be found in extinct squirrel species. Many characters, however, seem to vary without regard to evolutionary relationships, and dental characters are also frequently convergent. Further study of the fossil record of ground squirrels will allow for an improved understanding of the origin of the the newly recognized generic diversity of ground squirrels, as well as provide an alternative method of identification for incomplete *Proto-* and *Miospermophilus* specimens.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CRIBIFORM PLATE MORPHOLOGY AS A PROXY FOR OLFACTORY INNERVATION IN CARNIVORA

BIRD, Deborah, University of California Los Angeles, Westwood,, CA, United States, 90291; AMIRKHANIAN, Arsineh, University of California Los Angeles, Westwood,, CA, United States; DAVYDOV, Yevgeniy, University of California Los Angeles, Westwood,, CA, United States; PANG, Benison, University of California Los Angeles, Westwood,, CA, United States; VAN VALKENBURGH, Blaire, University of California Los Angeles, Westwood,, CA, United States

As yet, we know very little about olfactory ecology in extinct mammals. While most olfactory anatomy in a fossil is missing or destroyed, there is one feature in the nasal chamber that is relatively well preserved and may offer a view into olfactory function. This is the cribriform plate (CP), a perforated cup of bone that separates the nasal cavity from the olfactory bulb. Its many foramina usher the passage of olfactory signals and nerves from snout to brain and so provide an osseous imprint of olfactory innervation. CP morphology, specifically its size, the distribution, number, and size of its foramina, varies across mammalian species and likely reflects aspects of olfactory capacity. This suggests CP morphology may be a proxy for olfactory function. Toward this end, I compare CP morphology among living Carnivora, a group that includes closely related species from distinct ecologies, offering a view along a spectrum of olfactory demands. In two separate studies I use CT scans and 3-D imaging software to examine CP morphology, first in aquatic vs. terrestrial arctoid carnivorans, and then in two carnivoran groups known for their divergent hunting strategies, felids and canids. Novel spline technology allows the quantification of total cross-sectional area of foramina for the first time, yielding a relative metric for olfactory innervation. Preliminary results reveal that all features of CP morphology are reduced in aquatic carnivorans compared with their close terrestrial relatives, consistent with studies suggesting a reduced olfactory role in aquatic mammals. Likewise, total CP foramina area is smaller in felids than in canids, as predicted by the felids' relatively weaker reliance on olfaction in foraging, suggesting a trade-off between enhanced visual anatomy and olfactory innervation in cats. These methods, when applied to fossils in the future, may hold promising clues to the olfactory ecology of extinct mammals.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

TESTING MECHANISMS OF BODY SIZE TRENDS IN NORTH AMERICAN PLESIADAPIFORMES (MAMMALIA, ?PRIMATES)

BIRLENBACH, David, University of Illinois, Champaign, IL, United States, 61820; MARCOT, Jonathan, Univ of Illinois, Urbana, IL, United States

Around the Paleocene/Eocene boundary, several groups of 'modern' mammals (e.g., Rodentia, Euprimates, and Artiodactyla) immigrated to North America from Asia, which ultimately led to a reorganization in the indigenous mammalian communities. Previous studies suggest that North American Plesiadapiformes were forced to extinction due to competition with rodents and euprimates that shared similar diets and body sizes. This competition hypothesis predicts that plesiadapiformes would face different selective regimes before and after the immigration of modern mammals, and this should be reflected as a shift in their evolutionary dynamics.

We focus on a previously noted trend toward increasing plesiadapiform body size that has been attributed to competition with smaller bodied immigrants. We test three potential mechanisms for this trend: (1) the differential extinction of smaller and/or origination of larger lineages; (2) higher rates of (unbiased) body size evolution; and (3) biased body size evolution within lineages. To test Hypothesis 1, we divided 65Ma to 50Ma into 15 intervals, then determined the distribution of plesiadapiform body masses in each. To test Hypotheses 2, we created a composite plesiadapiform phylogeny compiled from the literature, then used it to test for shifts in the rate of body size evolution across the tree, and, separately, whether specific clades showed higher synapomorphic rates. For Hypothesis 3, we tested biased vs. unbiased models of body size change on the tree. For each of these phylogenetic analyses, we performed 1000 pseudo-replicate analyses to account for uncertainty in the phylogenetic relationships and ages of species. Our proxy for body size was the first component of a Principal Component Analysis of lengths and widths of premolars and molars compiled from the literature.

The variance in body size among plesiadapiformes increases for the first eight million years, but begins to decline approximately 56Ma, coincident with the immigration of 'modern' taxa. This decline suggests differential extinction of small-bodied plesiadapiformes. We failed to reject a single rate of body size evolution across the entire tree in most replicate analyses, but did find evidence of a higher rate of evolution within Carpolestidae. Furthermore, we found strong support for directional body size evolution within lineages throughout the phylogeny. These results suggest an influence by the immigration of 'modern' taxa on plesiadapiform evolution, but that the particular evolutionary response was likely clade-specific.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW BALAENIDS FROM THE ITALIAN PLIOCENE (MAMMALIA, CETACEA, MYSTICETI)

BISCONTI, Michelangelo, San Diego Natural History Museum, San Diego, CA, United States, 92101

In the last twenty years, several new fossil mysticetes have been discovered in the Pliocene sediments of different parts of Italy. They include four balaenopterids from Piedmont and Tuscany and five balaenids from Emilia Romagna (northern Italy), Tuscany, Umbria (both in central Italy,) and Calabria (southern Italy). The balaenid specimens include an articulated skeleton lacking the skull but preserving the dentary

from Emilia Romagna; the specimen is approximately 8 m long and is characterized by radius and ulna elongated and narrow with the ulna showing a well developed olecranon. The groove for the mental ligament is located in the inferior part of the anterior end of the dentary suggesting some resemblance of the dentary of *Balaenotus insignis* figured out by Van Beneden in the 19th century. The specimen from Calabria is a partial skeleton of a new balaenid taxon characterized by peculiar periotics in which the lateral process of the anterior process is pointed, narrow and spine-like. The specimen from Tuscany includes a juvenile individual tentatively assigned to *Balaenula astensis* that is represented by a partial skull. The two specimens from Umbria are partial skeletons of small-sized balaenids; one of them is clearly a juvenile and its periotic strongly resembles that of *Balaenotus insignis*. The skeleton from Emilia Romagna and that from Calabria are associated to shark teeth and to diverse mollusc faunas. These specimens will add considerable new information about the anatomy of the postcranial skeleton and the earbones of Pliocene balaenids contributing to improve our knowledge about the Pliocene diversity of these whales now absent from the Mediterranean basin.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A LATE OLIGOCENE ANURAN FAUNA FROM THE NSUNGWE FORMATION, SOUTHWESTERN TANZANIA

BLACKBURN, David, California Academy of Sciences, San Francisco, CA, United States, 94118; ROBERTS, Eric, James Cook University, Townsville, Australia; STEVENS, Nancy, Ohio Univ, Athens, OH, United States

Although molecular phylogenetic studies infer the presence of several anuran lineages on continental Africa since the Cretaceous, the fossil record of Mesozoic and early Cenozoic frogs remains remarkably depauperate. Here we document the first diverse African Oligocene anuran fauna from Afro-Arabia, represented by >100 cranial and postcranial specimens. Fossils were recovered from fluvial localities in the late Oligocene (~25 Ma) Songwe member of the Nsungwe Formation in the Rukwa Rift Basin of southwestern Tanzania. These localities are well dated to 25 Ma and reflect aquatic environments persisting within a semi-arid climate regime. The Nsungwe anuran fauna is dominated by isolated elements, including ilia, forelimb and hind limb bones, presacral vertebrae, and urostyles. Two isolated specimens preserve the fusion of the sacral vertebrae with the last presacral vertebra, morphology consistent with the Ptychadenidae and significant in representing the earliest record for this endemic African family. A second (non-ptychadenid) taxon is represented by two articulated specimens: an isolated hind limb, and a more complete specimen preserving most of a vertebral column, pelvis, and parts of both hind limbs. The ilia and urostyle on the latter specimen preserve high and well-defined dorsal crests, consistent with the morphology of Ranidae (sensu stricto). Several African anuran taxa are notably absent in the Nsungwe Fauna including pipids, brevicipitids, and hemisotids. Further, bufonids, a widespread cosmopolitan family, are as-yet unrepresented in the fauna. Several isolated cranial bones bear notable exostoses typical of taxa with hyperossified skulls, suggesting the presence of pyxicephalid frogs like *Pyxicephalus* and *Aubria*, although further study is needed to better document the distribution of this morphology across Pyxicephalidae.

Technical Session XIII (Friday, November 1, 2013, 3:00 PM)

ARTICULATED ISCHNACANTHID ACANTHODIAN JAWS FROM THE MOTH LOCALITY PROVIDE EVIDENCE FOR SPECIALIZED FEEDING IN EARLY DEVONIAN GNATHOSTOMES

BLAIS, Stephanie, University of Alberta, Edmonton, AB, Canada, T6G 2E9; WILSON, Mark, Univ of Alberta, Edmonton, AB, Canada

Acanthodians are an enigmatic group of small, spiny fossil fishes whose affinities remain dubious. Although their phylogenetic relationships are unclear, acanthodians, as some of the oldest jawed vertebrates, can provide us with valuable information about the early evolution of jaws and teeth. Ischnacanthid acanthodians in particular possessed many different forms of teeth, including isolated teeth, tooth whorls, tooth-like scales, and teeth ankylosed to unique dermal bones, which rested on the occlusal surfaces of their Meckel's and palatoquadrate cartilages. Because their skeletons were cartilaginous, descriptions of ischnacanthid acanthodians are often based entirely on isolated, disarticulated, dentigerous jaw bones; articulated fossils are very rare. The Man On The Hill (MOTH) fossil assemblage from the Mackenzie Mountains, Northwest Territories, Canada, has yielded hundreds of specimens of beautifully preserved Early Devonian (Lochkovian) vertebrates. These include many articulated acanthodian fossils, which have allowed us to study features that were not preserved to the same degree in fossils from other localities. Few studies have focused on the biomechanics of ischnacanthid jaws, and Early Devonian ischnacanthid jaws were considered to occlude in a simple, cog-like motion, where each tooth connected only with the pit between the teeth on the opposing jaw, causing the teeth to become blunted throughout the life of the fish. Articulated upper and lower dentigerous jaw bones and their associated cartilages from MOTH have revealed that Early Devonian ischnacanthid jaw biomechanics were more complex and specialized. Using micro-Computed Tomography (μCT) to create a 3-dimensional model of articulated ischnacanthid jaws from MOTH, we determined that they occluded in a more shearing and interlocking motion like that attributed to later ischnacanthids, where the teeth slid against the posterior surfaces of the opposing teeth into the inter-tooth pit, causing the teeth to be sharpened rather than blunted. This is especially true for the anterior-most teeth. In addition, one new ischnacanthid genus from MOTH was monognathically heterodont, with blunt, robust, tricuspid medial teeth that were almost as large as its long, sharp, monocuspid fang-like lateral teeth. This, along with the presence of cheeks suggested by interlocking lip scales, indicates these ischnacanthids were likely specialized feeders capable of orally processing prey with their teeth in a variety of ways.

Technical Session IV (Wednesday, October 30, 2013, 3:00 PM)

FIRST FOSSILS OF A PLATYRRHINE MONKEY FROM PANAMA PROVIDE EVIDENCE FOR MAMMALIAN DISPERSAL ACROSS THE CENTRAL AMERICAN SEAWAY IN THE EARLY MIOCENE

BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States, 32611-7800; WOOD, Aaron, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; RINCON BURBANO, Aldo Fernando, Florida Museum of Natural History & Department of Geological Sciences , University of Florida, Gainesville, FL, United States; WOODRUFF, Emily, Florida Museum of Natural History & Department of Biology, University of Florida, Gainesville, FL, United States; FOSTER, David, Department of Geological Sciences, University of Florida, Gainesville, FL, United States

While the northern-most distribution of South American monkeys (platyrrhines) today extends into the tropical forests of southern Mexico, this distribution is relatively recent, with mammalian interchange between South and Central America restricted by the Central American Seaway (CAS) for most of the Cenozoic. Despite geographic isolation, anthropoid primates arrived in South America from the Old World by the late Oligocene (*Branisella* from Salla, Bolivia; 26-27 Ma). Until now, evidence for anthropoids in Central America prior to the rise of the Isthmus of Panama has been lacking, with acceptance of "rafting" on floating vegetation across the Atlantic as a mechanism for their dispersal into South America directly from Africa. Here we describe 6 isolated teeth of a new platyrrhine primate recovered from a tuffaceous mudstone in the Las Cascadas Formation in Panama that are similar to those of extant South American capuchin (*Cebus*) and squirrel (*Saimiri*) monkeys. Results from morphological phylogenetic analyses with molecular contraints that include the new taxon suggest a close relationship to crown platyrrhines, specifically cebids. A U-Pb radioisotopic date (20.93 ± 0.17 Ma) from 37 euhedral magmatic zircons in an ash layer directly associated with the anthropoid fossils, together with a diverse mammalian fauna consistent with the late Arikareean North American Land Mammal Age, indicates an early Miocene age. The new primate is the second oldest platyrrhine known and provides the first definitive example of mammalian dispersal between South and Central America prior to the beginning of the Great American Biotic Interchange, supporting recent tectonic reconstructions that proposed a relatively narrow CAS in the Miocene. While early stages of biotic interchange across the CAS have been hypothesized for certain groups (amphibians, reptiles, freshwater fishes, and plants) lack of other South American terrestrial mammals in the Miocene of Central and North America might suggest that primates were uniquely better suited to northward dispersal at this time. Alternatively, anthropoids might have had a wider, largely un-sampled, tropical New World distribution during the Paleogene than currently understood. Discovery of new fossils from the New World Tropics will be critical to addressing questions surrounding the origin, dispersal, and early evolution of South American monkeys.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE INFLUENCE OF LATE QUATERNARY CLIMATES ON SPECIES DISTRIBUTION, ABUNDANCE, AND GENETIC DIVERSITY OF NORTHERN CALIFORNIA POCKET GOPHERS

BLOIS, Jessica, University of California, Merced, Merced, CA, United States, 95348; LI, Cheng (Lily), Stanford University, Stanford, CA, United States; HADLY, Elizabeth, Stanford University, Stanford, CA, United States

Climate change has significantly influenced the past abundance and geographic distributions of species, which are important components of ecological responses to future climate change. We determine the relationship between climate, geographic distribution, and abundance in gophers (*Thomomys*) using multiple lines of evidence: fossils from northern California that capture a record of paleoecological change over the past 18,000 years, modern and ancient genetic analyses, and paleodistribution modeling. For two species (*T. mazama* and *T. bottae*), we determine: (1) how abundance changed through time using multiple proxies (fossil relative abundance, genetic effective population size); (2) whether those changes are correlated with the modern climatic niche of the species; and (3) the mechanism underlying those abundance changes: in situ demographic expansion or range shifts. Fossil data, supported by aDNA identifications, document small range contractions (*T. mazama*) and range expansions (*T. bottae*), but the main changes observed were relative abundance changes. *Thomomys mazama* sharply declined starting around 17 thousand years before present (kyr BP) and became locally extirpated by 6 kyr BP. In contrast, *T. bottae* was present but rare in the Pleistocene and expanded dramatically across the Pleistocene–Holocene transition, with the increase in abundance at 14 kyr BP roughly coincident with warming during the Bolling–Allerod period. Phylogeographic data for *T. bottae* indicate their population expansion was due primarily to in situ expansion rather than long-range shifts in the distributions of clades. Overall, the temporal changes in abundance of *T. mazama* at Samwell Cave were strongly predicted by climatic changes, whereas *T. bottae* had a very broad climatic niche, indicating *T. bottae* abundance change was likely driven by declines in the relative abundance of *T. mazama* and the opening up of the underground niche.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

OXYGEN ISOTOPES FROM MAMMALIAN TEETH: SAMPLING GUIDED BY THE GEOMETRY OF ENAMEL MINERALIZATION

BLUMENTHAL, Scott , CUNY Graduate Center, New York, NY, United States, 10016; CERLING, Thure, University of Utah, Salt Lake City, UT, United States; Chritz, Kendra, , Salt Lake City, UT, United States; BROMAGE, Timothy, New York University College of Dentistry, New York, NY, United States; VALLEY, John, University of Wisconsin-Madison, Madison, WI, United States

Intra-tooth enamel oxygen isotope analysis can be used to reconstruct short-term changes in animal life history or environmental seasonality in the fossil record. Conventional sampling typically extends partially or entirely through the thickness of enamel and provides highly time-averaged isotope time-series, but the rapidly mineralizing innermost enamel layer may retain a less altered signal. We sampled the right maxillary incisor from a woodrat subjected to an experimentally induced water-switch during the period of tooth development. We use backscattered imaging in the scanning electron microscope (BSE-SEM) to measure enamel mineralization, and demonstrate that the innermost enamel layer mineralizes more rapidly than the rest of the enamel layer. We use secondary ion mass spectrometry (SIMS) to generate high-resolution intra-tooth $\delta^{18}O$ profiles within discrete layers of enamel, which all record the $\delta^{18}O$ shift associated with the water switch. Our results demonstrate that the innermost enamel layer records less blurred isotope time-series, and that decreasing sample spot size beyond conventional sampling outside the innermost enamel layer only minimally reduces signal blurring. Sampling the innermost enamel layer will be most beneficial when sampling large mammalian herbivores that are characterized by more slowly mineralizing enamel and record environmental input over periods of months to years.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

APPLYING DENTAL MICROWEAR TEXTURE ANALYSIS TO EXTANT AND FOSSIL PERISSODACTYLS AND NON-RUMINANT ARTIODACTYLS

BOARDMAN, Grant S., University of Nebraska - Lincoln, Lincoln, NE, United States, 68588-0340; SECORD, Ross, University of Nebraska-Lincoln, Lincoln, NE, United States

Dental microwear texture analysis (DMTA) has seen increasing use in characterizing the diets of primates, bovids, and carnivorans, but little work has been done to date with perissodactyls and artiodactyls outside of Ruminantia. Here a new database of dental microwear textures from four extant perissodactyls (*Equus burchelli*, *Diceros bicornis*, *Rhinoceros unicornis*, and *Tapirus terrestris*) and four extant artiodactyls (*Lama glama*, *Camelus bactrianus*, *Tayassu pecari*, and *Pecari tajacu*), representing four distinct dietary categories (browsers, frugivores, mixed-feeders, and grazers) is presented. Four surface attributes were calculated from 3-D point clouds collected from enamel bands on M2/ and M/2 using a white-light confocal profiler: surface complexity (*Asfc*), anisotropy (*epLsar*), scale of maximum complexity (*Smc*), and textural fill volume (*Tfv*). Results show significant differences in the four attributes among the dietary categories which are similar, though not identical, to results from extant bovids, indicating DMTA can accurately differentiate these groups. In addition to demonstrating the effectiveness of this technique it also provides a dataset against which to compare microwear textures from fossil non-ruminants, which have not been sampled previously using this method. Through comparison to this modern dataset the diets of four perissodactyls, *Mesohippus bairdi*, *Hyracodon nebraskensis*, *Subhyracodon* sp., and *Megacerops* sp., and three artiodactyls, *Agriochoerus antiquus*, *Eotylopus reedi*, and *Perchoerus probus*, from the upper Eocene/lower Oligocene of northwestern Nebraska are reconstructed. Microwear surfaces for *Agriochoerus*, *Perchoerus*, and *Eotylopus* are highly complex, and along with other surface texture attributes indicate major fruit consumption. Surface textures from *Megacerops* and *Hyracodon* indicate a large browse component, whereas fairly anisotropic surfaces for *Subhyracodon* and *Mesohippus* are consistent primarily with mixed-feeding. Results generally corroborate dietary hypotheses for these fossil taxa based on mesowear, and suggest that DMTA can be successfully applied to both extant and fossil non-ruminant ungulates with regards to categorizing diet.

Technical Session XV (Saturday, November 2, 2013, 11:00 AM)

ANATOMY AND ONTOGENY OF A TRANSITIONAL BALEEN WHALE: A NEW EOMYSTICETID (MAMMALIA, CETACEA) FROM THE LATE OLIGOCENE OTEKAIKE LIMESTONE OF NEW ZEALAND

BOESSENECKER, Robert, University of Otago, Dunedin, New Zealand; FORDYCE, R. Ewan, University of Otago, Dunedin, New Zealand

Although the Eocene history of cetacean evolution is now represented by the expansive fossil record of archaeocetes elucidating major morphofunctional shifts relating to the land to sea transition, the change from archaeocetes to modern cetaceans is poorly established. New fossil material of the recently recognized family Eomysticetidae from the upper Oligocene Otekaike Limestone includes a new genus and species represented by skulls and partial skeletons of an adult (OU 22044; CBL=184 cm), juvenile (OU 22163; CBL=109 cm), and an even smaller juvenile (OU 22075; CBL est. 85.7 cm). This new taxon is characterized by an elongate and narrow rostrum which retains vestigial alveoli and alveolar grooves. Palatal foramina and sulci are present only on the posterior half of the palate. The nasals are elongate, and the bony nares are positioned far anteriorly. Enormous temporal fossae are present adjacent to an elongate and narrow intertemporal region with a sharp sagittal crest. The earbones are characterized by retaining inner and outer posterior pedicles, lacking fused posterior processes, and retaining a separate accessory ossicle. Preliminary phylogenetic analysis supports this New Zealand mysticete within a monophyletic Eomysticetidae as the earliest diverging clade of toothless mysticetes. This eomysticetid clade also included *Eomysticetus whitmorei*, *Micromysticetus rothauseni*, "*Mauicetus*" *lophocephalus*, and *Yamatocetus canaliculatus*. This collection permits detailed study of the ontogenetic trajectory of various cranial features, using trends in morphology between the three specimens. Ontogenetic trends include the development of a sagittal crest, elongation of the intertemporal region, inflation of the zygomatic processes, elaboration of the nuchal crests, and elongation of the anterior processes of the petrosals. The most profound ontogenetic change is the elongation of the rostrum, which measures 48 cm in OU 22075, approximately 70 cm in OU 22163, and 130 cm in OU 22044; this roughly corresponds to a 60% increase in rostral length between the small juvenile and the adult (relative to interorbital width). Extreme positive allometry of the rostrum suggests a significant change in feeding ecology during ontogeny. Recognition of ontogenetic trends will permit ontogenetic evaluation of previously described mysticetes represented by putative adults, such as *Micromysticetus rothauseni*.

Technical Session I (Wednesday, October 30, 2013, 11:30 AM)

NEW INSIGHTS INTO THE DEVELOPMENT AND EVOLUTION OF THE VERTEBRAL COLUMN IN ARCHOSAURS

BÖHMER, Christine, Ludwig-Maximilians-Universität, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung fur Palaontologie und Geologie, Munich, Germany; WÖRHEIDE, Gert, Ludwig-Maximilians-Universität, Munich, Germany

Determination of the number and morphological identity of vertebrae are subjects of major importance in the development and evolution of vertebrates. Key determinants for the establishment of segments along the primary body axis of all metazoans are the *Hox* genes. The activity of these highly conserved genes is required for proper organization of the vertebrate body plan, and thus is responsible for the regionalization of the axial column. Our work examining the correlation of *Hox* gene expression and vertebral shape in the neck of amniotes has shown that changes in the genetic code are deducible from vertebral morphology. The highly variable cervical region has provided an illuminating model for the study of the relationship between genomic control and phenotypic changes. Here we present the first results of work assessing this correlation in the dorsal region of crocodiles, chickens, and mice. We have subsequently applied these findings to fossil archosaurs in order to establish the *Hox* code for extinct taxa on the basis of quantifiable changes in vertebral morphology. Whilst genetic information for mouse and chicken models was obtained from the literature, the present study extends previous analyses of the crocodilian *Hox* code. Our morphometric investigations reveal a taxon-specific subunit pattern of vertebral shape within the dorsal series. Crocodiles and the dinosaur *Plateosaurus* appear to share a similar pattern of 6 subunits united by a common morphology and function. This pattern changed to one of 5 subunits in birds whereas 8 subgroups are recognized in the mouse. The morphofunctional pattern is reflected by the *Hox* code in the analyzed extant taxa and allows inference of the genetic pattern in extinct animals. Thus an originally crocodile-like *Hox* gene expression pattern might be modified in birds, which have undergone significant modifications to their axial skeleton. In addition, this expression pattern might be changed to more strongly differentiated *Hox* code in mammals associated with their highly specialized body plan. The demonstrated correlation between vertebral morphology and *Hox* code allows us to hypothesize that the underlying genetic program of *Plateosaurus* resembled that of the crocodile. The evolution of *Hox* genes has been crucial in mediating the major transitions in the archosaurian body plan. Better understanding of vertebral development provides new insights into the evolutionary mechanisms responsible for the great morphological flexibility of the axial column.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

CONTINENTAL DWARFISM OF AN EARLY PLEISTOCENE HIPPOPOTAMID FROM THE SHUNGURA FORMATION, LOWER OMO VALLEY, ETHIOPIA

BOISSERIE, Jean-Renaud, CNRS, Poitiers, France

In insular context, some large mammals are prone to evolve smaller body sizes. The Hippopotamidae provide recurrent examples of such insular evolution during the Pleistocene and the Holocene, notably in Madagascar, Cyprus, Crete, and Malta. In continental context, there was until now no clear record of small body size evolution in hippopotamids. The extant Liberian hippo *Choeropsis liberiensis* is often called "pygmy hippo" by opposition to the much larger common hippo *Hippopotamus amphibius*. However, *Choeropsis* lacks a clear fossil record and it is currently not possible to conclude that its diminutive size resulted from an actual dwarfism, or instead reflects a primitive condition. I will present a well documented case of hippopotamid dwarfism on continental Africa. The species aff. *Hippopotamus aethiopicus* was first described in 1975 from the Shungura Formation, Omo Group, Ethiopia, and subsequently recognized from other formations in the Turkana Basin, but its temporal distribution, emergence, and evolutionary trends were unclear. Since 2010, the Omo Group Research Expedition, which reactivated field research in the Shungura Formation, collected new, abundant material of the pygmy species, dramatically increasing the number of known specimens. The study of this new material and the revision of the pre-existing hypodigm allow us to accurately identify the temporal distribution of this pygmy hippopotamid lineage in the Turkana Basin. Its evolutionary trends can be described step by step, including the rhythm and modalities of a clear decrease in body size. The factors that triggered the evolution of a dwarfed body size in this continental hippopotamid lineage can be investigated, and its congruence with the "island rule" can be tested.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

EVIDENCE OF EXTENSIVE SCAVENGING/PREDATION BY LATE CRETACEOUS MARINE ORGANISMS FROM THE BASAL HORNERSTOWN FORMATION, NEW JERSEY, USA

BOLES, Zachary, Drexel University, Philadelphia, PA, United States, 19104; LACOVARA, Kenneth, Drexel University, Philadelphia, PA, United States

The Main Fossiliferous Layer (MFL) of the Hornerstown Formation represents an Upper Cretaceous marine bonebed. Examination of recently collected fossils and those in the collections at the Academy of Natural Sciences of Drexel University reveal bite marks produced by predators and scavengers. These feeding traces can provide insight into the behavior, ecology, and functional morphology of the trace makers. The most common type of tooth marks are scores which are typically linear, shallow depressions in the bone that result from dragging the tooth along surficial compact bone. Such marks

could have been produced by a variety of organisms (e.g. sharks, fish, or invertebrates) making identification of a producer nearly impossible. However, two diagnostic markings have so far been identified in the sample. The first group of marks is very common and consists of short (~1-3 mm) striations usually surrounding a circular pit in the bone. These markings closely resemble those produced by modern echinoids while feeding on encrusting organisms. While one echinoderm taxon has been reported in the underlying Navesink Formation, no remains have been reported from the MFL. Consequently, the presence of the echinoid ichnofossil, *Gnathichnus pentax*, suggests their presence despite the lack of body fossils. The second group of markings are present on two crocodilian bones and are composed of several (~14) parallel striations produced by a carnivore with serrated teeth. These markings strongly resemble those previously attributed to the shark *Squalicorax*, for which teeth have been previously recovered from the site. Other sharks like hexanchids possess too few cusps per tooth while the other carnivorous taxa lack serrated teeth. Consequently, *Squalicorax pristodontus* is the only known taxon from the site which could have produced such bite marks. Based on the anatomical location of many feeding traces, scavenging was common and may have represented a major feeding strategy at this locality.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A PARTIAL SKULL OF *OPHISAURUS* (SQUAMATA, ANGUIDAE) FROM THE MIOCENE OF CATALONIA (NE IBERIAN PENINSULA)

BOLET, Arnau, Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; DELFINO, Massimo, Università di Torino, Torino, Italy; FORTUNY, Josep, Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; ALMÉCIJA, Sergio, Stony Brook University, Stony Brook, NY, United States; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain

The complicated taxonomic history of Miocene European Anguinae (Squamata, Anguidae), as illustrated by the problematic use of *Dopasia* instead of *Ophisaurus*, can only be clarified by combining a better knowledge on the osteology of extant taxa with the information provided by relatively complete and articulated fossil specimens. The application of non-invasive techniques, such as computed-tomography (CT) scanning, currently increases the amount of information that can be obtained from such specimens. They are however quite scarce, because anguine fossil remains are mostly retrieved through screen-washing techniques, which usually yield only isolated bones. In contrast, here we report a well-preserved, articulated anguine individual that preserves the partial skull and an associated trunk portion. The specimen, housed at the Institut Català de Paleontologia Miquel Crusafont, comes from the classical fossiliferous area of Hostalets Inferior—i.e., the late Aragonian levels (MN7+8) of els Hostalets de Pierola (Vallès-Penedès Basin, Catalonia, NE Iberian Peninsula), which has an estimated age of 12.5-11.2 Ma. The skull preserves its anterior region, including the premaxilla, maxillae, nasals and part of the frontals, as well as the anterior and middle portion of the two dentaries. The preserved trunk portion externally shows a great number of osteoderms in their original anatomical position, whereas CT scans show the morphology of the vertebrae preserved inside. CT scans further reveal additional morphological details of the skull hidden by the attached matrix, such as most of the dentition and elements of the palate. On the basis of the pointed and slightly recurved teeth of the dentary, the specimen is referred to the genus *Ophisaurus*. Conversely, *Pseudopus* displays blunt teeth along most of the dentary, whereas *Anguis* is characterized by fewer, more recurved, and widely-spaced teeth. The material reported here not only represents a good opportunity for studying the morphology of elements seldom recovered from the fossil record (e.g., nasals, palate elements), but it also records the presence in the Miocene of Catalonia of an anguine other than *Pseudopus*, thereby improving the rather poor knowledge on Miocene squamates from the Iberian Peninsula.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PREDICTIVE MODELING IN THE SEARCH FOR VERTEBRATE FOSSILS: GEOGRAPHIC OBJECT BASED IMAGE ANALYSIS (GEOBIA) IN THE EOCENE OF WYOMING

BOMMERSBACH, Bryan, Western Michigan University, Kalamazoo, MI, United States, 49008; ANEMONE, Robert, Western Michigan Univ, Kalamazoo, MI, United States; EMERSON, Charles, Western Michigan University, Kalamazoo, MI, United States

The development and testing of predictive models for identifying productive fossil localities represents a promising interdisciplinary endeavor among geographic information scientists, paleoanthropologists, and vertebrate paleontologists. Recent work demonstrates that even medium resolution Landsat imagery can be successfully used in a pixel-based artificial neural network (ANN) approach to identify the multi-spectral signature of productive fossil localities in the Eocene of the Great Divide Basin, Wyoming. Although sufficient for a basin-wide reconnaissance, the limitations of this approach reside in the relatively large pixels, and in the ANN approach itself (a "black box" which doesn't allow statistical characterization of the spectral classes). We analyzed high resolution (2 m resolution, pan-sharpened to 0.5 m) commercial satellite imagery from the Worldview-2 satellite of the Salt Sage Draw area of the Great Divide Basin using a GEographic Object-Based Image Analysis (GEOBIA) technique, which segments the image into spectrally homogeneous, multi-pixel image objects. In addition to allowing statistical analysis of the spectral characteristics of the image objects, GEOBIA techniques also let analysts incorporate expert knowledge and contextual information to improve classification accuracy. The spectral characteristics of the image objects that represent a highly productive sandstone locality (Tim's Confession, WMU-VP-220) were used to identify similar image objects throughout the local research area. A total of thirteen known fossil localities, including Tim's Confession, are located in the Salt Sage Draw area. While the earlier ANN model correctly identified 9 of the 13 localities, the GEOBIA technique matched 12 localities. These approaches allow a multi-scale analysis involving a combination of medium resolution Landsat imagery for regional and basin-wide analyses with high resolution Worldview-2 imagery in local research areas in order to generate and ground-truth predictive models for locating productive fossil localities.

Romer Prize Session (Thursday, October 31, 2013, 8:00 AM)

STABLE ISOTOPE PALEOECOLOGY OF LATE PLEISTOCENE MEGAHERBIVORES FROM WESTERN NORTH AMERICA

BONDE, Aubrey, University of Nevada Las Vegas, Las Vegas, NV, United States, 89123

Late Pleistocene (40-10 Ka) megaherbivore communities of California and Nevada were examined for ecological function (diet, mobility, niche partitioning, and range of ecological tolerance) and environmental information (flora and climate). Megaherbivore specimens were selected from seven localities in California and Nevada and stable carbon and oxygen isotopes in enamel or dentin of teeth were analyzed. Analyzed taxa include *Odocoileus, Euceratherium, Equus, Bison, Mammuthus, Ovis, Nothrotheriops*, and *Megalonyx*. Averaged results show that species were able to tolerate a wide range of diets and habitats, while serial data show that individuals exhibit much less ecological flexibility. Serial $\delta^{13}C$ and $\delta^{18}O$ data reveal that individuals consumed a similar type of vegetation throughout the year, and that most individuals experienced limited mobility or occupied similar habitats seasonally. Data indicate ecological partitioning between co-occurring megaherbivores, suggesting a weak degree of competition. Isotopic data acquired in this study, combined with data from prior analyses, reveal that northern California and northern Nevada were forested and woodland environments which hosted predominantly browsing species, while many of the same species in southern Nevada occupied an array of herbivorous niches (browsing, mixed feeding, and grazing), indicating the inclusion of mixed grassland in the region. These data reveal a wide range of ecological plasticity for Late Pleistocene megaherbivore species. Integrating the isotopic information into a constrained temporal framework reveals that environments were becoming warmer and more arid toward the close of the Late Pleistocene. Carbon data from *Equus, Mammuthus, Bison, Camelops*, and *Nothrotheriops* reveal that these taxa did not respond to this warming trend by increasing C_4 consumption, as would be expected from increased aridity. Rather, to cope with changing climates through the terminal Pleistocene, most taxa exhibited an expansion of dietary strategies (increased browsing or increased grazing), resulting in niche conservatism at the generic level.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

VERTEBRATES OF THE NEWARK CANYON FORMATION (BARREMIAN?-ALBIAN?), EAST-CENTRAL NEVADA: A PRELIMINARY REPORT AND IMPLICATIONS FOR MID-CRETACEOUS GEOGRAPHY OF THE INTERMOUNTAIN WEST

BONDE, Joshua, University of Nevada Las Vegas, Las Vegas, NV, United States, 89123; HILTON, Richard, Sierra College, Rocklin, CA, United States; JACKSON, Frankie, Montana State UnivMuseum of the Rockies, Bozeman, MT, United States; DRUSCHKE, Peter, ExxonMobil, Houston, TX, United States

The Newark Canyon Formation, exposed in mountain ranges of east-central Nevada, was the first formation to yield Cretaceous-aged fossils from the state. For the past three years our team has been mapping and collecting paleontological specimens in select exposures in the Newark Canyon Formation and has been successful in expanding the known fauna. To date, we have found the remains of Hybodontidae, Holostei, Glyptopsidae, Crocodilia (cf. Goniophilidae), Thyreophora, Iguanodontidae, possible Sauropoda, and Theropoda, with the latter including eggshell of the family Elongatoolithidae. Material has been recovered from braided to meandering fluvial sandstones and siltstones, as well as lacustrine silty mudstones. This faunal list is grossly similar to contemporaneous deposits of the Cedar Mountain Formation of east-central Utah.

The Newark Canyon Formation is interpreted as the deposits of a piggy-back basin associated with Sevier retroarc thrust tectonics, whereas the Cedar Mountain Formation represents those of the Sevier retroarc foreland basin. Primary zircons from the uppermost part of the type-section are Aptian in age, detrital zircons in overlying units are Albian in age, and this discrepancy implies deposition in the sub-basins of the Newark Canyon Formation was diachronous. The similarity in fauna between the Cedar Mountain Formation and the Newark Canyon Formation, two different tectonic settings, implies that as of Early Cretaceous time uplift in central Nevada had not yet progressed to the extent that a disjunct fauna characterized Utah and Nevada, and that uplift of the Nevadaplano likely postdated deposition of the Newark Canyon Formation.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

BISON DO NOT MARCH IN UNISON: A GEOMETRIC MORPHOMETRIC APPROACH TO DIFFERENTIATING NORTH AMERICAN BISON SPECIES BASED ON HOOF SHAPE MORPHOLOGY

BORMET, Allison, Indiana University, Bloomington, IN, United States, 47405

North American extant bison are large, horned bovids that exist in regions of Canada and Alaska as *Bison bison athabascae*, the wood bison, and in the American west as *Bison bison bison*, the plains bison. These animals are smaller-bodied with shorter horns than their recently extinct Pleistocene counterparts, *Bison latifrons* and *Bison antiquus*. Limb dimensions of *B. latifrons* suggest it was a large-bodied animal that was less cursorial than modern bison. Its geographic range included heavily wooded environments of western America. *B. antiquus*, considered to be the ancestor of modern bison, is not as cursorial as *B. b. bison*, but is more cursorial than *B. latifrons*. It most likely inhabited pockets of woodland steppe in southwestern America. Due to the overlap of geographic ranges and skeletal similarity, these species have been difficult to differentiate in the fossil record. Typically, species assignments were performed using skull characteristics, specifically horn cores. Due to the varying degree of habitats the

genus has inhabited, analysis of postcranial elements using geometric morphometrics may help discern ecomorphological variation between the species. The distal phalanx (PH3) was analyzed in this study because of good fossil preservation and its direct interaction with terrain, suggesting it may show ecomorphological shape variations across habitat types. Using photographs, fifty semi-landmarks were placed marginally around the plantar surface of the PH3, producing an outline that was Procrustes superimposed and subjected to a principal components analysis. Principle component one explains 64.4% of the total variance and represents the morphological trajectory of an elongated, tapered PH3 to a curved, blocky PH3 with a postero-lateral projection. Principle component two explains 13% of the total variance and represents the trajectory of a thinner, elongated PH3 to a curved, shorter PH3. Results of a MANOVA test indicate that PH3 morphologies of *B. antiquus* and *B. b. bison* are significantly different, with *B. antiquus* having more variation and elongation. *B. latifrons* tends to have a more prominent posterior-lateral projection than *B. bison* or *B. antiquus*. However, a larger sample size of *B. latifrons* is needed to determine if this species' PH3 morphology is significantly different than *B. antiquus* or *B. b. bison*. In addition, *B. b. athabascae* specimens will be added to the analysis to further compare morphological similarities between the extinct species, which lived in areas with more tree cover.

Technical Session VI (Thursday, October 31, 2013, 10:30 AM)

THE MOST COMPLETE AFRICAN HYAENODONTID (MAMMALIA, "CREODONTA") FROM THE LATEST EOCENE OF EGYPT AND THE EVOLUTION OF APTERODONTINAE

BORTHS, Matthew, Stony Brook University, Stony Brook, NY, United States, 11794; SIMONS, Elwyn, Duke University, Durham, NC, United States; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, United States

Before carnivorans appear in the Afro-Arabian fossil record in the latest Oligocene (~23 Ma), the terrestrial carnivore niche on the island continent was occupied by species from the extinct mammalian family Hyaenodontidae. Hyaenodontidae is often placed with Oxyaenidae in the order Creodonta. Hyaenodontids are also found in Eurasia and North America and are diverse in Africa, with species ranging from weasel-sized (*Masrasector*) to polar bear-sized (*Hyainailouros*). Several subfamilies have been proposed within the family including the Apterodontinae, a subfamily limited to the Eocene and Oligocene of Africa and early Oligocene of Europe. The enigmatic group combines reduced molar metaconids (an indicator of derived carnassial shear and a hypercarnivorous diet in extant carnivorans) with well-developed talonid basins (an indicator of a grinding ability associated with less specialized diets in extant carnivorans). Apterodontines exhibit prominent sagittal crests, wedge-shaped lambdoidal crests, and a long, narrow neurocrania. The relationships between species placed in Apterodontinae are not well-resolved and the acquisition of these mosaic features have not been established. Excavations in the Fayum Depression, Egypt, at the latest Eocene (late Priabonian) Locality 41 (L-41) have recovered the most complete apterodontine from Afro-Arabia. The new species has an estimated body mass of 23 kg, making this a relatively small apterodontine. While the skull is dorso-ventrally crushed, the specimen preserves the complete upper and lower dentition along with portions of the petrosal and a lambdoidal crest. The m1-2 retain an incipient metaconid ridge, and the M1-2 preserve a small metastyle. The postcranial skeleton includes a robust humerus with a prominent medial epicondyle and a short, stout ulna with a long olecranon process. Other preserved elements include the femur, tibia, fibula, calcaneus, astragalus and portions of each vertebral region. The morphology of the limbs and the long, fusiform body indicate fossorial or semi-aquatic capabilities in the L-41 taxon. This specimen provides the first opportunity to conduct a systematic analysis of Apterodontinae that incorporates postcranial characters. The L-41 specimen was recovered as a basal member of Apterodontinae, while *Kyawdawia*, a large 'proviverrine' hyaenodontid from the late Eocene of Myanmar, was placed as the sister taxon of Apterodontinae. This relationship suggests an Asian origin for the subfamily and dispersal to Afro-Arabia during the middle Eocene.

Technical Session VIII (Thursday, October 31, 2013, 3:00 PM)

LIFE HISTORY AND REPRODUCTIVE STRATEGY OF THE PERMO-TRIASSIC DICYNODONT *LYSTROSAURUS*

BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa; CODRON, Daryl, National Museum, Bloemfontein, South Africa

The dicynodont *Lystrosaurus* is one of the few therapsids that survived the end-Permian mass extinction. In South Africa, there are currently four valid *Lystrosaurus*</I> species, with *L. maccaigi* found only in Permian deposits, *L. murrayi* and *L. declivis* only in Triassic deposits and *L. curvatus* on both sides of the boundary. The Triassic species, *L. murrayi* and *L. declivis*, are well known for their high relative abundance in the aftermath of the extinction and this genus is thus an ideal model for assessing survival strategies in response to dramatic environmental perturbations of the end Permian. Although several studies have used osteohistology to study the growth of *Lystrosaurus*, none of these have considered both ontogeny and biostratigraphy simultaneously while assessing the pre- and post-extinction bone microstructure. In this study all four South African species were used to assess changes in life history during the end-Permian extinction. Results show that juveniles of all species reveal rapidly forming, highly vascularized, uninterrupted fibro-lamellar bone. However, Permian species exhibit multi-year growth as shown by the presence of numerous annuli and Lines of Arrested Growth in ontogenetically older individuals. In contrast, Triassic species exhibit a notably reduced life span, with a maximum of two growth rings appearing in individuals of similar ontogenetic stage to Permian species. Comparative analyses of body size distributions mirror the pattern of Triassic individuals exhibiting lower survival potential to adulthood, indicating that life expectancies (rather than maximum life span) had become reduced in the aftermath of the end-Permian extinction. Age-structured population growth models are used to test the prediction that Triassic *Lystrosaurus* compensated for reduced life expectancy by reaching sexual maturity earlier than their Permian counterparts.

Technical Session III (Wednesday, October 30, 2013, 3:45 PM)

NASAL TURBINATES IN PACHYCEPHALOSAURIDS (DINOSAURIA: ORNITHISCHIA): RECONSTRUCTING NASAL ANATOMY AND AIRFLOW, WITH IMPLICATIONS FOR PHYSIOLOGY

BOURKE, Jason, Ohio University, Athens, OH, United States, 45701; PORTER, William, Ohio University, Athens, OH, United States; LYSON, Tyler, Smithsonian Institution, Washington D.C., DC, United States; SCHACHNER, Emma, University of Utah, Salt Lake City, UT, United States; BELL, Phil, University of Alberta, Edmonton, AB, Canada

The existence of respiratory turbinates in extinct dinosaurs has been contentious due to their association with extant tachymetabolic endotherms. As thin walled, poorly- or unmineralized structures, turbinates rarely fossilize. Thus osteological correlates (e.g., ridges) are typically required to infer turbinates. The hypermineralized skulls of pachycephalosaurs are excellent candidates for preservation of such ridges or even of turbinates themselves. CT scanning of well-preserved skulls of *Stegoceras* and *Sphaerotholus* revealed mineralization of nasal capsular structures that normally remain cartilaginous. Olfactory turbinates, as judged by their location in the nasal cavity caudodorsal to the choana and immediately rostral to the olfactory bulbs of the brain, were present in both taxa. In addition, *Stegoceras* presented ridges along the walls of the nasal cavity that may have anchored soft-tissue turbinates in the living animals. To test this interpretation, the airway of *Stegoceras* was segmented in Avizo 7.1 and modeled in Maya to incorporate variations in shape (e.g., width of airway, presence and shape of turbinates). These models were subjected to a fluid dynamic analysis using Fluent. Segmentation results revealed that both olfactory turbinates and portions of the outer wall of the cartilaginous nasal capsule were preserved. Even with olfactory turbinates in place, the diameter of the olfactory airway was still larger than airways of extant sauropsids of similar size, suggesting that the olfactory concha filled this space in the living animals. Bony-bounded airways (i.e., not accounting for soft tissues) resulted in air unrealistically bypassing the olfactory chamber completely. Restoring even small turbinates attached to the presumptive turbinate crests in the rostral region of the nasal capsule produced a baffling effect, splitting the airfield into an olfactory and a main air stream. Incorporating soft-tissue (mucosal) corrections based on extant sauropsids greatly enhanced the flow of air within the nasal capsule, producing flow patterns concordant with those of extant sauropsids. This analysis suggests that pachycephalosaurs had good olfactory abilities with nasal cavities capable of housing turbinates or equivalent mucosal structures that would have aided in cerebral thermoregulation and reduction in respiratory evaporative water loss.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW TURTLES (REPTILIA, TESTUDINES) FROM THE LAS CASCADAS FORMATION, PANAMA CANAL BASIN, SUGGEST LOW DIVERSITY IN THE EARLY MIOCENE (ARIKAREEAN) NEOTROPICS

BOURQUE, Jason, Florida Museum of Natural History, Gainesville, FL, United States, 32611; RINCON BURBANO, Aldo Fernando, Florida Museum of Natural History, Gainesville, FL, United States; WOOD, Aaron, Florida Museum of Natural History, Gainesville, FL, United States; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, United States; MACFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL, United States

New World non-marine fossil turtles from the Arikareean North American Land Mammal Age (NALMA) are rare and typically fragmentary. In North America, these assemblages are marked by low chelonian diversity (e.g., in Florida and Texas). As a result, little is known about the evolution and paleogeography of many terrestrial and freshwater turtle groups during this interval, particularly in the ancient New World tropics. We report new fossil turtles collected along the Panama Canal from the early Miocene Las Cascadas Formation (21 Ma), a volcaniclastic sequence that represents the oldest appearance of terrestrial habitats in the southern Panama Canal Basin. Only three testudinoid taxa representing two families have been recovered from Las Cascadas over five years of collecting effort, suggesting that overall turtle diversity was low. The most abundant testudinoid fossils represent small to mid-sized terrestrial testudinids (land tortoises). One partial shell and unassociated shell fragments show some similarities (particularly in plastral forelobe characteristics) to the North American genera *Stylemys* (Whitneyan through Arikareean NALMAs) and *Gopherus*. A second partial testudinid shell is ambiguous with regard to its affinities and probably represents a new genus. Two partial shells, as well as unassociated isolated shell elements, represent a single species of turtle perhaps superficially similar to terrestrial and semi-aquatic forest-type geoemydids like extant *Rhinoclemmys*. This taxon is small (24-26 cm carapace length) and thin-shelled, with plastral kinesis along the hyo-hypoplastral suture, highly reduced hypoplastral buttresses, and fused sutural contacts between akinetic elements of the shell. In part, these features are diagnostic of the Ptychogastrini (=Ptychogasteridae), a group known from the early Eocene-late Miocene (earliest Ypresian-Tortonian or Messinian European Land Mammal Ages) of Europe with possible records from the latest Eocene (Chadronian NALMA) of North America. The Las Cascadas chelonians represent groups that likely dispersed from North America into Central America. Turtle diversity in the Panama Canal Basin greatly increased later in the early Miocene during the Cucaracha Formation (~19 Ma), with species diversity more than double that of the Las Cascadas Formation.

Symposium 3 (Friday, November 1, 2013, 8:00 AM)

EARTHTIME: HIGH PRECISION GEOCHRONOLOGY AND THE CALIBRATION OF EARTH HISTORY

BOWRING, Samuel, MIT, Cambridge, MA, United States, 02139; BLACKBURN, Terrence, DTM, Washington, DC, DC, United States; BURGESS, Seth, MIT, Cambridge, MA, United States; RAMEZANI, Jahandar, MIT, Cambridge, MA, United States

The stratigraphic record preserves much of what we know about the evolution of life and its relationship to environmental change from the composition of the oceans and atmosphere to major extinction events. The past decade has seen a revolution in temporal resolution of the stratigraphic record fueled by our ability to resolve the timing of major events as well as the rates of biologic and climatic change. This is in large part due to improvements in radioisotopic and astronomical dating techniques as well as acquisition and integration of high resolution paleontological and chemostratigraphic data and improved correlation techniques. The EARTHTIME initiative was designed to bring together geochronologists, stratigraphers, and paleontologists with the goal of improving the resolution of Earth history. It is now possible to resolve time with radioisotopic tie points to better than 0.02% with even finer scale resolution via interpolation, application of the Astrochronologic Time Scale and correlation of chemostratigraphic trends. Much progress has been made in integrating multiple chronometers and understanding intertechnique and interlaboratory biases. Applications of high-precison geochronology include constraining rates of biological, geological, and climate change. Examples illustrating this integrated approach include mass extinctions and recoveries, rapid climate change induced by volcanism, timescales of major changes in ocean chemistry, and global correlations of evolutionary events. Much more progress can be made with careful and integrative work as well as community inreach and public outreach

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

INVESTIGATING THE TAXONOMIC UTILITY OF SERRATION DENSITY ON THE CANINES OF NORTH AMERICAN NIMRAVID FELIFORMS

BOYD, Clint, South Dakota School of Mines and Technology, Rapid City, SD, United States, 57701; WELSH, Ed, Badlands National Park, Interior, SD, United States

It has long been recognized that “dirk-tooth” and “scimitar-tooth” nimravids display relatively fine and coarse serrations on their canine teeth, respectively. However, little work has been done to determine if differences in canine serration density between nimravid taxa are taxonomically informative. If such differences are present, they would provide powerful tools for referring fragmentary, taxonomically ambiguous material to specific clades, enhancing our ability to assess their geographic and biostratigraphic ranges. The present study focused on evaluating patterns of canine serration density among the nimravid taxa: *Nimravus* (n=7), *Dinictis* (n=12), and the hoplophonins *Hoplophoneus* (n=19) and *Nanosmilus* (n=2). Serration density was measured on the upper and lower canines over a length of at least five millimeters and then averaged to obtain the serration count per millimeter (SPM). Significant differences (p-value < 0.001) were noted between the mean values obtained for the upper canines of *Nimravus* (2.14 SPM), *Dinictis* (3.39 SPM), and the clade Hoplophonini (4.48 SPM). No overlap was observed in the values recorded for these three taxa, though the 95% confidence intervals for the latter two taxa do slightly overlap. Alternatively, values of SPM were found to be relatively consistent along the carinae of individual teeth, between left and right canines in individual specimens, and between deciduous and adult canines from the same taxon (the latter tested in *Nimravus* and *Hoplophoneus*). Similar, taxonomically significant trends in SPM value are seen in the lower canines of the sampled taxa, though sample sizes were smaller. Preliminary examination of some specimens of other “saber-tooth” feliform carnivores (i.e., the barbourofelid *Barbourofelis* and the felids *Smilodon*, *Nimravides*, and *Pseudalurus*) reveals that these "scimitar-tooth" and "dirk-tooth" taxa also display low and high SPM values, respectively. These preliminary results suggest that canine serration size in “saber-tooth” feliform carnivores is influenced by the morphology of the upper canines. Though broader sampling of nimravid taxa is needed, these preliminary results suggest that SPM values are a useful tool for identifying fragmentary specimens to specific clades, though resolution to the genus or species level may not be possible for all taxa.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TOOTH AND POSTCRANIAL GROWTH RATES IN A JUVENILE *GORGOSAURUS LIBRATUS*

BRADLEY, Gavin, University of Alberta, Edmonton, AB, Canada, T6G 2E9; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

Recent years have witnessed a substantial increase within paleontology in the understanding of dinosaurian growth rates, with theropod dinosaurs receiving particular attention. This burgeoning field has produced a wealth of data on the allometric growth rates of tyrannosaurids, including *Gorgosaurus libratus*. Despite the relative success of this incipient field, growth rates calculated for *Gorgosaurus libratus* postcranial material have yet to be compared to tooth growth and replacement rates of these large theropods. However, work on a new specimen from the prolific Dinosaur Park Formation in Dinosaur Provincial Park, Alberta, Canada, reveals the juxtaposition of growth rates from these two behaviorally important factors. The Campanian aged specimen, University of Alberta (UALVP) 49500, was collected by a team from the University of Alberta in 2008, and represents an uncharacteristically complete juvenile *Gorgosaurus libratus*; the scarcity of substantial juvenile specimens within the dinosaurian fossil record has been a much lamented hindrance, particularly in behavioral studies.

Using previously published femoral circumference/body mass regression equations, body mass estimations of the new juvenile specimen were extrapolated from femoral dimensions. An estimate of the age at death of the animal has also been made by counting the annually deposited lines of arrested growth in thin sections of a rib. As an amedullar bone that has previously been demonstrated to show minimal secondary reworking throughout the ontogeny of the animal, ribs are appropriate for age estimations in tyrannosaurids; unseen lines of arrested growth are unlikely to have been reabsorbed back into the matrix. By comparing the body mass estimate with that for age at death, a growth rate for the juvenile *Gorgosaurus libratus* was calculated and compared with previously published allometric growth curves for tyrannosaurids.

Furthermore, thin sections of a number of dentary teeth from both UALVP 49500, and an adult *Gorgosaurus* allowed for comparison of the number of incremental growth lines in the dentine. By counting these laminar depositions, thought to represent daily dentine accretions in a process similar to that which creates the analogous lines of von Ebner in some extant amniotes, the rate of tooth formation can be ascertained for the first time in *Gorgosaurus libratus*. Preliminary results mirror those of similar studies in other tyrannosaurids in that the juvenile displays a more rapid tooth development rate in relation to the development of the body than the adult. Such rapid, early tooth development as witnessed in juvenile *Gorgosaurus libratus* may yet provide corroborating evidence to suggest precocious behavior amongst juveniles. Furthermore, it may also provide useful data in the context of the more expansive problem of possible changes in ecological roles during tyrannosaurid ontogeny.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

INTERPRETING THE FACIAL INTEGUMENT OF ANKYLOSAURS

BRAMBLE, Katherine, University of Alberta, Edmonton, AB, Canada, T6G 2E9; ARBOUR, Victoria, University of Alberta, Edmonton, AB, Canada; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

The dorsal and lateral surfaces of adult ankylosaur skulls are covered by extensive sculpturing and fusion of osteoderms. This ornamentation may or may not be subdivided into discrete polygons. The integumentary covering of ankylosaur cranial ornamentation was investigated in order to determine if each polygon was covered by a single epidermal scale, and to determine what may have covered more amorphous rugose cranial ornamentation. Potential osteological correlates for integumentary structures were identified on ankylosaur skulls using variables previously identified for ceratopsian skulls, such as the presence or absence of rugosity, and the type of rugosity if present. In ankylosaurs with polygonal ornamentation, such as *Ankylosaurus* and *Edmontonia*, discrete polygons are separated by shallow but well-demarcated furrows, and each polygon was probably covered by a single epidermal scale. The quadratojugal and squamosal horns of *Ankylosaurus* and *Minotaurasaurus* are pitted, rugose, and have striations, features that are correlated with thin, cornified sheaths. Some ankylosaurs, such as *Crichtonsaurus*, *Gastonia*, and *Shamosaurus*, have rugose cranial ornamentation not subdivided into discrete polygons. In these species, the texture of the cranial ornamentation does not fit any of the categories previously described for ceratopsian facial integument. *Talarurus* lacks discrete polygonal cranial ornamentation, but raised bumps of the frontonasal ornamentation may correspond to epidermal scales; these are similar to bumps posterior to the orbit and on the midline of the parietal bar in ceratopsians. *Talarurus* is more derived than *Crichtonsaurus* and *Gastonia*, but is basal to *Ankylosaurus*; as such, it may represent a transitional morphology between amorphous and polygonal cranial ornamentation in ankylosaurids. Nodosaurids appear to have evolved polygonal cranial ornamentation independently of ankylosaurids, because the earliest members of each lineage have undifferentiated cranial ornamentation. New osteological correlates need to be identified to determine the integument of ankylosaurs with undifferentiated frontonasal ornamentation.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CROCODYLIFORM FEEDING TRACES ON CERATOPSID DINOSAURS FROM THE UPPER CRETACEOUS (LATE CAMPANIAN) KAIPAROWITS FORMATION, SOUTHERN UTAH

BRANDAU, Deanna, NHMU/Univ. of Utah, Salt Lake City, UT, United States, 84121

Tooth traces can provide a unique glimpse into the feeding behavior and ecology of extinct organisms. Tooth-marked dinosaur bones are relatively common, but the frequency of tooth traces is lower in the Mesozoic compared with Cenozoic mammal assemblages. However, recent studies suggest the frequencies of tooth marks on Cretaceous dinosaur bones are slightly higher than previously predicted. Here, I report evidence of feeding traces from two ceratopsid dinosaur associated skeletons from the late Campanian Kaiparowits Formation of southern Utah. The multiple bitten ceratopsid elements represent disarticulated but associated ceratopsid specimens preserved in sandy siltstone overbank deposits. The feeding traces consist of two size classes that occur on dorsal ribs and fragments, several cervical ribs and two ischia. Multiple pits and scores are observed on ischia and most dorsal ribs. Two dorsal rib shafts and an ischium display a row of small, serial pit marks. The presence of conical to oval-shaped marks, bisected pits and scores, U-shaped scores and pits, and hooked scores suggest tooth marks are diagnostic traces from one or more crocodyliform individuals at each site. This is further confirmed by the low frequency of traces (3-10% of preserved elements) on the bones, and absence of striations and gross gnawing on broken margins, which are often produced by theropod dinosaurs and mammals. The variable size in tooth traces suggest feeding behavior from either a single crocodyliform with a heterodont dentition or feeding from small and larger-sized crocodyliforms. These data are consistent with recent reports of crocodyliform feeding traces on other ornithischian dinosaur remains from the Kaiparowits Formation. Extant crocodylians are opportunistic predators, and their Cretaceous relatives appear to have scavenged and preyed upon a variety of clades of large and small-bodied ornithischian dinosaurs in the Kaiparowits ecosystem.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EXCAVATION AND FOSSIL RECOVERY AT DON'S GOOSEBERRY PIT, BLACK HILLS, SD

BRANDBORG, Donald , Denver Museum of Nature and Science, Denver, CO, United States, 80205; MATTHIAS, Angela, , Littleton, CO, United States; GRAHAM, Russell, Penn State Univ, University Park, PA, United States

Don's Goosebery Pit (DGP), a pit cave almost full of sediment to the surface when found, is located on US Forest Service land in the southeastern section of the Black Hills of SD. The cave is being excavated as part of a paleonvironmental project sponsored by the Pennsylvania State University and Illinois State Museum. Volunteers from these two institutions as well as from the Denver Museum of Nature & Science and the Western Interior Paleontological Society have been involved with the excavations for more than 10 years. The fauna, primarily small vertebrates, mostly mammals (23 taxa), with a few large ones, spans the Last Glacial Maximum (LGM), ca. 18,000 radiocarbon years ago (RCYBP), up until today. Even though it appears that the stratigraphy of the site is intact and excavations have been careful with 5 cm levels within natural stratigraphic units, the fauna is mixed as shown by radiocarbon dates. This problem can be resolved by dating individual specimens, identified at generic or species level, to provide a reliable paleoevironmental and biogeographic reconstruction of the northern Plains. The faunal sequence documents an overall warming in the climate since the LGM with ecological replacement of species. The remains of the collared lemming (Dicrostonyx) are of particular interest in this cave because they provide the first record of this arctic-boreal species for SD and they are extremely abundant (dozens of specimens) in contrast to other caves that have produced lower numbers of specimens (usually less than 10). Furthermore, ancient DNA (aDNA) indicates that the fossils from DGP and other sites in the Midwest (originally classified as *D. torquatus*) are closely related to *D. richardsoni* which has a "relict" distribution west of Hudson's Bay today. Because *D. richarsoni* is adapted to a more temperate, although tundra, environment than the more northerly distributed *D. torquatus* or *D. groenlandicus*, its presence in Pleistocene faunas may alter earlier interpretations of harsh climate conditions. These studies are fundamental to understanding the potential effects of future global warming in the Black Hills.

Symposium 2 (Thursday, October 31, 2013, 3:15 PM)

NUTRITIONAL STRESS INDUCES MORPHOLOGICAL CHANGES IN DIRE WOLVES FROM RANCHO LA BREA

BRANNICK, Alexandria, Marshall University, Huntington, WV, United States, 25755; MEACHEN, Julie, Marshall University, Huntington, WV, United States; O'KEEFE, F. Robin, Marshall University, Huntington, WV, United States

Prior studies on dire wolves from the Rancho La Brea tar pits have demonstrated a temporal pattern in tooth wear and breakage, with higher incidences of tooth breakage in those living during the Last Glacial Maximum (LGM). High breakage and wear is probably attributable to increased nutrient stress and carcass utilization at ~15 ka. These fluctuations in food availability may lead to a change in morphology and rate of development. In order to identify any morphological variations co-occurring with food availability oscillations, a landmark-based shape analysis on dire wolf jaws was performed. This study is the first to analyze mandibular variations in *Canis dirus* over a 20,000 year time period. We scored 16 landmarks on each mandible from specimens gathered from five pits: 61/67 (~12 ka), 13 (~15 ka), 2051 (~21 ka), 91 (~30 ka), and 77 (~35 ka). Multiple temporal shape patterns were detected. In particular, mandible dimensions display a trend towards a stunted, progenetic morphology at the LGM. This is in accordance with previously analyzed morphometrics of dire wolf skulls, where morphology resembles more juvenile-like features, including proportionally smaller snouts, during the LGM. Their shape then returns to normal in pit 61/67, concurrent with the end-Pleistocene extinction event. This suggests that the dire wolf population at Rancho La Brea did not have limited food availability directly preceding extinction. In addition, using the extant gray wolf (*Canis lupus*) as a guide, sexually dimorphic signals are also distinguishable among the mandibles. Skulls of gray wolves have shown that males have significantly larger coronoid processes, while females have proportionally larger molars. Using analysis of centroid size as a body size indicator, these trends are apparent in this dire wolf population as well. Coronoid process height increases as centroid size increases, while the grinding surface length of the first molar and the length of the second molar decrease with increasing centroid size. While sexual dimorphism is evident, it appears to be constant over time, unlike other morphological aspects of the jaw.

Romer Prize Session (Thursday, October 31, 2013, 8:15 AM)

HIND LIMB ROBUSTICITY IN TWO FAMILIES OF SOUTH ISLAND NEW ZEALAND MOA (AVES, DINORNITHIFORMES) COMPARED TO MODERN RATITES: NEW VOLUMETRIC BODY MASS ESTIMATES AND FINITE ELEMENT ANALYSIS

BRASSEY, Charlotte, University of Manchester, Manchester, United Kingdom

The moa of New Zealand were flightless ratites, ranging in size from 20 kg to >200 kg. In the absence of terrestrial predators, moa are hypothesized to have evolved limb bones with higher safety factors than normally expected due to a lack of selective pressure to minimize bone mass. Yet without reliable estimates of body mass, the extent to which moa limbs were relatively more robust than modern ratites is unclear. Previous mass estimates have relied upon linear regression techniques of single bone measures. However, the nature of their unusual skeletons makes mass estimation based upon single linear dimensions problematic. Furthermore, undertaking biomechanical analysis of a limb bone by applying a mass derived from said limb bone is circular. This study applies a new volume-based mass estimation method to two species of moa, *Dinornis robustus* and *Pachyornis australis* and tests leg bone strengths using finite element analysis.

Mounted skeletons of modern ratites were digitised using LiDAR, and minimum convex hull volumes calculated. The relationship between hull volume and live mass was used to predict the mass of moa. The estimated masses were: *D. robustus* 196 kg (155-245 kg); *P. australis* 50kg (33-68 kg). Subsequently, finite element analysis was conducted on femora and tibiotarsi of modern ratites and moa loaded under compression, bending and torsion. *P. australis* experienced the lowest values for Von Mises stress under all loading conditions and is confirmed as highly robust. In contrast, stress values in the femur of *D. robustus* were similar to those of modern flightless birds, whilst the tibiotarsus experienced the highest stress values of any ratite.

Dinornithiformes adopted a variety of biomechanical strategies to cope with the problem of island flightlessness, with increased limb robusticity not always occurring. Differences in robusticity between families may indicate habitat preference. *P. australis* is associated with sub-alpine localities, and may reflect adaptation to uneven terrain and poor load predictability. Furthermore, safety factors during locomotion are mediated not only via bone robusticity, but also postural and behavioural modifications. The use of multi-body dynamics analysis may further illuminate the trade-off between cursoriality and safety factors in flightless giant birds.

Symposium 4 (Saturday, November 2, 2013, 8:00 AM)

AN OSTEICHTHYAN-LIKE SKULL FROM SIBERIA AND THE EVOLUTION OF CROWN GNATHOSTOME BRAINCASE MORPHOLOGY

BRAZEAU, Martin, Naturalis Biodiversity Center, Leiden, Netherlands; GILES, Sam, , Oxford, ; FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom

The phylogenetic placement of Silurian and Devonian fishes remains one of the greatest impediments to a coherent picture of the early evolution of jawed vertebrates. Although some cladistic investigations have begun to make progress on this problem, the state of the field is comparatively immature. The disparity of dermal skeletal characters in early gnathostome taxa limits the utility of these traits in resolving deep gnathostome divergences. Neurocrania (braincases) provide rich sources of character information that can have a profound impact on our understanding of early gnathostome evolution. Here we report the anatomy of an Early Devonian fish braincase from Siberia with significant implications for the comparative anatomy of early gnathostome braincases. The skull, exhibiting an osteichthyan-like dermal skull roof, was examined using high resolution computed tomography scanning. The results revealed the thin, delicate perichondral shell of a nearly complete braincase. The tomography renderings show clear anatomical details including a distinct eyestalk attachment, hyoid arch articulations, and a mediolaterally narrow basicranium with a network of impressions for the basicranial circulation. Despite the osteichthyan-like skull roof, the neurocranium is devoid of any clear osteichthyan synapomorphies. Nevertheless, it lacks any features that might unite it uniquely with the chondrichthyans, or any lineage of 'placoderm'. In spite of this phylogenetic uncertainty, the specimen is clearly interpretable in terms of osteichthyan, chondrichthyan, and arthrodire basicranial anatomy. The result helps deliver a unified perspective on the neurocranial anatomy of these lineages, but also provides new insights that may assist in the identification of some previously enigmatic early gnathostomes.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DIVERSITY IN FROGS (RANIDAE) FROM THE HAGERMAN LOCAL FAUNA, PLIOCENE OF IDAHO

BREDEHOEFT, Keila, Hagerman Fossil Beds National Monument, Hagerman, ID, United States, 83332; SAMUELS, Joshua, John Day Fossil Beds National Monument, Kimberly, OR, United States

Frogs are an abundant but little-studied component of the Hagerman local fauna (upper Pliocene, Glenns Ferry Formation). The collection at Hagerman Fossil Beds National Monument includes over 2500 frog specimens, representing about 10% of the total collection. Part of the difficulty in studying fossil anurans lies in the lack of resolution of taxon identifications past the family or generic level, especially when using only isolated, often fragmentary parts, as is most often the case with microfauna. Here we use a geometric morphometric approach to evaluate the taxonomic affiliations of the Hagerman frogs and identify characteristics that might allow species diagnoses. A set of 12 landmarks were digitized onto a large sample of ilia from throughout the Hagerman section. Relative warp and canonical variates analyses indicate the presence of as many as three ranid species. Species show differences in the shape of the acetabulum, position of the iliac shaft and supra-acetabular fossa, and the angle of between the dorsal acetabular expansion and dorsal prominence. The analyses showed a reliable classification of species, with greater than 80% accuracy in all cases. These results also confirm the presence of the bullfrog, *Rana catesbeiana*, a species that has been identified from the Hagerman fauna, but is generally considered by ecologists to be historically introduced to Idaho and therefore invasive. In addition, the large sample size from a range of locality elevations allows us to study morphological variance and relative species abundance through time. Notably, bullfrogs are not found in strata closest to the top of the section, possibly indicating a prehistoric displacement from the area.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

REASSESSMENT OF THE 'LAST' GONIOPHOLIDID: *DENAZINOSUCHUS KIRTLANDICUS* FROM THE LATE CRETACEOUS OF NEW MEXICO

BREMER, Oskar, Uppsala University, Uppsala, Sweden; KEAR, Benjamin, Uppsala University, Uppsala, Sweden

The holotype and only known skull of the late Campanian crocodylian, *Denazinosuchus kirtlandicus*, from the Kirtland Formation of the San Juan Basin, New Mexico, was found by the famous fossil collector Charles Hazelius Sternberg and recognized as a late-surviving member of the Goniopholididae by the Swedish vertebrate

palaeontologist Carl Wiman in 1932. The specimen comprises most of the right-hand side of the cranium from the posterior edge of the external naris to the anterior margin of the supratemporal fenestra. Three-dimensional CT-imaging carried out for this study has also identified an additional isolated right squamosal. Parsimony and Bayesian phylogenetic analyses of *D. kirtlandicus*, rescored into the most comprehensive published data sets of Neosuchia and Goniopholididae, confirmed its placement as a derived goniopholidid, as well as the 40 million year stratigraphical range extension of the clade into the latest Cretaceous. *Denazinosuchus kirtlandicus* occurred sympatrically alongside three alligatoroid genera in the non-marine Kirtland, and the underlying estuarine Fruitland Formation: *Brachychampsa*, *Leidyosuchus*, and the colossal apex carnivore *Deinosuchus*. Only *Brachychampsa* has been found sympatrically with *D. kirtlandicus*, implying that these taxa must have partitioned their environment via contrasting feeding ecologies. Indeed, a relative warps assessment of two-dimensional landmark data mapped from skull shape shows that *D. kirtlandicus* conforms to a generalist predator morphotype. In contrast, *Brachychampsa* was clearly a specialist durophagous feeder, perhaps feeding on turtles and benthic molluscs.

Technical Session XIV (Saturday, November 2, 2013, 11:00 AM)

CAN MORPHOLOGY PREDICT DIETARY ECOLOGY IN LIVING AND EXTINCT BIRDS OF PREY?

BRIGHT, Jen, University of Bristol, Bristol, United Kingdom; COBB, Samuel, Hull York Medical School, York, United Kingdom; MARUGAN-LOBON, Jesus, Universidad Autonoma de Madrid, Madrid, Spain; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom

Birds are one of the most diverse clades of modern vertebrates, and have historically been regarded as a classic group in which to study adaptation through evolution. Different lineages of birds often display remarkable convergence in their cranial and beak morphologies, frequently presumed to be associated with similarity in dietary niche. We tested this assumption by performing Geometric Morphometric (GMM) analyses within a subset of extant neognathous birds, the diurnal birds of prey. Recent molecular phylogenies have classified this group as polyphyletic. There are therefore multiple examples of convergence within this subset of birds, for instance between the falcons (Falconidae) and hawks (Accipitridae), or between the Old World vultures (Accipitridae) and New World vultures (Cathartidae). Three-dimensional landmarks and semi-landmarks were collected from the beaks and skulls of diurnal raptors. Principal Components Analysis shows that carrion feeders (the Old and New World vultures) tend to cluster together in morphospace regardless of phylogeny, indicating strong morphological as well as dietary convergence. Elsewhere, there is considerable morphospace overlap between falconids and accipitrids. This indicates that although the skull morphology of predatory birds is highly constrained overall, it does not appear to be a strong predictor of preferred prey even in birds with highly specialized diets. Dietary niche may be predicted based on cranial morphology in some species, but this is the exception rather than the rule: feeding ecology alone is insufficient to explain the variety of forms seen in extant birds of prey. This highlights the importance of establishing an extant framework for applications of GMM to fossil taxa and questions of paleoecology.

Technical Session IX (Friday, November 1, 2013, 8:00 AM)

PREVALENCE, ORIGIN, AND ANATOMY OF DENTICLE AMPULLAE IN THEROPOD DINOSAUR TEETH

BRINK, Kirstin, University of Toronto Mississauga, Mississauga, ON, Canada, L5L 1C6; LEBLANC, Aaron, University of Toronto Mississauga, Mississauga, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; REISZ, Robert, University of Toronto Mississauga, Mississauga, ON, Canada

Ziphodont teeth are typified by denticles extending apico-basally along the mesial and distal carinae, and are ubiquitous among toothed theropod dinosaurs. A unique structure, the ampulla, has been previously identified in thin section between the bases of adjacent denticles along the distal carinae of *Albertosaurus*. The ampulla is a void in the dentine that is connected to the external surface of the tooth via a channel in the enamel. The channel and ampulla are hypothesized to function as a 'kerf and drill', which mitigate tensional stress exerted on the carina during feeding and prevents the propagation of cracks through the tooth. However, it is unknown if ampullae form before tooth eruption, or are created in response to stresses during feeding. Although ziphodonty occurs in numerous amniote clades, the presence of ampullae has only been accurately documented in *Albertosaurus*. The widespread presence of ampullae within Theropoda could represent an important innovation in the evolution of carnivorous feeding behavior.

To examine the pervasiveness of ampullae in theropods, teeth from six taxa (*Tyrannosaurus rex, Coelophysis bauri, Carcharodontosaurus saharicus, Troodon formosus, Allosaurus fragilis*, and an indeterminate dromaeosaurid) were examined histologically. Results show that ampullae are present in all theropod taxa examined here, with the exception of *Troodon*. Contrary to previous hypotheses, ampullae are present on both the mesial and distal carinae, and are not encircled by a layer of enamel, but rather are composed of atubular dentine. In order to assess how these structures develop, an unerupted tooth of *A. fragilis* was thin-sectioned to determine if the enamel channel and ampulla are present before the tooth becomes part of the functional tooth row, or if it forms after eruption in response to external stress on the denticles. Interestingly, the unerupted tooth of *A. fragilis* does not have an enamel channel or ampulla, indicating that ampullae are only present in functional teeth and thus are the result of stress, not developmental history. These results suggest that the ampulla is a reparative structure in which the dentine immediately surrounding an enamel crack is remodeled to stop the propagation of the crack and prevent catastrophic breakage or infection of the tooth. The functional implications of this evolutionary novelty may have played an important role in the radiation of this diverse group of terrestrial carnivores.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

MOLAR MORPHOLOGY AND FUNCTION OF *HALDANODON EXSPECTATUS* (DOCODONTA, MAMMALIAFORMES)

BRINKKÖTTER, Janka J., Universität Bonn, Bonn, Germany; MARTIN, Thomas, Universität Bonn, Bonn, Germany

In the history of mammalian evolution a talonid-like crushing zone in the lower molars convergently evolved up to three times before the appearance of the Tribosphenida. The most basal group with such "pseudotribosphenic" teeth are the docodonts. They possess a fairly derived dentition with a mesially situated "pseudotalonid".

To examine the dental function of *Haldanodon*, a large number of isolated teeth and upper and lower tooth rows from the Kimmeridgian of the Guimarota coal mine in Portugal were studied by SEM, synchrotron, and micro-CT. Wear facets were mapped and their striation recorded which served together with 3D models as the basis for an analysis of the chewing cycle with the Occlusal Fingerprint Analyser (OFA). By OFA analysis, the occlusal relationships of *Haldanodon* molars were reconstructed in detail. Previous models with an occlusion of the upper molars in between the lower molars and contact of the mesial part of the upper molar with the distal part of the lower molar were confirmed. The distal part of the upper molar contacts the mesial part of the following lower molar. This implies that the "pseudoprotocone" actually occludes mesiolingually of the "pseudotalonid". Therefore the amount of crushing occurring in the "pseudotalonid" is actually quite small. Instead, the majority of the crushing function is conducted in the distally situated "pseudotrigon" of the upper molar by cusp b of the lower molar.

The OFA-analysis also revealed a considerable "overbite" in the molars of *Haldanodon*, with main cusp a of the lower molar occluding beyond the dental crown-root-boundary of the upper molar. This overbite is compensated by grooves in the maxilla between the upper molars. Noteworthy is also a change from mesially heavier worn molar tooth rows in juvenile specimens to distally heavier worn molar tooth rows in older specimens probably due to a distally shifted chewing focus, a relatively thin enamel layer and highly abrasive food.

Symposium 3 (Friday, November 1, 2013, 10:15 AM)

PRELIMINARY SEQUENCE STRATIGRAPHY OF THE CEDAR MOUNTAIN FORMATION OF UTAH WITH U-PB LA-ICP-MS DETRITAL ZIRCON AGES FOR EACH SEQUENCE

BRITT, Brooks, Brigham Young University, Provo, UT, United States, 84602; GREENHALGH, Brent, Wexpro, Salt Lake City, UT, United States; MORI, Hirotsugu, University of Alaska Fairbanks, Fairbanks, AK, United States; MACKAY SORENSEN, Amanda, Ridgeland Operating Systems, Lindon, UT, United States; SCHEETZ, Rodney, Brigham Young University, Provo, UT, United States

The Cedar Mountain Formation has produced a wealth of vertebrate fossils but assessing their ages and the ages of the units from which they are derived has been hampered by a reliance on lithostratigraphy and a paucity of volcanic ash beds usually required for radiometric ages. Here, we summarize our efforts to (1) place the formation into a chronostratigraphic framework using sequence stratigraphic methods (using 42 measured sections) and (2) determine the ages of these sequences via dating of detrital zircons (DZ) using U-Pb laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) methods applied to >50 DZ samples of silty mudstones.

The base of the Cedar Mountain Formation in Utah (DZ maximum depositional age 124 Ma) is separated from the underlying Morrison Formation by an unconformity spanning 25 Ma, whereas the top of the formation has an $^{40}Ar/^{39}Ar$ age of 97 Ma and is bounded above by the initial transgression of the Western Interior Seaway. Between these bounding surfaces we utilize significant terrestrial erosional surfaces and paleosols to discriminate at least three major sequences. From oldest to youngest these are (1) the Yellow Cat Sequence (124 to ~119 Ma [Buckhorn Conglomerate Member + Yellow Cat Member + Poison Strip Member]); (2) the Ruby Ranch Member Sequence (~116 to ~108 Ma); and (3) the Mussentuchit Sequence (~104 to 97 Ma [Mussentuchit Member + Dakota Sandstone/Naturita Formation, from the San Rafael Swell to Moab]); paleovalley incision suggests the Mussentuchit Sequence consist of multiple subsequences.

Although the Cedar Mountain Formation in the forebulge area of the basin is ~100 m thick it spans ~27 Ma, early Aptian to early Cenomanian. The recognition of the three sequences permits temporal correlation of vertebrate quarries within each sequence throughout the formation, eliminating the errors of facies-based correlations. For example, even though *Falcarius* and *Utahraptor* have not been found together they are part of the Yellow Cat Sequence along with *Gastonia* plus an array of sauropods and ornithopods. Furthermore, the radiometric age brackets for these sequences facilitates comparison with coeval faunas elsewhere.

Technical Sesssion XII (Friday, November 1, 2013, 3:00 PM)

A NEW, PHYLOGENETICALLY SIGNIFICANT ALLIGATOROID FROM THE LATE CRETACEOUS (CAMPANIAN) OF MÉXICO

BROCHU, Christopher, University of Iowa, Iowa City, IA, United States, 52242; LANGSTON, Wann, Univ of Texas at Austin, Austin, TX, United States; ROWE, Timothy, Univ of Texas at Austin, Austin, TX, United States

A small short-snouted crocodylian from the Late Cretaceous of Baja California helps fill the substantial morphological gulf separating the earliest globidontans (forms resembling living alligators) from more basal alligatoroids. It was collected from upper Campanian deposits informally known as the "El Gallo Formation" and is one of the oldest known crocodylians. The specimen is from an animal less than 2.5 m in length. It has a short, flat snout and remarkably flattened anvil-like teeth at the back of the maxillary series. The distal dentary teeth are also expanded, and the lateral margin of the suborbital fenestra is bowed medially, forming a bony shelf adjacent to the enlarged

posterior teeth found in other short-snouted and possibly durophagous crocodylians. It shares several derived character states with other globidontans, such as the absence of a notch between the maxilla and premaxilla, and the shape of the skull is similar to that of the Campanian-Maastrichtian globidontan *Brachychampsa*, but unlike *Brachychampsa* and other globidontans, the El Gallo form preserves several character states currently optimized as plesiomorphic within Alligatoroidea, including a frontal forming a substantial part of the supratemporal fenestral margin and fourth and fifth maxillary alveoli of nearly the same size. A phylogenetic analysis supports a sister group relationship between the new form and all other globidontans. It also reinforces a North American origin for Globidonta and other basal alligatoroid clades, with multiple dispersal events to Eurasia and South America. Moreover, the morphology of the snout is consistent with a specialized, possibly durophagous, condition for the ancestral alligatorid and a reversal toward a more generalized morphology in living forms.

Technical Session VIII (Thursday, October 31, 2013, 1:45 PM)

THE INFLUENCE OF SAMPLING ON THE FOSSIL RECORD OF PALEOZOIC SYNAPSIDS, AND THE EFFECT OF OLSON'S EXTINCTION ON THEIR EVOLUTION

BROCKLEHURST, Neil, Museum für Naturkunde, Berlin, Germany; KAMMERER, Christian, Museum für Naturkunde, Berlin, Germany; FRÖBISCH, Jörg, Museum fur Naturkunde, Berlin, Germany

Synapsids dominated the terrestrial realm between the late Pennsylvanian and the Triassic. Their early evolution includes some of the first amniotes to evolve large size, herbivory and macro-carnivory. However, little research has been done on the changes in diversity occurring in synapsids during the earliest period in their evolution, or on the potential effects of anthropogenic sampling bias on their record. Here synapsid diversity is assessed between the Carboniferous (Moscovian) and the Middle Permian (Capitanian). A raw, taxic diversity (richness) estimate is generated, and two separate methods are used to correct for sampling bias. A recently published modification of the residual diversity method is applied to remove the effect of anthropogenic sampling bias, and a supertree is generated using the matrix representation with parsimony method to infer ghost lineages and obtain a phylogenetic diversity estimate.

Evidence of significant anthropogenic sampling bias is suggested by a strong positive correlation between the number of amniote-bearing collections and the taxic diversity of synapsids. The patchiness of the geographic distribution of fossils also highlights the gaps in our knowledge.

Previous analyses of tetrapods have indicated a mass extinction between the Early and Middle Permian (Olson's extinction). Sampling-corrected diversity curves of Synapsids support significant extinction in this clade across the Kungurian/Roadian boundary, in which Edaphosauridae and Ophiacodontidae disappear and Sphenacodontidae experiences a large decrease in diversity. However, the extinction does not affect all synapsid groups equally; Therapsida and Caseidae increase in diversity across the boundary. Whilst the uncorrected diversity curve indicates a recovery from the extinction during the remainder of the Roadian, the sampling-corrected diversity curves indicate that diversity remains low, with further extinction amongst Sphenacodontidae and Caseidae. It is concluded that this extinction marks the turnover between the 'pelycosaur'-dominated fauna of the Early Permian and the Therapsid-dominated fauna of the late Permian.

Technical Session VII (Thursday, October 31, 2013, 3:30 PM)

BODY SIZE RELATED TAPHONOMIC BIASES IN THE LATEST MAASTRICHTIAN; IMPLICATIONS FOR THE END-CRETACEOUS EXTINCTION

BROWN, Caleb, University of Toronto, Toronto, ON, Canada, M5S 2C6; CAMPIONE, Nicolas, University of Toronto, Toronto, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

The Late Maastrichtian (Cretaceous) remains one of the best systems for investigating evolutionary and ecological dynamics leading up to mass extinction events, and offers a chance to understand the processes that drive major biotic shifts in Earth's history. The Hell Creek Formation (HCF), and equivalent beds of the northwestern USA, represent the best studied and most well-sampled dinosaur dominated ecosystem of the Late Maastrichtian and hence remain a focal point for studies of diversity patterns and dinosaur community structure immediately before the end-Cretaceous mass extinction. The dinosaur body size distribution within the assemblage of the HCF, as with other alluvial-paralic systems, shows a negative skew in which large taxa are more diverse than small taxa. This represents a non-analogue condition, opposite from size distributions in modern ecosystems, and can be interpreted as either reflecting an ecological signal, or due to a taphonomic signature. Here we quantitatively test for the presence of a taphonomic size bias in the HCF by testing for correlations between body mass (range: 0.26–12,000 kg) and multiple taphonomic indices (skeletal completeness, date of description, taphonomic mode, and relative abundance). We find strong evidence for a taphonomic size bias acting to decrease the completeness and articulation of species less than 60 kg. Species greater than 60 kg show a logarithmic rate of discovery, nearing a plateau, whereas those smaller than 60 kg show an increasing rate of discovery. Large taxa were also systematically more abundant than smaller taxa when all census data were analyzed. Finally, results are independent of taxonomic synonymy and formational boundaries, tested by contrasting results of taxonomic lump/split datasets and comparing results for the HCF only, and the HCF and Lance combined datasets. All results can be explained by a single strong taphonomic bias against small skeletons. Such a process will also directly decrease the apparent diversity of small taxa, and thus have major implications for how community structure and diversity dynamics are interpreted leading up to the end-Cretaceous mass extinction event.

Preparators' Session (Thursday, October 31, 2013, 10:15 AM)

PRACTICAL METHODS FOR THE USE OF CYCLODECANE IN VERTEBRATE MICROFOSSIL PREPARATION

BROWN, Gregory, University of Nebraska State Museum, Lincoln, NE, United States, 68588-0514

Since 1995, cyclododecane (CDD), a waxy cyclic alkane hydrocarbon that sublimes at room temperature, has found increasing use by conservators as a temporary binder, facing, barrier coat, consolidant or mounting medium in the conservation of a range of fragile objects from ceramics and textiles to ancient paintings and frescoes. Over the past decade, CDD's unique and advantageous properties have led to its adoption by vertebrate paleontology preparators for a variety of uses, including temporary fills during molding or reinforcing support during transportation, but its primary use is as a temporary mount or "work-holder" for delicate microfossils during preparation. The basic concepts of the latter use have been presented before: the specimen or its containing block of matrix is partially imbedded in a small container of melted CDD which is then secured to a work platform that can be easily held and manipulated under the microscope. However, the details and nuances of carrying out this procedure safely (for both the specimen and the preparator) have not been presented adequately. In addition to its support function, CDD can be used during micro-preparation to provide protection for fragile elements previously exposed and as a "warning-cushion" for edges of access while working inside enclosed cavities (such as endocrania). CDD is also useful as a temporary consolidant of non-cohesive matrix in cases where removal of matrix would otherwise result in collapse of the enclosed specimen. Since CDD is hydrophobic and insoluble in strong polar solvents, consolidation of otherwise porous matrix and specimen also allows use of the "water-bead" technique to enhance visual differentiation of matrix and bone. The proper use of special tools and the selective warming (or not) of specimens is key to the successful application and removal of CDD in these and other micro-prep procedures. Although the MSDS indicates that CDD has low toxicity, thorough safety studies have not been conducted. CDD is known to be a bioaccumulant with primary routes of entry through respiration and skin absorption. It is strongly recommended that heating, melting and application of CDD be done under a fume hood and gloves and safety glasses be worn during use.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

***EQUUS OCCIDENTALIS* LEIDY FROM ASPHALTO, KERN COUNTY, CALIFORNIA**

BROWN, Kristen, Natural History Museum of Los Angeles County, Los Angeles, CA, United States, 90007; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States; AKERSTEN, William, Idaho State University, Pocatello, ID, United States

The Asphalto vertebrate fossil locality near Buena Vista Lake in Kern County, California has produced mammal fossils dating to the Blancan and Rancholabrean North American Land Mammal Ages (NALMAs). The locality is situated in the Tulare Formation, which regionally has yielded Blancan vertebrates including *Borophagus*, *Ischyrosmilus*, and *Equus*. At Asphalto, younger Rancholabrean fossils derive from asphaltic sediments inset into the older Tulare Formation.

Two upper teeth of Blancan *Equus* from Asphalto were combined with a left P3 from an undiagnosed locality in Tuolumne County, California to erect the species *Equus occidentalis* Leidy 1865. The Tuolumne specimen was later chosen as the lectotype. Because the lectotype locality is not known, topotypal fossils are unavailable. This, coupled with the lack of specific diagnosticity in any of the original specimens, has led to the determination that the name *E. occidentalis* is technically a nomen dubium.

Despite this, the name *Equus occidentalis* continues to be employed in Pleistocene mammalian paleontology – especially at the Rancho La Brea asphalt locality, where the name is frequently assigned to large horse fossils from that site. Because of the prominence of the Rancho La Brea biota in late Pleistocene studies throughout North America, usage of the species name in this sense has been promulgated at many other sites. Another, less common interpretation suggests that *E. occidentalis* may be a valid plesippine equid dating to the Blancan NALMA. This view employs lower cheek teeth from the Tulare Formation exhibiting with deep ectoflexids – a diagnostic character of plesippine equids – to buttress the definition of the species as defined from Asphalto, effectively disregarding the Tuolumne lectotype.

We examined horse fossils from Asphalto and from other non-asphaltic localities in the Tulare Formation, confirming that plesippine fossils are abundant. However, dental metrics reveal at least two plesippine species, including medium- and large-sized forms, in the Blancan component of this formation. The paratypes of *Equus occidentalis* from Asphalto lack any diagnostic characters, and cannot be confidently assigned to either the larger or the smaller equid morphs from the Tulare Formation based upon size. The plesippine nature of other equid teeth from this formation is therefore irrelevant to resurrecting the nomen as a valid species. *E. occidentalis* is still best considered a nomen dubium, and should not be employed in Pleistocene studies for either Blancan or Rancholabrean equids.

Preparators' Session (Thursday, October 31, 2013, 11:30 AM)

FOSSIL SPECIMENS AS THEORETICAL MODELS

BROWN, Matthew, The University of Texas at Austin, Austin, TX, United States, 78758

The study of fossil vertebrates is based on anatomical remains preserved in the geological record. These remains are excavated, prepared in the laboratory, and housed in museum collections, at which point they are defined most broadly as natural history specimens. Of those three transformative steps, the act of preparation is often the most time consuming and requires the most extensive human interaction with the fossil. For the purposes of research, museum specimens are generally assumed to a) represent a

natural organism, and b) to remain static through their life in the collections. However, fossils are a result of a complex interaction between biological and geological processes subject to physical and chemical alteration both prior to discovery and continuing through their museum life.

Often mischaracterized as a purely technical activity centered on accurate exposure of anatomy, fossil preparation is in fact a process of scientific interpretation. Reducing error is certainly a focus of preparation, but in practice, decision-making is based on the judgment of a worker in the laboratory. For example, identification of a "natural" margin between cancellous tissue and matrix near the epiphysis of a limb bone is often impossible because this boundary results from an interface between multiple types of materials. Therefore, an artificial determination of "bone surface" is produced through interpretation of physical evidence. The end result of the process is a physical representation of a theoretical model created by an individual combing knowledge of anatomy, geology, and chemistry with skilled manipulation of materials.

Furthermore, alteration of specimens continues throughout their museum lifetime. Agents of deterioration are constantly acting upon specimens, and specimens are periodically re-prepared or conserved. Museum specimens change four-dimensionally; their physical properties can vary through time. Thus, observations that inform scientific theories may not be reproducible at any given point on the continuum. Consideration of specimens as ever-shifting theoretical models allows a unique opportunity for study of philosophical concepts regarding scientific practice.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

SPECIES RELATIONSHIPS OF *COPEMYS* (RODENTIA, CRICETIDAE) SPECIMENS RECOVERED FROM THE MIDDLE MIOCENE BARSTOW FORMATION

BROWNE, Ian, Oklahoma State University Center for Health Sciences, Tulsa, OK, United States, 74107; SMITH, Kent, Oklahoma State Univ Center for Health Sciences, Tulsa, OK, United States

Six species of the cricetid genus *Copemys* have been reported from the middle Miocene Barstow Formation: the small-sized *C. pagei*; the medium-sized *C. russelli*, and *C. tenuis*; and the large-sized *C. longidens*, *C. barstowensis*, and *C. esmeraldensis*. Our analysis of specimens housed at the University of California Museum of Paleontology, the San Bernardino County Museum, and within new collections made by the Sam Noble Oklahoma Museum of Natural History suggest the genus is over-split in the Barstow Formation and that no more than three species of *Copemys* are represented. Specimens recovered from the late Hemingfordian (He2) and early Barstovian (Ba1) localities are normally distributed with respect to size. Morphological characters historically used at Barstow to differentiate *Copemys* species (e.g. anterocone/-id symmetry, mesoloph/-id length, and presence/absence of protolophule I) are equally represented throughout this normal distribution, suggesting these specimens represent a single relatively small species. In the past, all *Copemys* fossils recovered from the He2- and Ba1-age strata of the Barstow Formation have been identified as *C. pagei*. Our analysis suggests that these specimens are larger than *C. pagei*, and in terms of size, are more consistent with identification as either *C. tenuis* or *C. russelli*. High in the stratigraphic sequence, at the late Barstovian (Ba 2) "Rodent Hill" locality and above, *Copemys* specimens are bimodally distributed with respect to size and statistically significant correlations occur between size classes and morphological character states suggesting the presence of two taxa. The smaller taxon is characterized by its size, the possession of long mesoloph/-ids, and strong development of protolophule I on the upper first and second molars. The larger taxon is characterized by its size, short mesoloph/-ids, and the absence of protolophule I on the upper first and second molars. These morphological characters are consistent with identification of the smaller species at this stratigraphic level as *C. russelli* and the larger species as *C. longidens*. Below the level of "Rodent Hill", in older Ba2-age strata, the *Copemys* sample size is relatively small. These older Ba2 specimens exhibit a normally-distributed wide range in size, and do not display statistically significant correlations between morphological character states and size. Currently the species relationships between these early Ba2 specimens and the older He2-Ba1 and younger late Ba2 specimens remain unclear.

Romer Prize Session (Thursday, October 31, 2013, 8:30 AM)

THE PHYLOGENY OF COELUROSAURIAN THEROPODS (ARCHOSAURIA: DINOSAURIA) AND PATTERNS OF MORPHOLOGICAL EVOLUTION DURING THE DINOSAUR-BIRD TRANSITION

BRUSATTE, Stephen, University of Edinburgh, Edinburgh, United Kingdom

In one of the great evolutionary transitions in the history of life, birds evolved from theropod dinosaurs. This transition has emerged as a case study for understanding the origins of major clades, body plans, and ecological behaviors, thanks to a rapidly expanding fossil record of early birds and their closest dinosaurian relatives. Despite a flurry of recent work on avian origins, however, there remains little consensus on the phylogenetic relationships of the coelurosaurian theropods (birds and their closest relatives) and there has been little work on large-scale macroevolutionary patterns during the theropod-bird transition. I conducted a comprehensive species-level phylogenetic analysis of Mesozoic coelurosaurs, building upon the longstanding Theropod Working Group (TWiG) project by adding new data focused primarily on basal (non maniraptoran) coelurosaurs. Parsimony analysis of the dataset, which is approximately twice the size of previous TWiG analyses (150 taxa, 853 characters), produces a well resolved phylogeny. Salient results include the placement of Tyrannosauroidea (including *Dilong* and *Guanlong*) as the most basal major coelurosaurian subclade; the position of *Bicentenaria*, *Zuolong*, and *Tugulusaurus* near the base of Coelurosauria; and the recovery of a derived maniraptoran clade that includes alvarezsauroids, therizinosauroids, oviraptorosaurs, and paravians to the exclusion of ornithomimosaurs and tyrannosauroids. The phylogeny was used as a framework to study trends in morphological disparity (anatomical variability) and rates of character change across the theropod-bird transition. Basal avialans overlap in morphospace with their closest non-avialan kin and there is no significant statistical separation between them, demonstrating that, in general anatomical terms, birds were merely part of a continuum of coelurosaurian morphological evolution. However, the origin of Avialae and proximal nodes on the tree are associated with significantly elevated rates of discrete character change. This suggests that the origin of major groups on the tree of life may involve an uptick in the pace of morphological change.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

EXTERNAL AND INTERNAL ANATOMY OF A BLUE WHALE FETUS: DOCUMENTING MILESTONES IN BALAENOPTERID DEVELOPMENT

BUCHHOLTZ, Emily, Wellesley College, Wellesley, MA, United States, 02481; ROSTON, Rachel, Wellesley College, Wellesley, MA, United States

The secondary entry of cetaceans into aquatic habitats required the reorganization of multiple mammalian anatomical systems. The development of living cetaceans provides clues to the sequence and timing of this evolutionary transition. The broad outlines of early development in delphinid odontocetes are well known, allowing comparisons to the more rarely studied mysticetes. We describe the anatomy of a 130 mm blue whale (*Balaenoptera musculus*) fetus collected at the Donkergat Whaling Station in Saldanha Bay, South Africa in 1922. Externally, it resembles odontocete embryos in lacking both a caudal fluke and a dorsal fin. In contrast, it exhibits an elongate rostrum, a resorbed umbilical hernia, partially exposed corneas, and spatial separation of the anus and genitalia, all of which are typical of the first stage of odontocete fetal development (Fetal Stage 20). Internal anatomy was studied noninvasively using microCT. The larynx displays the distinctive U-fold and laryngeal sac characteristic of mysticetes. The axis of the triangular heart lies at an angle of about 40° to that of the vertebral column, and its ventricles are thin-walled spheres that are independent of each other. Dermal ossification of the cranial bones has begun, but the endochondral skeleton is completely cartilaginous. The shape and position of the maxilla suggest that the earliest stages of the distinctive mysticete skull telescoping process are in progress, but there is no indication of occipital overlap posteriorly. We propose a model of changes in *B. musculus* body length by gestational age by integrating previous observations of its reproductive and migration cycles, records of fetal size by date of catch from the International Whaling Statistics database, and patterns of embryonic and fetal growth in other mammals. This model predicts that the described specimen was approximately 65 days post conception at the time of death. Comparisons of this specimen and previously described congeneric embryos with those of delphinid odontocetes reveal striking parallels in size, age, and external morphology. Nevertheless, multiple uniquely mysticete traits of visceral and skeletal anatomy are already in place before the onset of balaenopterid fetal growth.

Preparators' Session (Thursday, October 31, 2013, 9:15 AM)

DAMAGE CONTROL, SAFETY, AND PREPARATION ON A VOLUNTEER-BASED EXCAVATION OF AN *IN SITU* BONEBED AT THE MAMMOTH SITE OF HOT SPRINGS, SD, INC.

BUGBEE, Monica M., Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States, 57747; WILKINS, William J., Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States

The Mammoth Site of Hot Springs, SD, Inc., a 501 (C) 3 non-profit organization located in the Black Hills of South Dakota, houses a 26,000 year old in situ bonebed containing non-permineralized fossils of over 60 mammoths. The bonebed was deposited inside a sinkhole fed by a hot spring, which acted as a natural trap for mammoths and other Pleistocene fauna. For six weeks each year, volunteer dig crews organized through two outside non-profit organizations come to the Mammoth Site to excavate. The typical volunteer excavator is usually retired, with a long held interest in paleontology or archaeology, but little to no experience in excavation. Many participants also have mobility or balance concerns. Because excavations occur amongst approximately 1,500 in situ mammoth bones in a high relief bonebed, having a limited mobility dig crew creates serious challenges for excavator safety, specimen safety and enforcing proper excavation methods. At the close of the 2012 dig season, an excavation-related damage and preparation report was compiled recording causes of damage to in situ specimens. Of the 67 specimens requiring treatment, 65% sustained preventable damage, caused primarily by foot traffic, bumping and poor digging habits. Results of the report prompted a reevaluation of excavation and safety training for volunteers. Instructional methods were refocused with heavy emphasis on preventative safety and proper excavation. The new training program is designed to mitigate difficulties caused by limited mobility without alienating volunteers, some of whom come to the Mammoth Site with unrealistic expectations, but end up as donors or off-season volunteers. The approach will first be implemented during the July 2013 excavation, with new measures including an expanded introductory lecture covering safety and the goals of in situ preservation, more individualized hands-on instruction, and restrictions on unnecessary movement of volunteers throughout the bonebed. Additionally, each excavator will be required to devote a set amount of time to pathway maintenance and overburden removal in order to improve safety and create more excavation space, respectively. Excavation and damage reports from the 2012 and 2013 field seasons are presented and contrasted.

Technical Session IX (Friday, November 1, 2013, 9:00 AM)

THE MYOLOGICAL CONSEQUENCES OF EXTREME LIMB REDUCTION: NEW INSIGHTS FROM THE FORELIMB MUSCULATURE OF ABELISAURID THEROPODS

BURCH, Sara, Stony Brook University, Stony Brook, NY, United States, 11794

Forelimb reduction occurred independently in multiple lineages of theropod dinosaurs, with highly divergent morphologies exhibited by each lineage. Although tyrannosaurs are renowned for their tiny, two-fingered forelimbs, the degree of their reduction in length is surpassed by abelisaurids, which possess an unusual morphology distinct from that of other theropods. Although short, the forelimbs of abelisaurids are robust and exhibit numerous crests, tubercles, and scars that allow for inferences of muscle attachment sites. Phylogenetically-based reconstructions of the musculature were used in combination with close examination of the osteology to create detailed muscle maps of the forelimbs, and patterns of the muscular and bony morphology were compared with those of extant tetrapods with reduced or vestigial limbs. Although abelisaurids display a typical distal-to-proximal directionality of reduction of the forelimb, they also possess several osteological and myological features not found in the reduced limbs of extant tetrapods. Most tetrapods with reduced or vestigial limbs exhibit some amount of reduction of the elements of the shoulder girdle, especially in cases where the distal reduction is substantial. Abelisaurids, by contrast, do not show any reduction in the size of the pectoral elements relative to body size, despite the advanced stages of reduction in the antebrachium and manus. The morphology of the scapulocoracoid and humerus points to retention of well-developed adductor and retractor musculature accompanied by a de-emphasis on abduction and protraction. Fusion of many of the antebrachial muscles into a set of flexors and extensors is common in other tetrapods and likely also occurred in abelisaurids. However, the lack of ossified carpals in all ceratosaurs regardless of forelimb development, along with unique tubercles on the antebrachial elements of abelisaurids, indicates that the muscles attaching to the carpus may not have been lost in these taxa, as they typically are in lizards with reduced forelimbs. Abelisaurids show some signs of the advanced stages of forelimb reduction preceding limb loss, while also retaining and developing features that suggest that the forelimb was not completely vestigial. The conformation of abelisaurid forelimb musculature was unique among theropods and further emphasizes the unusual morphology of the forelimbs in this clade.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A PHYLOGENETIC ANALYSIS OF *WOODBINESUCHUS BYERSMAURICEI*, AND A POTENTIAL NEW CLADE OF NEOSUCHIANS

BURKEY, Matthew, University of Iowa, Iowa City, IA, United States, 52246

Goniopholididae includes neosuchian crocodyliforms known from the Jurassic and Cretaceous of Laurasia that are superficially similar to living crocodylians, but the group has been used as a wastebasket for Jurassic and Cretaceous crocodyliforms lacking specializations that would link them with other groups. *Woodbinesuchus byersmauricei* was first referred to Goniopholididae due to the imbricating rectangular osteoderms and lack of a mandibular fenestra thought to be distinctive of goniopholidids. No phylogenetic analysis was performed in the original description, leaving its designation as a goniopholidid based solely on character presence. In this study, I reexamined available material of *Woodbinesuchus* and scored it for a phylogenetic analysis in the software package TNT using the traditional search method. The analysis consisted of 65 taxa and 216 characters and resulted in 786 most parsimonious trees (MPTs). *Woodbinesuchus* was not returned as a goniopholidid; the strict consensus placed it in a polytomy. In many MPTs, *Woodbinesuchus* grouped with two other crocodyliforms, *Denaziosuchus* and *Vectisuchus*, which had previously been assigned to Goniopholididae. All three taxa are from the Late Cretaceous. When the three are recovered as a clade, the neosuchians form the sister group to Goniopholididae + Eusuchia. However, *Woodbinesuchus* is labile, resulting in the tree collapsing into a polytomy with other Neosuchia in the strict consensus. Further examination of *Woodbinesuchus* should help to reduce its lability and determine if this small clade is real or not.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

GROWTH, DEVELOPMENT, AND THE PROBLEM OF ANKYLOSAURIAN ONTOGENY

BURNS, Michael, University of Alberta, Edmonton, AB, Canada, T6G 2E9; HAYASHI, Shoji, Steinmann Institute for Paleontlogy, Bonn, Germany; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada; WATABE, Mahito, Hayashibara Museum of Natural Science, Okayama, Japan

Bone histology has emerged as a powerful tool for examining the biology, growth dynamics, physiology, and reproductive strategies of extinct organisms, including dinosaurs. This technique, however, has not been extensively applied to the armored dinosaurs, and has focused predominantly on postcranial osteoderms. Because ankylosaurs generally form a rare component in most dinosaurian faunas, especially with respect to confidently identifying juvenile material, their ontogenetic variation is not well understood. Here paleohistological techniques are used on juvenile ankylosaur material for the first time to examine the ontogeny of their postcrania and armor.

Taxonomic sampling included an indeterminate ankylosaurid, *Edmontonia*, *Euoplocephalus*, *Gargoyleosaurus*, an indeterminate nodosaurid, and *Pinacosaurus* (juveniles). Osteoderms of the cervical region in ankylosaurids overlie a basal band of bone that has a smoother texture than the external osteoderms. The cervical half-rings of the basal ankylosaur *Gargoyleosaurus* show thick, organized collagen bundles in their primary structure, which is a characteristic retained in the derived nodosaurid *Edmontonia*. This indicates metaplastic mineralization of the dermis. The same is true for the cervical osteoderms of derived ankylosaurids. The basal bony band, however, lacks metaplastic tissue, and instead shows primary fibrolamellar bone indicative of intramembranous ossification. Interestingly, this mirrors the development of cranial ornamentation in ankylosaurids.

All juvenile *Pinacosaurus* limb bones show an azonal fibrolamellar microstructure with incipient primary osteons and an average vascularity of 7%. This is similar to the condition in the juvenile stage of *Stegosaurus* and to later, less well-vascularized stages in ornithopods. This may be indicative of overall growth rates that are slower than other ornithischians; similar rates have been suggested for *Stegosaurus*, but were lower in *Scutellosaurus*. Adult ankylosaur postcrania show some of the most heavily-remodeled bone known in any dinosaur group.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

USE OF A NETWORK ALGORITHM TO RAPIDLY GENERATE ONTOGENETIC SEQUENCES

BURROUGHS, Robert, The University of Texas at Austin, Austin, TX, United States, 78759; MORRIS, Zachary, The University of Texas at Austin, Austin, TX, United States; COLBERT, Matthew, Univ of Texas at Austin, Austin, TX, United States

Ontogenetic sequence analysis (OSA) is a method for establishing sequences of ontogenetic events based on parsimony analysis of a matrix of ontogenetic events and individual organisms. Unfortunately, the utility of the method is compromised because it is not automated, requiring an enormous time investment to generate the sequence diagrams (OSA maps) 'by hand' using MacClade and Adobe Illustrator. Accordingly OSA has only been used in a limited number of studies, despite its applicability to both paleontological and neontological research. In an attempt to facilitate construction of OSA maps, we generated a developmental network in the program SplitsTree. We used a weighted-parsimony split algorithm originally designed for generating phylogenetic networks. We analyzed a dataset comprising of 92 skull and limb characters for 13 neonates of *Monodelphis domestica* spanning birth (day 0) to 20 days in age. We constructed traditional OSA maps from trees generated using a non-reversible parsimony algorithm and then compared those maps with those generated using the developmental network in SplitsTree. The OSA maps are similar with the SplitsTree network, with many identical sequence segments in both analyses. The network approach yielded slightly more resolution than established OSA methodology, when mapping potential development sequences. However, the degree to which this increased resolution better reflects the realized developmental sequences in *M. domestica* is unclear. Event placement between the OSA maps and SplitsTree developmental networks are not congruent which reflects differences in the optimality criteria used in the two methods. The SplitsTree developmental networks can be generated essentially instantaneously, which dramatically increases the ease of assessing both the order of appearance of developmental events and the range of developmental variation. The optimality criterion used in SplitsTree offers a new perspective on developmental sequences complementary to the established OSA method and when used together can facilitate a broader understanding of the potential dynamics of the developmental system.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE VERTEBRATES OF LAS HOYAS: A PRELIMINARY ASSESSMENT OF THE ROLE OF PAST AND PRESENT ECOMORPHOTYPES

BUSCALIONI, Angela D, Universidad Autonoma de Madrid, Madrid, Spain; MARUGAN LOBON, Jesus, Universidad Autonoma de Madrid, Madrid, Spain; DE MIGUEL, Carlos, Universidad Autonoma de Madrid, Madrid, Spain; POYATO-ARIZA, Francisco, Univ Autonoma De Madrid, Cantoblanco, Madrid, Spain

The fossil Konservat-Lagerstätte of Las Hoyas (Upper Barremian, Cuenca, Spain) is unique in the quality of its fossils, its diversity and in the way in which the information has been recovered and recorded (www.yacimientolashoyas.es). Namely, after 25 years of systematic excavations this site has yielded more than 17 000 fossils corresponding to more than 200 species of plants and animals, reflecting the nearly complete floral and faunal mosaic of a Cretaceous wetland ecosystem. Out of this diversity of plants and animals, the vertebrate assemblage comprises an astonishing variety of fishes (14%), amphibians (5%), lizards (ca. 3%) and archosaurs (ca., 9%), including crocodiles, pterosaurs and non-avian and avian dinosaurs. The research agenda at Las Hoyas has come into a new and integrative focus, involving the first exploration of the trophic structure of this ancient ecosystem, addressing the roles of its constitutive taxa into a trophic web. In Recent wetlands, fishes, crocodiles and birds are focal animals. According to actualistic criteria, our preliminary survey of the Las Hoyas foodweb structure shows that the main linkage between aquatic and terrestrials levels is bridged by the arthropods. Furthermore, although the structure of past and present trophic webs in subtropical and seasonal wetlands appears comparable, there is no clear-cut analogy between vertebrate ecomorphotypes. We discuss how modern species may be surrogates for the ecomorphology of ancient vertebrates and their role in their corresponding niches.

Technical Sesssion XII (Friday, November 1, 2013, 1:45 PM)

A NEW SPECIES OF THE ERYTHROSUCHID *GARJAINIA* FROM THE EARLY TRIASSIC OF SOUTH AFRICA PROVIDES NEW INSIGHTS INTO THE EARLY ARCHOSAURIFORM RADIATION

BUTLER, Richard, University of Birmingham, Birmingham, United Kingdom; HANCOX, John, University of the Witwatersrand, Johannesburg, South Africa; BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa; SENNIKOV, Andrey, Borissiak Paleontological Institute RAS, Moscow, Russia; GOWER, David, The Natural History Museum, London, United Kingdom

Erythrosuchidae was one of the first major radiations of Archosauriformes, diversifying in the aftermath of the Permian-Triassic (PT) mass extinction and forming

the apex predators in many Early and Middle Triassic terrestrial ecosystems. The best-known erythrosuchid is *Erythrosuchus africanus* from the Middle Triassic (Anisian) of South Africa, but stratigraphically older erythrosuchid material (*Garjainia prima*) is known from the late Early Triassic (late Olenekian) of Russia. Over the last two decades, abundant and well-preserved cranial and postcranial material referable to Erythrosuchidae has been collected from the late Olenekian Subzone A of the *Cynognathus* Assemblage Zone of the Burgersdorp Formation of South Africa. These specimens represent a new erythrosuchid species that is notably smaller than the stratigraphically younger and very large-bodied *Erythrosuchus* from the same basin. We refer the South African material to a new species of *Garjainia*, clearly distinguished from the Russian *G. prima* by a number of features including large bony bosses on the lateral surfaces of the jugals and postorbitals, and a proportionately elongate postacetabular process of the ilium. Bone histology of the new species reveals thick compact cortices comprised of highly vascularized, rapidly-forming fibro-lamellar bone tissue, similar to that of *Erythrosuchus*. This histology indicates rapid growth rates in the new species, which is consistent with many other Triassic archosauriforms, but also a high degree of developmental plasticity as growth remained flexible. The new species is the geologically oldest erythrosuchid known from the Southern Hemisphere, and demonstrates that erythrosuchids achieved a broad paleobiogeographical distribution by the end of the Early Triassic, within five million years of the PT mass extinction. It provides new insights into the diversity of the Subzone A vertebrate assemblage and biostratigraphic correlations to Russian vertebrate assemblages, shedding new light on the early archosauriform radiation and the recovery of terrestrial ecosystems from the PT extinction.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

BIOMECHANICAL EVIDENCE FOR NICHE PARTITIONING BETWEEN SYMPATRIC SAUROPOD DINOSAURS

BUTTON, David, University of Bristol, Bristol, United Kingdom

The sauropod dinosaurs were the largest terrestrial vertebrates. Given the extreme nature of their biology, sauropods present many problems – not least how they secured sufficient food intake to fuel their massive bodies. Furthermore, many sauropod faunas are highly diverse, implying sophisticated resource partitioning between taxa.

The high craniodental diversity differentiating sympatric sauropod taxa has often been cited in support of niche partitioning. This is particularly so for the well-known Morrison Formation fauna, which contains a high diversity (~9 genera) of sauropod taxa. In particular, the abundant *Diplodocus* and *Camarasaurus* represent extreme end-members in the spectrum of sauropod cranial morphology and have been hypothesized as being adapted towards specialized branch-stripping and the production of higher bite forces, respectively. However, while biomechanical modelling has previously been used to investigate feeding behavior in *Diplodocus*, no such work has been attempted on *Camarasaurus*. Here we rectify this deficiency through muscle reconstruction, functional morphology and application of finite element analysis (FEA) to a skull of *C. lentus*. This model was then compared to that of *Diplodocus*, allowing testing of the niche partitioning hypothesis in a biomechanical context.

Myological reconstruction demonstrates a greater importance of the external adductors relative to the pterygoideus musculature than in *Diplodocus*, although overall muscle volumes are similar. Despite this, the more mechanically efficient skull and favorable lines of muscle action result in significantly greater calculated maximum bite forces for *Camarasaurus*. FEA indicates that the skull of *Camarasaurus* was well-adapted to resist forces resulting from biting and is "stronger" under conditions of static biting than that of *Diplodocus*, with lower stresses in the snout and palate. Under loading conditions simulating other hypothesized feeding behaviors (bilateral and lateral stripping/tugging) stresses are again very low, indicating that *Camarasaurus* would have been capable of exploiting a varied foraging repertoire.

The results here provide biomechanical evidence for niche partitioning between Morrison sauropod taxa, with *Camarasaurus* employing high bite forces and a range of behaviors to deal with a greater range of coarser foodstuffs than sympatric diplodocoids, which were instead more specialized in their feeding behaviors.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TOOTH ENAMEL MICROSTRUCTURE OF THE EARLY CRETACEOUS THERIZINOSAURIAN *FALCARIUS UTAHENSIS* (THEROPODA, MANIRAPTORA)

BUTTON, Khai, North Carolina State University, Raleigh, NC, United States, 27612; ZANNO, Lindsay, North Carolina Museum of Natural Sciences, Raleigh, NC, United States

Enamel is the hardest and most biomineralized vertebrate tissue. The durability of this tissue allows for exceptional preservation of microstructure in tooth fossils. Enamel microstructure has been extensively studied in mammals and non-mammalian amniotes but has been examined only to a much smaller degree in Dinosauria. Recent analyses have greatly expanded our understanding of the phylogenetic and functional patterns present in dinosaur tooth enamel, particularly among theropods; however, several notable clades have not yet been sampled. Here we characterize the enamel microstructure of *Falcarius utahensis*, the most primitive taxon of the Therizinosauria described to date. The diet of therizinosaurians is widely regarded to rest within the omnivory/herbivory spectrum, providing an ecological contrast with other closely related theropod subclades.

We sampled a single, isolated maxillary tooth from the monodominant Lower Cretaceous Crystal Geyser Quarry (Utah Museum of Natural History specimen UMNH VP 22857). The tooth was lanceolate in form and characteristically diminutive, measuring 0.5 cm in apical height and 0.4 cm mesiodistally. Miniscule serrations were present along the mesial carina. There was no indication of tooth wear. Three longitudinal thin sections were cut and polished to a thickness of 0.1 mm. Sections were etched using 1 M hydrochloric acid for 10-30 seconds. The samples were coated with approximately 5 nm of Au-Pd and then imaged using a Jeol JSM-6010LA scanning electron microscope.

Falcarius maxillary tooth enamel is thickest at the apex and gradually winnows toward the root/crown junction. Structurally, it is composed of uniformly parallel crystallite enamel with clear incremental lines. Parallel enamel is commonly seen in Coelurosauria, including carnivorous dromaeosaurids. Our results support previous proposals that enamel type in theropod dinosaurs reflects a predominant phylogenetic signal and appears to have been constrained despite widespread ecological and dietary differences. Finally, characterization of *Falcarius* enamel type offers a benchmark for testing whether enamel microstructure underwent later specializations during the evolution of Therizinosauria.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

GEOPHYSICAL IMAGING OF SNAKE BURROWS IN AEOLIAN SANDS: IMPLICATIONS FOR THE FOSSIL RECORD OF SQUAMATES

BUYNEVICH, I.V., Temple University, Philadelphia, PA, United States, 19122; WIEST, L.A., Temple University, Philadelphia, PA, United States; BIEN, D. WARD W., Drexel University, Philadelphia, PA, United States; SMITH, K.P.W., Drexel University, Philadelphia, PA, United States; NYQUIST, J.E., Temple University, Philadelphia, PA, United States

*Terrestrial versus marine origin of snakes during the Cretaceous relies heavily on the burrowing ability of their ancestors. Therefore, understanding the paleoecological aspects of biogenic structures associated with ophidians is key to recognizing analogous features in the fossil record. Due to challenges in studying complex excavations in loose sediment (open and backfilled entrance tunnels, external mounds, brooding chambers, hibernacula, and hollow neonate escape structures), neoichnological studies of fossorial squamates are aided by novel applications of subsurface imaging technologies, such ground-penetrating radar (GPR). Survey grids using 800 MHz GPR antenna were employed to characterize excavations of a prolific burrower, the Northern Pine Snake (*Pituophis melanoleucus*) in aeolian deposits of New Jersey. Inclined shafts and tunnels of juvenile and adult snakes extended downward from 0.3 to >1.0 m from the burrow entrance, with diameters of 3-8 cm. The electromagnetic (EM) wave velocity of 14 cm/ns allows 4.5-6.0 cm vertical resolution, with profile spacing of 0.3 m sufficient for constructing pseudo-3D images and depth slices spanning the burrow penetration range. Survey grids with 5 cm spacing further reduce the need for spatial interpolation in 3D space. High-amplitude anomalies (hyperbolic diffractions) result from dielectric contrast between air-filled burrows and sediment, with localized signal attenuation and basal "pull up" dependent on air cavity volume. In 2D sections, alteration of primary bedding subjacent to point-source return helps differentiate infilled burrows from high-density targets (e.g., roots). Presence of live snakes produces localized downwarping of GPR reflections due to ten-fold reduction in EM signal velocity through a fluid-filled body. Where rising water table precludes subsurface investigation by traditional methods, the applicability of georadar imaging will be enhanced due to increased resolution (2.0-2.5x) in saturated media. Penecontemporaneous pedogenesis and rapid burial may enhance burrow preservation, making GPR a valuable tool for recognizing and interpreting similar biogenic structures in the fossil record.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ASSESSING THE POTENTIAL FOR ONTOGENETIC ECOMORPHOLOGY IN THEROPODS: A CASE STUDY USING *ALLOSAURUS FRAGILIS* FROM THE CLEVELAND-LLOYD QUARRY

BYKOWSKI, Richard, Indiana University, Bloomington, IN, United States, 47405-1405

Recent work on dinosaur ontogeny has discovered potential patterns of changing morphology through growth in ceratopsians, pachycephalosaurs and theropods. However, much of this work has centered on answering questions related to alpha diversity and organismal growth and has not directly answered questions centering on functional morphology or community ecology, given that some of these observed changes occur in functionally significant portions of the skeleton (hind limb proportions, dentition, and skull shape). There exists the potential that morphological differences of a given species at different stages of growth allowed for ecological niche partitioning between adults and juveniles, such as prey specialization among carnivorous theropods. To assess the degree that functional morphology would change with growth, data were collected from specimens of *Allosaurus fragilis* at various ontogenetic stages. A geometric morphometric analysis was performed to quantify shape variation in the maxilla and was compared with measurements from the hind limb and dentition. Preliminary results indicate that while the previously demonstrated patterns of decreasing cursoriality through ontogeny are observed, skull and dental morphology is conserved relative to other large-bodied theropods. These results suggest factors governing the functional evolution of theropod skull shape, the ecologic structure of dinosaur communities, and niche partitioning based on growth and age, are different from those governing communities of vertebrates with determinate growth.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ONTOGENETIC VARIATION AMONG POLYCOTYLID PLESIOSAURS (SAUROPTERYGIA: PLESIOSAURIA) AND ITS IMPLICATIONS FOR PLESIOSAUR GROWTH

BYRD, Christina, Marshall Univ, Huntington, WV, United States, 25703

Understanding ontogenetic variation within plesiosaurs of the family Polycotylidae, short-necked marine reptiles from the Cretaceous Period, can shed light on their evolutionary history. In this study, I analyzed a specimen from the University of Nebraska State Museum (UNSM 55810), a juvenile polycotylid plesiosaur from the

Pierre Shale (99-65 Ma) of Nebraska. It is a partial skeleton possessing a fragmented skull, nearly complete pectoral and pelvic girdles, left humerus, both femora, and an assortment of upper limb bones and phalanges. Previous qualitative research using UNSM 55810 was conducted, but no formal description has been produced. UNSM 55810 is probably referable to the genus *Dolichorhynchops* based on several cranial characteristics. In order to understand the ontogenetic changes of polycotylids, I collected metric data from UNSM 55810 and compared it among related plesiosaurs. The scapulae of the pectoral girdle and the ischia of the pelvic girdle exhibit a significant amount of allometric growth along the anterior and posterior margins. However, the clavicles, coracoids, and pubes appear to grow isometrically during ontogeny. In the clavicles, the relative morphological conservatism may be attributed to their dermal origin as opposed to the endochondral ossification of the other girdle elements. For the coracoids and pubes, the measurements suggest isometry but certain processes were not factored in and must be considered further. The juvenile girdle elements lack ossification along their margins, which suggests that cartilage may have been present in order to provide support to the girdles at the time of birth prior to complete ossification, particularly away from the glenoid and acetabulum. The presence of cartilage is indicated by a change in bone thickness along the margins of all girdle elements. This thinner part of the margin represents the extension of the endosteum from within a sheath of perichondral bone. Polycotylid girdle ontogeny resembles the morphological progression of basal sauropterygians such as nothosaurs, pistosaurs, and basal plesiosaurs, thereby recapitulating the sauropterygian phylogeny. Understanding morphological variation during polycotylid ontogeny will provide information for better identification of subadult specimens, as well as provide insight to the evolutionary and developmental changes that occurred during plesiosaur ontogeny and evolution.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ADDITIONAL BATS FROM THE LATE PLEISTOCENE OF THE TALARA TAR SEEPS (NORTHWESTERN PERU) - PALEOENVIRONMENTAL IMPLICATIONS

CADENILLAS, Richard, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru; MARTINEZ, Jean-Noël, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru; CZAPLEWSKI, Nicholas, Univ of Oklahoma, Norman, OK, United States

New excavations in the late Pleistocene Talara Tar Seeps (Northwestern Peru) recovered eight well preserved bat humeri. The bat fossil material previously reported for this locality consisted of mandibles and isolated teeth provisionally assigned to *Eptesicus* and a canine of *Lophostoma occidentalis* (=*Tonatia silvicola occidentalis*). The new material we collected belongs to at least three different species. All humeri have distal articular facets in line with the axis of the humerus and a relatively narrow epitrochlea. This morphology is present only in Molossidae and Vespertilionidae. We assign these eight humeri to Vespertilionidae because of their well developed lesser tuberosity and relatively low trochlea, which is exactly the opposite of what is seen in Molossidae. A complete right humerus (BREA 1000), small-sized, with a rounded head, is compatible with the genus *Myotis*. We cannot be more specific and so refer this humerus to *Myotis* sp. A complete left humerus (BREA 1001), also is small-sized and is significantly smaller than the humerus of any species of *Lasiurus* or *Histiotus*. Its elliptical head and its supraglenoid fossa, not as deep as in *Lasiurus* but deeper than in *Histiotus*, allow us to identify it as *Eptesicus*. This specimen is smaller than *Eptesicus furinalis* and *E. brasiliensis*. As *Eptesicus innoxius* is a small occidental Andean species, we tentatively assign this humerus to *Eptesicus* cf. *innoxius*. The other six humeri (BREA 1002, 1003, 1004, 1005, 1006, and 1007) are significantly larger than *Lasiurus* and *Histiotus*. Their elliptical heads and their supraglenoid fossae, shallower than in *Lasiurus* but deeper than in *Histiotus*, are consistent with *Eptesicus*, but a much larger species than *Eptesicus innoxius*. We provisionally assign these humeri to *Eptesicus* sp. All of the identified bats are aerial insectivores and can live in habitats ranging from dry deciduous forest to humid multistratal tropical evergreen forest. However, *Lophostoma occidentalis* is a highly specialized bat that inhabits commonly the more humid parts of the dry forest in the Amotape cordillera and is also found in the Choco rain forest. As for the large *Eptesicus*, it has no equivalent in the extant fauna in the vicinity of Talara and would be compatible with *Eptesicus fuscus* which is found on the east side of the Andes.

Technical Session II (Wednesday, October 30, 2013, 11:00 AM)

DISPARITY IN THE MOLAR MORPHOLOGY OF EXTANT AND FOSSIL GOPHERS (RODENTIA, GEOMYIDAE) IMPLICATIONS FOR TAXONOMIC RICHNESS

CALEDE, Jonathan, University of Washington, Seattle, WA, United States, 98195; GLUSMAN, Jennifer, University of Washington, Seattle, WA, United States

The late Oligocene-early Miocene (Arikareean, 30–18.8 million years ago) burrowing herbivore fauna of North America includes numerous species of gophers of the subfamily Entoptychinae. These rodents are found throughout the Arikareean in the Great Plains, the Rocky Mountains, and the Columbia Plateau. As a consequence, entoptychines have been used in the biostratigraphy of the John Day Formation (Columbia Plateau) and Cabbage Patch beds (Rocky Mountains). We used a geometric morphometric analysis to assess intra- and interspecific variation in cheek tooth morphology in these fossil gophers. To this end, we analyzed the morphology of the enamel outline of the potentially diagnostic last upper molar. We used canonical variance analysis to test the hypothesis that a taxonomic signal could be recovered in an extant gopher sample by this geometric morphometric approach. Our comparative sample of extant gophers (Geomyinae) included over 90 specimens representing ten different species. The results of our analyses demonstrate that extant genera can reliably be differentiated using the shape of the enamel outline of the tooth. An analysis restricted to the best sampled extant genus, *Thomomys*, shows that species can also be differentiated using this method. Similar analyses of over 50 specimens of fossil entoptychines enabled generic differentiation. We compared the range of morphological variation within extant genera to that observed within fossils. We found that the ranges of variation within the fossil genera *Pleurolicus* and *Entoptychus* are much greater than those within the extant genera *Geomys*, *Cratogeomys*, and *Thomomys*. This result appears to be true even when accounting for the number of species and individuals sampled within genera. It suggests that the fossil genera represent a large morphological disparity that may translate into a greater taxonomic richness than currently recognized. Alternatively, a greater spatiotemporal distribution of the fossil specimens could account for this comparatively high variation. Nevertheless, the cranial fossil record also suggests several undescribed species within the *Pleurolicus* material from the Cabbage Patch beds. Taken together, these analyses suggest that the range of dental morphology of extant gophers could offer guidance for recognizing fossil gopher species. This revised taxonomic framework will help elucidate spatiotemporal patterns in the morphology and distribution of entoptychine gophers across Arikareean communities of the northern United States.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

INTRATOOTH HETEROGENEITY IN THE DENTAL MICROWEAR OF ARTIODACTYLS AND PERISSODACTYLS: IMPLICATIONS FOR INTERPRETING PALEODIET IN EXTINCT UNGULATES

CAMPBELL, Daniel, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States, 11568; GHANI, Ishrat, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States; MIHLBACHLER, Matthew, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States

Most dental microwear (DM) studies are focused on a single cusp or crest that is homologous across species. Little work has been done to understand (1) how DM varies within teeth, (2) if specific parts of teeth provide higher paleodietary resolution than others (3) and if phylogeny biases DM. Intratooth DM heterogeneity was quantified in 255 upper molars from 18 extant and extinct perissodactyls (6 equids, 11 rhinos, 1 tapir) and 4 extant ruminants (bison, wildebeest, giraffe, moose). DM was sampled from the labial edge, the lingual edge, and, when possible, near the labio-lingual midpoint of the occlusal surface. We used paired t-tests to compare frequencies of pits and scratches in different parts of molars. All perissodactyls show significant intratooth heterogeneity trends with the highest densities of pits always on the labial edges of molars. Scratches are homogeneously distributed in equids but are often most numerous on the lingual edge in rhinos and tapirs. Browsing extant perissodactyls generally exhibit stronger labio-lingual trends than grazers. The distribution of DM on ruminant molars is considerably different from perissodactyls. DM is homogenously distributed on browsing ruminant molars but grazing ruminant molars are characterized by significant intratooth heterogeneity in scratch and, in some cases, pit distribution but without consistent labio-lingual trends in pit or scratch frequency. Discriminant function analyses (DFA) of DM data from the labial edge correctly classifies extant perissodactyls according to diet more frequently than DM data from other parts of the molars. However, ruminant molars are most often correctly classified according to diet with DM data from the opposite (lingual) edge. Combining DM data from multiple areas always produced more correct post hoc dietary classifications of extant species than when any single area was examined alone. To summarize: (1) patterns of intratooth DM heterogeneity are influenced by both diet and phylogeny, (2) DM from homologous parts of perissodactyl and ruminant molars reflect diet differently, and (3) inclusion of DM data from multiple areas across the tooth, rather than a single cusp or enamel crest, will improve the accuracy of paleodietary inferences.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A SPECIMEN-BASED PHYLOGENETIC ANALYSIS OF THE CHASMOSAURINE CERATOPSID *CHASMOSAURUS* (ORNITHISCHIA) FROM THE UPPER CRETACEOUS (CAMPANIAN) DINOSAUR PARK FORMATION OF WESTERN CANADA SUGGESTS THE VALIDITY OF ONLY ONE SPECIES

CAMPBELL, James, Carleton University, Ottawa, ON, Canada, K1S 5B6; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, United States; SCHRÖDER-ADAMS, Claudia, Carleton University, Ottawa, ON, Canada; HOLMES, Robert, University of Alberta, Edmonton, AB, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

Two recognized species of the chasmosaurine ceratopsid *Chasmosaurus, C. belli* and *C. russelli*, are known from the Campanian Dinosaur Park Formation (DPF) of Alberta and Saskatchewan. They are diagnosed by the shape of the posterior parietal margin and the position and shape of the epiparietals (EPs), and have been reported as being stratigraphically separated in the lower (*C. russelli*) and upper (*C. belli*) DPF, respectively.

A specimen-based phylogenetic analysis of *Chasmosaurus* was performed to determine the relationships of skulls assigned to the genus. Characters determined to be ontogenetically variable were then mapped onto the consensus tree, along with skull size. It was determined that, as skull size increases, the nasal and orbital horns are resorbed, epiossifications undergo fusion and modification, and the posterior margin of the parietal supporting the medial epiparietals recurves. The latter characters result in the development of a dorsally-recurved 'ridge' on the posterior parietal margin in mature specimens of *C. russelli* (e.g., Canadian Museum of Nature specimen CMN 2280) that is consistent with the same structure seen on the *C. belli* holotype (CMN 491). The shape of the posterior parietal (embayed vs. straight) is found to vary randomly across all ontogenetic stages indicating that it is not a valid diagnostic character for either species and may be sexually dimorphic. Based on the recovered ontogenetic trajectory, the problematic taxa *'Eoceratops canadensis', 'Chasmosaurus kaiseni'* and *'Mojoceratops perifania'* are recovered as subadults, supporting their previous synonymization with *Chasmosaurus*.

All but two examined *Chasmosaurus* specimens appear to represent ontogenetic variations of a single taxon characterized by a posterior parietal margin that varies from being embayed to nearly straight and adorned with 6 epiparietals. We suggest that *C. belli* and *C. russelli* are synonymous, with *C. belli* having priority. This proposed synonymy is supported by the recent rediscovery of the *C. russelli* holotype (CMN 8800) quarry at the top of the DPF which indicates that, contrary to previous reports, *C. russelli* and *C. belli* are not stratigraphically segregated, and that CMN 8800 occurs in the same stratigraphic interval as *Vagaceratops*. Two Chasmosaurus skulls, American Museum of Natural History (AMNH) 5402 and Peabody Museum (YPM) 2016, interpreted as being ontogenetically immature and mature, respectively, are morphologically similar, but bear 10 EPs on their straight posterior frill margins. This epiparietal count is previously unreported for *Chasmosaurus* and may represent an autapomorphy of a new taxon.

Symposium 2 (Thursday, October 31, 2013, 3:00 PM)

THE OWLS OF RANCHO LA BREA: PREDATORS, NOT SCAVENGERS, RULE

CAMPBELL, Kenneth, Natural History Museum of LA County, Los Angeles, CA, United States, 90007

The late Pleistocene strigiform, or owl, paleoavifauna of the Rancho La Brea asphalt deposits comprises nine species represented by a total of more than 8000 specimens from a minimum of 1103 individuals. Two of the eight represented genera are extinct, as are three of the represented species. The most common species present is the medium-sized Burrowing Owl (2775 specimens from at least 378 individuals), whereas the two smallest species are represented by only a few specimens. Analysis of the distribution of the species by pit, or excavation site, reveals that a total of 31 pits produced owl specimens, although 11 pits had less than a dozen specimens each. The top five pits produced approximately 73% of the total owl specimens, whereas the top ten pits produced 93% of the total owl specimens. Analysis of the limb elements showed that, as expected, the tarsometatarsus was the most commonly preserved bone, with 1662 specimens, followed by the tibiotarsus (1526) and humerus (1110). Owls are true predators, thus it can only be assumed that they were entrapped in the asphalt seeps because they were preying on entrapped animals that were still alive. It is perhaps surprising then that the number of owl specimens in the Rancho La Brea collections is larger than the number of true scavengers, such as the four species of New World vultures (~500 individuals, or less than half the number of owl individuals), perhaps indicating that animals trapped, but still living, were more of an attraction to predators than dead animals were to scavengers. Animals trapped in the asphalt seeps do not die immediately, or sink out of sight in pools of liquid asphalt. Rather, they are prone to struggle on the surface of a seep until dying of thirst or starvation. Although other bird species, such as the Golden Eagle and Caracara, are both scavengers and predators, and common in the Rancho La Brea collections, it is not unreasonable to conclude that they, too, were, more often than not, going after prey that was entrapped but still alive. Avian predators customarily move in at high speed for the kill and were probably killed instantly upon hitting the ground when their targeted prey, pierced by sharp talons, could not be pulled free from the asphalt. Scavengers, on the other hand, would more often have landed near carcasses and become entrapped while walking or hopping around them during feeding.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW OPHIDIOMORPH TAXON FROM THE TURONIAN OF CROATIA

CAMPBELL, Michelle, University of Alberta, Edmonton, AB, Canada, T6G2E9; KRIZMANIC, Katerina, Croatian Natural History Museum, Zagreb, Croatia; JAPUNDZIC, Drazen, Croatian Natural History Museum, Zagreb, Croatia; CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada

In the summer of 2008, a new marine squamate, identified here as a probable "pontosaur" was discovered on the island of Dugi Otok, Croatia (Turonian; Upper Cretaceous). Though heavily weathered at the time of its discovery, the specimen is a well-articulated representative of a group of marine lizards previously thought to have gone extinct in the upper Cenomanian. Unfortunately, after two years of further weathering on the sea cliffs, it now consists of a worn impression and a few remaining bones. The remaining elements include the majority of the cervical and dorsal vertebrae, fragments of the dorsal ribs, and an exquisitely preserved left forelimb. Impressions from the cervical and most of the dorsal ribs are present, as is the impression of the pectoral girdle. The cranium, the tail, and the hind limbs have been lost. Based on the length of the torso, the individual appears to have been roughly a meter in length. Its distinctively long, cylindrical body included between 8-10 cervical vertebrae, approximately 23 preserved dorsal vertebrae with posteriorly curved ribs; these numbers are consistent with other described, long-bodied pythonomorphs/ ophidiomorphs. Unfortunately, due to the missing pelvis, the exact dorsal count cannot be absolutely established, though it would be greater than 23. Assessment of the left forelimb suggests that a new taxon is represented, showing unique features of the paddle-like forelimb, and in particular, the manus. The articulated hand shows a broad, flattened first metacarpal similar to that found in the mosasauroid clade Mosasaurinae. However, the long neck (> 7 cervical vertebrae) implies the consideration of this animal as a pontosaur, within the family Dolichosauridae.

Technical Session VII (Thursday, October 31, 2013, 2:45 PM)

A NEW MATHEMATICALLY DERIVED SCALING EQUATION FOR ESTIMATING BODY MASS IN EXTINCT BIPEDS

CAMPIONE, Nicolás, University of Toronto, Toronto, ON, Canada, M5S2C6; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; BROWN, Caleb, University of Toronto, Toronto, ON, Canada; CARRANO, Matthew, Smithsonian Institution National Museum of Natural History, Washington, DC, United States

Strong correlations exist between body mass and numerous physiological and ecological attributes in extant organisms. Accurate estimates of body mass are therefore critical to understanding the paleobiology of extinct taxa through the history of life, but reliable, rigorous methods for achieving them have been elusive until recently. Stylopodial (humerus and femur) circumferences scale conservatively with body mass in extant terrestrial quadrupeds, and figure into a robust method for estimating body mass in extinct quadrupeds. Unfortunately, this model cannot be applied directly to estimate body masses in bipeds. In addition, other mass estimation scaling models based on extant bipeds (i.e., birds) are limited because they incur substantial extrapolation— ca. 60% of non-avian bipedal dinosaurs occur above the body size range of living birds.

Here we present a new scaling equation for estimating body mass in extinct bipeds that mathematically corrects the recently derived quadruped-based model. Importantly, it assumes that the femoral cross-sectional area in a biped is equivalent to the combined stylopodial cross-sectional areas in a quadruped of equal body mass. Its derivation is thus calculated as the systematic difference between the circumference-to-area scaling relationship of two circles (representing a hypothetical quadruped) and one circle (a hypothetical biped). When applied to a sample of extant bird skeletons with associated masses, the correction factor reveals a mean percent prediction error (45.9%) that is statistically indistinguishable from that already inherent to the empirical dataset (36.7%), and is significantly better than the Anderson bipedal equation (80.1%).

Dinosaur masses obtained using the new model are generally higher than those based on previous circumference-mass scaling models (e.g., Anderson's bipedal model) and are more consistent with estimates based on volumetric reconstructions. This new model estimates the largest *Tyrannosaurus rex* specimen (Field Museum of Natural History specimen FMNH PR 2081) at 8.4±2.1 tonnes. Unlike volumetric reconstructions that are time consuming, subjective, and require well-preserved specimens, this equation requires only the femur and thereby offers a simple, consistent method with which to estimate body masses in extinct bipeds. Thus it affords much broader opportunities for investigating large-scale evolutionary patterns of body size in terrestrial vertebrates, including hypotheses of miniaturization in the origin of birds and gigantism in theropod dinosaurs.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

GEOCHRONOLOGICAL AND TAXONOMICAL REVISION OF THE MIDDLE EOCENE WHISTLER SQUAT QUARRY (DEVIL'S GRAVEYARD FORMATION, TEXAS) AND IMPLICATIONS FOR THE EARLY UINTAN IN WEST TEXAS

CAMPISANO, Christopher, Arizona State University, Tempe, AZ, United States, 85287; KIRK, E. Christopher, University of Texas, Austin, TX, United States; TOWNSEND, K.E. Beth, Midwestern University, Glendale, AZ, United States; DEINO, Alan, Berkeley Geochronology Center, Berkeley, CA, United States; MCDOWELL, Fred, University of Texas, Austin, TX, United States

The Whistler Squat Quarry (TMM 41372) of the lower Devil's Graveyard Formation (DGF) in Trans-Pecos Texas is a middle Eocene locality recently attributed to the Ui1b biochron. Specimens from the Whistler Squat Quarry (WSQ) were collected principally by J.A. Wilson in 1970-74 immediately above a volcanic tuff with K/Ar ages of ~47-50 Ma (feldspar separate) and ~5 meters below an additional tuff dated to ~44 Ma (biotite separate). New $^{40}Ar/^{39}Ar$ analyses of both of the originally collected samples provide ages that are indistinguishable from each other at ~45 Ma, with the underlying tuff dated to 44.88 ± 0.03 Ma. These dates are compatible with magnetically reversed sediments at the site attributable to C20r and recent dating of a stratigraphically lower basalt to 46.8 Ma. A reanalysis of the WSQ specimens includes the addition of three new taxa and confirms the early Uintan designation for the site, but also highlights several biogeographical/biochronological differences when compared to stratotypes in the Bridger and Uinta Formations. For example, the WSQ includes the rodent *Thisbemys plicatus* (typically restricted to the Bridgerian) and the artiodactyl *Pentacemylus progressus* (an Ui3 index species). Recent fieldwork in the DGF and the Canoe Formation has also helped clarify the stratigraphic, chronologic, and geographic placement of previously dated marker beds in relation to their middle Eocene assemblages. For example, prior stratigraphic correlations suggest that although the faunal assemblages from the lowermost Devil's Graveyard Formation (basal Tertiary conglomerate) and the lowermost Turtle Bluff Member (=Bridger E) of the Bridger Formation (Donna's Locality) represent a Bridgerian-Uintan transitional interval assigned to Ui1a, the DGF assemblage may be chronologically older than the Turtle Bluff Member by several hundred thousand years.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

BONE MICROSTRUCTURE PROVIDES NEW EVIDENCE FOR TERRESTRIAL LIFESTYLE ADAPTATIONS FOR THE LOWER TRIASSIC STEREOSPONDYL *LYDEKKERINA* (TETRAPODA: TEMNOSPONDYLI)

CANOVILLE, Aurore, University of Cape Town, Cape Town, South Africa; CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, 7700 , South Africa

Aside from macromorphological studies, additional information about the biology of extinct vertebrates can be inferred from the microstructure of fossil bones. Although bone

histology has been extensively applied to the diverse non-mammalian therapsids from the Karoo Basin of South Africa, few studies have been conducted on amphibians, which were fairly abundant in the Permo-Triassic ecosystems.

Lydekkerina huxleyi, a basal and small stereospondyl dominated the amphibian fauna of the South African Lower Triassic *Lystrosaurus* assemblage zone. Even though the anatomy of this amphibian has been described in detail, this taxon remains enigmatic in term of growth strategies and lifestyle habits. In previous studies, the uniformity in skeleton sizes has been attributed to a predominance of subadult and adult specimens recovered. Moreover, anatomical data suggest that the relatively small size of this species, compared to its Permo-Triassic relatives, could be linked to a shortened developmental period as an adaptation to maintain successful breeding populations under difficult environmental conditions. *Lydekkerina* has been described as either aquatic or mostly terrestrial. The latter hypothesis is controversial as Triassic stereospondyls are generally considered as aquatic or semi-aquatic animals.

The current study utilizes histological and microanatomical data to re-assess previous hypotheses pertaining to the biology and ecology of *Lydekkerina*. Bone microstructure of various skeletal elements of several specimens is analyzed to better understand its growth strategies, intra-skeletal variability and lifestyle adaptations.

Bone histology reveals that our sample comprises individuals at different ontogenetic stages, i.e., from juvenile to mature individuals. Our results confirm that these amphibians had a strategy of fast and sustained growth to reach sexual maturity quickly. The microanatomy of the long bones, with their thick bone walls and distinctive medullary cavity, suggests that *Lydekkerina* may have been amphibious with a tendency to be more terrestrial.

This study suggests that *Lydekkerina* employed a particular growth strategy and lifestyle, which may have enabled it to prosper during the harsh dry conditions of the Early Triassic.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW LIGHT ON THE EVOLUTIONARY RELATIONSHIPS BETWEEN "THORACOSAURS" AND MODERN GHARIALS: EVIDENCE FROM A NEW GAVIALOID FROM THE LATE CRETACEOUS OF CHIAPAS, MÉXICO

CARBOT-CHANONA, Gerardo, Secretaría de Medio Ambiente e Historia Natural, Tuxtla Gutiérrez, Mexico; BROCHU, Christopher, Univ of Iowa, Iowa City, IA, United States; BUSCALIONI, Angela, Universidad Autónoma de Madrid, Madrid, Spain; REYNOSO ROSALES, Victor Hugo, Universidad Nacional Autónoma de México, Ciudad Universitaria, Mexico

The slender-snouted Campanian through Ypresian "thoracosaurs" are currently viewed as early relatives of the living Indian gharial *(Gavialis gangeticus)*, which is the focus of an unresolved phylogenetic conflict between morphological and molecular data sets. However, substantial stratigraphic and morphological gaps exist within thoracosaurs and between them and more younger, derived gavialoids. A new crocodylian from the Ocozocoautla Formation (Maastrichtian, Late Cretaceous) of Chiapas, México, fills a morphological gap in the thoracosaur record. The new specimen consists of a partial skull and lower jaw, appendicular elements, vertebrae, and osteoderms preserving a unique combination of character states. Differences from the Cretaceous-early Paleocene thoracosaurs *Eothoracosaurus* and *Thoracosaurus* include large, nearly circular supratemporal fenestrae with a linear medial margin separated by a very narrow interfenestral bar and a palatal premaxillary-maxillary contact extending to the second maxillary alveolus. The morphology of the skull table resembles that of Paleocene *Eosuchus*, and *Eosuchus* and the Chiapas form share a large external mandibular fenestra not found in other thoracosaurs. However, the Chiapas form lacks the alveolar couplets of the dentary tooth row diagnostic of *Eosuchus*. It also lacks derived states linking *Eosuchus* with later gavialoids. A phylogenetic analysis places the Chiapas form as the sister lineage to a clade including *Eosuchus* and the more derived gavialoids that first appear in the latest Eocene. Our analysis continues to support a close relationship between thoracosaurs and *Gavialis*, and it reinforces a marginal marine origin for a lineage currently restricted to fresh water, but the maxillary tooth counts of the Chiapas form and *Eosuchus* (21) are smaller than those of *Eothoracosaurus* (26) and *Thoracosaurus* (23), suggesting phyletic shortening of the snout that was reversed in later gavialoids.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CONFIRMATION OF LIFESTYLES OF EXTINCT FELIDS BASED ON COMPARISON OF HOMOLOGOUS CHARACTERS OF LIVING CATS

CARLON, Burcu, Northern Illinois University, DeKalb, IL, United States, 60115; NAPLES, Virginia, Northern Illinois Univ, DeKalb, IL, United States

Living and extinct felid morphology ranges from robust ambush predator to gracile-limbed cursor. Identification of similar osteological characters that correlate with locomotor habits in living forms allows estimation of lifestyle in extinct species of comparable morphology. Here, we examine forelimb characters of the living taxa *A. jubatus* and *P. leo* with homologous features in the extinct genera *S. fatalis* and *P. atrox* as a means of identifying factors that help predict habits.

We performed a geometric morphometric analysis (Generalized Procrustes Superimposition and Principal Components) of homologous features of the scapula, humerus, and ulna to allow identification of skeletal features that correlate with different lifestyles in extinct taxa.

PC1 accounted for 40.8% for the scapula, 43.6% for the humerus, and 76.6% for the ulna. *S. fatalis* had positive PC1 scores, and *A. jubatus* had negative PC 1 scores. *P. atrox* and *P. leo* grouped together and were positioned in between the *A. jubatus* and *S. fatalis*. The Panthera group differed significantly from *S. fatalis* and *A. jubatus* (α=0.05).

Among felids, the details of forelimb use dominate hunting style, from ambush to cursorial predator. The shape analysis methods reveal discrete characters that can predict lifestyles of extinct taxa based on comparison of homologous features observed among living cats. Each species studied here shows a unique character suite, allowing further refinement of the predictions of lifestyle and the most significant features that predict locomotor habits.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

USING ONTOGENY AND PHYLOGENY TO TEST HYPOTHESES OF ANAGENESIS IN THE VERTEBRATE FOSSIL RECORD: A CASE STUDY OF THE SISTER GROUP RELATIONSHIP BETWEEN *DASPLETOSAURUS* AND *TYRANNOSAURUS* (DINOSAURIA, COELUROSAURIA)

CARR, Thomas, Carthage College, Kenosha, WI, United States, 53140-1994

The evolution of derived tyrannosaurine tyrannosaurids is well represented by a series of stratigraphically separate species. These include, in ascending chronological order: *Daspletosaurus torosus* (Oldman and Dinosaur Park Formations), a new taxon (upper Two Medicine Formation), and *Tyrannosaurus rex* (Hell Creek Formation and its lateral equivalents). This stratigraphic sequence of closely related species provides the opportunity to test the hypothesis that they are an anagenetic lineage. This study proposes a protocol for evaluating hypotheses of anagenesis based on a quantitative comparison of phylogenetic and ontogenetic patterns (i.e., sequences of homologous character transformations). To reach this end, a cladistic analysis of Tyrannosauroidea was executed that, for completeness, includes the recently named tyrannosaurine *Zhuchengtyrannus*. Growth series for *D. torosus*, the new taxon, *T. bataar*, *T. rex*, and outgroup taxa were recovered using cladistic analysis of morphological characters. This was done to compare the ontogenetic changes in each species with the phylogenetic character changes at each node from where they extend. The phylogenetic and biogeographic history of derived tyrannosaurines is complex, where (1) several Asian taxa separate *T. rex* phylogenetically from the earlier Laramidian species, and (2) multiple dispersal events occurred between Laramidia and Asia. These factors complicate a straightforward account of anagenesis in Laramidian tyrannosaurines during the Campo-Maastrichtian.

Symposium 1 (Wednesday, October 30, 2013, 11:15 AM)

FIRST DEFINITIVE ASSOCIATION BETWEEN EMBRYONIC *ALLOSAURUS* BONES AND *PRISMATOOLITHUS* EGGS IN THE MORRISON FORMATION (UPPER JURASSIC, WYOMING, USA)

CARRANO, Matthew, Smithsonian Institution, Washington, DC, United States, 20013-7012; MATEUS, Octavio, Museu da Lourinhã, Lourinhã, Portugal; MITCHELL, Jonathan, University of Chicago, Chicago, IL, United States

Despite more than a century of collecting, resulting in one of the best-studied vertebrate fossil records anywhere in the world, the Upper Jurassic Morrison Formation has produced surprisingly few examples of dinosaur eggs associated with embryonic remains. Even more puzzling, none of these seem to pertain to the theropod *Allosaurus*, one of the most common and best-understood dinosaur taxa in the formation. Here we report on a dinosaur nest site that has produced both abundant prismatoolithid eggshell and embryonic (or perinatal) bones of *Allosaurus* from Fox Mesa, Wyoming. This represents the first such discovery for any theropod in the Jurassic of North America. The nest is heavily weathered but contains a few ellipsoid eggshell clusters that suggest an egg size of about 8 x 6.5 cm. Study of the eggshell morphology and microstructure confirms that a single egg type is present throughout, which is indistinguishable from *Prismatoolithus coloradensis*. All of the identifiable embryonic materials pertain to theropods, and two premaxillae specimens show the five alveoli diagnostic for *Allosaurus* among Morrison theropods. This confirms the theropod origin of *Prismatoolithus* eggs and implicates *Allosaurus* as the specific Morrison parent taxon. As a result, it is now possible to assign several previous discoveries of dinosaur eggs and potential nests to *Allosaurus*, including the isolated egg from the Cleveland-Lloyd Quarry. This discovery also calls into question prior assignments of *Prismatoolithus* eggs to ornithopods, and suggests that more detailed study of such sites is warranted. *Prismatoolithus* eggshells are also associated with the Upper Jurassic theropod *Lourinhanosaurus* from Portugal, along with larger embryos that exhibit four premaxillary alveoli.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

VARIATION OF OSTEODERM ANATOMY IN THE CARAPACE OF THE NORTH AMERICAN GLYPTODONT, *GLYPTOTHERIUM* (XENARTHRA, CINGULATA)

CARRANZA-CASTAÑEDA, Oscar, Centro de Geociencias, Universidad Nacional Autonoma de Mexico, Campus Juriquilla, Queretato, Mexico; GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ, United States

Beginning in 1875 with the description of *Glyptodon mexicanus* Cuatáparo and Ramirez (=*Glyptotherium mexicanum*) from Pleistocene deposits in the Valley of Mexico, discoveries of glyptodonts have been common in Mexico, the United States and Central America. *Glyptotherium* includes *G. cylindricum* and *G. mexicanum* in Mexico; and *G. texanum*, *G. floridanum* and *G. arizonae* in North America. These species have been described mainly on the basis of osteoderm osteology, without reference to position in the carapace. The dorsal-sagittal region of the carapace includes the preiliac area, where the osteoderms are symmetrical hexagons, with the diameter of the central figure approximately 50% of the side-to-side diameter, and with 8-10 peripheral figures of uniform size and shape. Borders of peripheral figures are sometimes shared by adjoining osteoderms. Close to the cephalic area the osteoderms are hexagonal but elongated in the anteroposterior axis. Osteoderms of the lateral middle region retain the hexagonal shape but they are asymmetrical. Within the postiliac region, osteoderms range from asymmetrical hexagons to trapezoidal or rectangular, with the central figure occupying approximately 50% of the surface. Peripheral figures of the osteoderms in this area vary

in size and shape. Towards the caudal margin, osteoderms are polyhedral, with the central figure occupying up to 70% of the surface and projecting slightly from the peripheral figures. The lateral profile of the postiliac region is concave especially near the caudal margin. Outer edges of marginal osteoderms are elongated and directed caudally, the central figure occupies over 70% of the surface area, and peripheral figures are almost imperceptible. In succeeding rows of osteoderms, shapes vary from rectangular to trapezoidal, the central figure is progressively reduced, and peripheral figures become more evident. In the lateral cephalic region on both sides of the skull, the osteoderms are strongly convex, the central figure and the peripheral figures are small or nonexistent, and the rear portion is elongated and flat with multiple bony protuberances for insertion of integument; these structures suggest the lateral sides of skull had some mobility that allowed the animals to move the skull during feeding. In males, osteoderms of the dorsal midline at the caudal margin are larger and have a prominent conical boss that diminishes gradually toward the posterolateral margin. In females the osteoderms of the caudal row are flat and only slightly convex without a prominent boss.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

FUNCTIONAL MORPHOLOGY OF THE AZHDARCHID MANUS

CARROLL, Nathan, Montana State University, Bozeman, MT, United States, 59718

Previous studies of the inferred terrestrial locomotor ability of pterosaurs rely on limb proportions or pedal morphology as the basis for subsequent functional interpretations and often do not consider the morphology of the manual digits. This is especially true for the Azhdarchidae, which are typically represented by fragmentary elements and/or obscured preservation of the manus. Three-dimensional preservation of manual elements in an azhdarchid from the Two Medicine Formation of Montana allows for an evaluation of its functional morphology and a comparison to other Late Cretaceous pterosaurs. Phalanx III- 1 differs greatly between taxa and is particularly informative for differentiating pterosaur manual morphologies. A principal component analysis of pterosaur proximal phalanges shows that azhdarchids form a cluster separate from other Cretaceous pterosaurs, particularly in the size of the abductor process and the robustness of the proximal phalanges. This unique morphology of phalanx III-1 in azhdarchids is likely a synapomorphy for this group. It is proposed that the greatly expanded proximal portion of phalanx III-1 of azhdarchids is an adaptation to accommodate higher stress loads during quadrupedal walking, and that this phalanx bore the majority of the weight at the metacarpophalangeal joint. This study provides further evidence that azhdarchids were likely proficient walkers and spent a considerable amount of time on the ground.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

CHANGES IN DIVERSITY AND STRUCTURE OF THE VALLESIAN (LATE MIOCENE) RODENT RECORD FROM THE VALLÈS-PENEDÈS BASIN (CATALONIA, SPAIN)

CASANOVAS-VILAR, Isaac, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; GARCÍA-PAREDES, Israel, Instituto de Geociencias IGEO (CSIC/UCM), Madrid, Spain; VAN DAM, Jan, Utrecht University, Utrecht, Netherlands

The Vallès-Penedès Basin (Catalonia, Spain) is the type area for the Vallesian stage (early late Miocene; 11.1-8.7 Ma), which is considered an interval of important changes in the European mammal faunas. Several middle Miocene taxa, associated with forested environments, seem to have disappeared abruptly at 9.6 Ma during an event known as the "Vallesian Crisis". Simultaneously, many taxa that later will characterize the rest of the late Miocene (Turolian) first occur in Western Europe.

We analyze the diversity dynamics and changes in the structure of the Vallesian rodent assemblages from this basin. The record comprises more than 5000 specimens recovered from 82 different fossil sites. The age of most localities can be accurately estimated using a combination of biostratigraphic and magnetostratigraphic methods. Furthermore, we have considered the biases introduced by the variations in the quality of the record.

Five different local biozones (named V1 to V5) can be recognized on the basis of the rodent content. The rodent fauna of zone V1 is basically identical to that of the late Aragonian (latest middle Miocene), which implies that the dispersal of the equid *Hippotherium* into the area was not accompanied by any significant environmental change that influenced the rodent fauna. Zones V2 and V3 show a diverse rodent assemblage overwhelmingly dominated by the cricetine *Cricetulodon*, which usually accounts for more than 80 % of the specimens.

The boundary between zones V3 and V4 corresponds with the "Vallesian Crisis". However, the impact of this event on the rodent faunas is found to be less important than previously thought. Several species of sciurids, castorids, glirids, eomyids and cricetids are said to have disappeared from the area at 9.6 Ma, but our data show that many of them did in fact survive until the end of the Vallesian, being sporadically recorded in some sites. Their apparent absence may reflect the fact that the quality of the record is much better during the early (zones V1-V3) than the late Vallesian (zones V4-V5). All the missing species are generally rare in our assemblages, so they require a greater sampling effort to be recorded. Alternatively, these taxa may have been associated with very specific habitats that for unknown taphonomic reasons are not recorded during the late Vallesian. Zone V4 also records the dispersal of the first murids (*Progonomys*). In contrast to what occurred in other Iberian basins, the rodent assemblage continued to be cricetine-dominated and murids did not become the dominant rodents until the upper part of zone V5.

Symposium 4 (Saturday, November 2, 2013, 11:00 AM)

VERTEBRATE DIVERSITY AND RESPONSE TO OCEAN TEMPERATURE DECLINE DURING THE LATEST CRETACEOUS IN THE ANTARCTIC PENINSULA

CASE, Judd, Eastern Washington University, Cheney, WA, United States, 99004

The James Ross Basin, northeastern Antarctic Peninsula is the only Antarctic region to exhibit a significant fossil vertebrate record from the Santonian through the Eocene. The latest Cretaceous marine deposits bearing vertebrate remains from the beginning of the Santonian to the end of the Maastrichtian crop out on northern James Ross Island, southern Vega Island to the north and southern Seymour Island to the east. Through this approximately 18 million year time span, an 8°C drop in ocean temperature occurs (from 16°C to 8°C) based on changes in oxygen isotope values. The latest Cretaceous vertebrate faunas show a pattern of stable diversity in teleost fish, neoselachian sharks and non-avian dinosaurs. Marine reptiles, including plesiosaurs and especially mosasaurs, show a pattern of increasing diversity and abundance through the latest Cretaceous. Thus, the drop in ocean temperature created some taxonomic turnover, but had little effect on overall diversity in the latest Cretaceous Antarctic vertebrate faunas. In the Middle Eocene of the La Meseta Formation, at 45.2 Ma, the diversity of neoselachian sharks is very high (Shannon diversity index, H= 1.814) which nearly equals the values in the tropics today (H= 1.920). The mid-Eocene water temperatures were at 8°C. In the Late Campanian (ca 74.2 Ma), from the Herbert Sound Member, the water temperature was twice as high as the mid-Eocene at 16°C, yet the shark diversity level was only 25% (H= 0.483) of the mid-Eocene value. Whereas shark diversity today is directly correlated with water temperature, this was not the case for Antarctica's distant past. The 8°C drop in temperature during the latest Cretaceous had little or no negative effect on the diversity of Antarctic vertebrate faunas. Thus, there seems to be no particular correlation between decreasing ocean temperatures and a decrease in diversity in the latest Cretaceous Antarctic vertebrate faunas.

Technical Session VIII (Thursday, October 31, 2013, 2:00 PM)

NEUROANATOMY AND OSSEOUS LABYRINTH OF A NEW PERMIAN DICYNODONT FROM MOZAMBIQUE

CASTANHINHA, Rui, Museu da Lourinhã e Instituto Gulbenkian de Ciência, Lisboa, Portugal; ARAÚJO, Ricardo, Museu da Lourinhã and SMU, Dallas, TX, United States; COSTA JÚNIOR, Luís, Museu Nacional de Geologia, Maputo, Mozambique; ANGIELCZYK, Kenneth, Field Museum of Natural History, Chicago, IL, United States; G. MARTINS, Gabriel, Centro de Biologia Ambiental, Faculdade de Ciências, Universidade de Lisboa., Lisboa, Portugal

A nearly complete skull and mandible, with a series of 19 articulated dorsal, sacral and tail vertebrae, ribs, ilia, partial pubis, and femur (ML1620) was collected from Late Permian Karoo sediments, Metangula Graben, northern Mozambique (Niassa Province), Cádzi Formation. The µ-CT 3D visualization of the internal cranial bones, combined with a phylogenetic analysis demonstrates a set of characters shared with Emydopoidea, a restricted clade of small-sized dicynodonts. The brain is narrow and the cerebellum is broader than the forebrain, resembling the condition of other non-mammalian therapsids. The orbits are located far anteriorly relative to the olfactory bulbs. The olfactory bulbs are separated from the cerebrum by a short olfactory tract. The trigeminal nerve arises near the floculi anteroventrally. The abducens nerve is directed laterally and passes between a notch on the ventral border of the prootic and the dorsal border of the basisphenoid. The facial and vestibulocochlear nerves are closely associated and arise behind the semicircular canals. The glossopharyngeal and the vago accessory nerves exit the hindbrain laterally at nearly midheight. The hypoglossal nerve pierces the exoccipital, arising from the hindbrain with a mediolateral orientation. The anatomy of osseous labyrinth, pristinely preserved, shows a bulky vestibule with a lateromedially-oriented canal that links to the fenestra ovalis and then slopes into a stout, dorsoventrally-oriented portion. The semicircular canals are subequal in diameter. The anterior and posterior semicircular canals are of equal thickness, whereas the horizontal semicircular canal is broader. The brain of this dicynodont displays a conservative reptilian-grade brain morphology. In fact, the brain morphology here described closely resembles the *Dicynodon* condition due to the elongated and narrow shape as well as the wide angles between the different brain regions, as opposed to the *Lystrosaurus* condition.

Technical Session II (Wednesday, October 30, 2013, 9:15 AM)

MESOWEAR AND HYPSODONTY THROUGH TIME IN HYPERTRAGULIDS (ARTIODACTYLA) FROM THE TURTLE COVE MEMBER OF THE JOHN DAY FORMATION OF OREGON

CAVIN, Jennifer, John Day Fossil Beds, Kimberly, OR, United States, 97848; SAMUELS, Joshua, , Kimberly, OR, United States

The Turtle Cove member of the John Day Formation includes approximately 400 meters of strata that represent around five million years of deposition. These strata are very well dated, as they are interspersed with six mapped and dated volcanic beds, from about 31 to 26 Ma. Overall, the Turtle Cove member is highly fossiliferous, and by far the most abundant taxa represented are the hypertragulids (mouse deer). Hypertragulids were small, browsing artiodactyls living in a mixed woodland habitat. This habitat gradually became drier and more open through the Oligocene, as evidenced by paleosol data and the appearance of open habitat specialist taxa. As the habitat changed and after major volcanic events, it would be expected that due to increased ingested grit, the teeth of hypertragulids would exhibit greater wear and selection would favor higher crowned teeth. To examine whether hypertragulids show differences in tooth wear or crown height through time, we measured mesowear and hypsodonty index of lower second molars. Specimens were examined from each stratigraphic unit of the Turtle Cove member, from unit A through unit K2, and an analysis of variance was used to test for

differences in means between these units. Hypertragulids exhibited no significant differences in wear levels in strata immediately after volcanic events. There were also no differences in mesowear or hypsodonty through time, despite the environment becoming drier and more open. As field work continues in the Turtle Cove member, sample size will increase, which may ultimately strengthen or refute these results. One hypothesis to explain the apparent stasis is that hypertragulids did not adapt to changes in the environment, potentially simply tracking favored wooded habitats. As these habitats declined, this may have led to their being replaced by more hypsodont taxa. Preliminary results seem to indicate reciprocal abundance through time, with hypertragulids decreasing through time while other small browsers increase.

Technical Session X (Friday, November 1, 2013, 9:30 AM)

ECOLOGICAL CHANGES IN THE TURKANA BASIN OVER 4 MA

CERLING, Thure, University of Utah, Salt Lake City, UT, United States, 84112; HARRIS, John, George C Page Museum, Los Angeles, CA, United States; LEAKEY, Meave, National Museums of Kenya, Nairobi, Kenya; LEVIN, Naomi, Johns Hopkins University, Baltimore, MD, United States; MANTHI, Fredrick Kyalo, National Museums of Kenya, Nairobi, Kenya

Ecological changes based on sedimentology, relative species abundances, and paleosols have been suggested for the Turkana Basin in northern Kenya. In this study we examine the $\delta^{13}C$ of mammal teeth at the ecosystem scale for 25 different modern regions in East Africa and use that as an analogue for understanding ecosystem change in the past 4 Ma. We analyzed stable isotopes in > 1500 modern individuals from 25 distinct modern ecosystems and > 2000 fossil individuals through the past 4 Ma in the Turkana Basin in northern Kenya. Although most modern mammals have diets similar to their fossil supposed ancestors, some do not and, in fact, have diets completely different than their supposed ancestors. Modern ecosystems can be classified by considering taxa at the tribe/genus level using stable carbon isotopes. Fossil mammals at this same taxonomic level of ID - tribe/genus - show important changes over 4 Ma for a few lineages. However, comparison at the ecosystem scale shows major differences occurring in East Africa between 2 and 2.5 Ma. The most significant changes occur in the taxa that are grazers, with only bovids having the same relative success throughout 4 Ma. Non-bovid families had more grazing taxa in the Pleistocene than they do in the present. Major changes in ecosystem structure in Africa over the past 4 Ma are indicated using stable isotopes in mammalian teeth. We find some fossil ecosystem structures for which we have not observed the modern equivalent, even though all major lineages are present in both the fossil and modern assemblages. We speculate that C4 grass evolution, almost invisible in the fossil record, may be partly responsible for these differences.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

WIESBADEN - AMONEBURG IN GERMANY: THE FIRST STEPS OF THE MODERN SQUAMATE FAUNA IN EUROPE DURING THE EARLIEST MIOCENE

CERNANSKY, Andrej, Senckenberg Research Institute , Frankfurt am Main, Germany; RAGE, Jean Claude, Museum national d Histoire naturelle, Paris, France; KLEMBARA, Jozef, Comenius Univ Bratislava, Bratislava, Slovakia

Squamate faunas fom the MN 1 - MN 3 interval (earliest Miocene) are only poorly known in Europe (and even worldwide). Our research brings the first report of a complete squamate fauna from zone MN 2 in Europe. It comprises relatively numerous specimens that come from Wiesbaden-Amoneburg (western Germany). This fauna fills an important gap in our knowledge of the paleobiodiversity of herpetofaunas from this time interval in Europe. The new finds are important for two reasons. 1) The beginning of the Miocene represents the temporary return of a para-tropical humid climate after the relatively cool and dry Oligocene. The new material reported here provides an opportunity to observe changes in the paleoherpetofaunas during a particularly pertinent time. It shows different snake and lizard responses to the climate changes at the beginning of the Miocene. The amphisbaenid and lizard assemblage of Wiesbaden-Amoneburg is very similar to that of the younger locality Merkur - North (MN 3) in the Czech Republic, i.e. the only fauna of MN 3 age in Europe. This MN 2 assemblage includes Gekkota indet., *Lacerta poncenatensis*, Lacertidae indet., Scincomorpha indet., *Pseudopus* cf. *ahnikoviensis*, *Ophisaurus spinari*, *Ophisaurus* sp., Anguidae indet., *Merkurosaurus ornatus*, Shinisauria indet., Platynota indet., *Blanus* sp. nov. and Lacertilia indet. However, snakes include both Oligocene survivors (booids) and immigrants (natricines, colubrines, viperids). 2) The early Miocene was also marked by the collision of Eurasia with Africa. This event potentially permitted immigration of African squamates into Europe, including re-immigration of squamate lineages which were absent in Europe during the cooler and drier Oligocene, but were present there during the Eocene and survived elsewhere, for example in Africa. Taxa such as Chamaeleonidae and Cordylidae, which occur in MN 3 at Merkur - North, are missing from Wiesbaden-Amoneburg. This suggests that African taxa had not yet reached Europe by MN 2, but were able to enter it during MN 3.

Technical Session XIV (Saturday, November 2, 2013, 10:45 AM)

THE DROMORNITHID OR THE EGG? SIZE CONSTRAINTS IN FLIGHTLESS BIRDS

CHAN, Nicholas, Macquarie University, Sydney, Australia

The removal of flight as a constraint on size has led to the evolution of gigantism in several lineages of birds. However, even they have not attained the size of large non-avian (n-a) theropods. Predictions of two hypotheses were tested to examine potential size constraints in flightless birds. The first is that egg shell strength restricts the size of the incubating bird and that the extreme sexual dimorphism seen in the moa genera *Dinornis* and *Pachyornis* was an adaptation to reduce the stresses placed upon eggs during incubation. If so, then similarly large birds should also exhibit extreme dimorphism. This was tested for in *Genyornis newtoni* (Aves: Dromornithidae), an anseriform bird similar in size to *Dinornis*. Coefficients of variation in the size of leg bones from a sample of adult *Genyornis* from Lake Callabonna, South Australia are three times lower than that of *Dinornis*, suggesting that extreme dimorphism was absent.

Alternatively, a mechanical constraint caused by femoral orientation may restrict mass in flightless birds. Unlike n-a theropods, birds lack a long counter-balancing tail, and a sub-horizontal orientation of the femur places the knee under the center of mass. This restricts femur morphology, with femoral length constrained to maintain the position of the knee and robusticity increasing with body mass to counteract greater torsional strains. Previous studies have suggested that these restrictions may limit body mass in flightless birds. As a result, avian scaling curves are expected to exhibit a lower inflection point than is seen in n-a theropods. In addition, if this is a universal constraint in birds then different avian phylogenetic groups should scale similarly. Femoral length and circumference measurements were taken for 43 species from 7 orders of flightless terrestrial birds and regression results compared to a data set for 81 n-a theropods compiled from the literature. Polynomial regressions reveal significant curvilinearity in avian femoral scaling, whilst model II regressions show significant overlap of slope and intercept confidence intervals (CIs) for ratite (n=19), gruiform (n=13), and galloanseraean (n=8) birds. Conversely, n-a theropods show no significant curvilinearity and the CIs of maniraptorans (n=17) and tyrannosauroids (n=18) do not overlap. This suggests greater flexibility in femoral proportions in n-a theropods than in flightless birds, supporting previous suggestions that femoral scaling in birds is constrained by the loading regime.

Technical Session XIII (Friday, November 1, 2013, 2:15 PM)

DENTAL DEVELOPMENT OF THE STEM OSTEICHTHYAN *ANDREOLEPIS HEDEI* REVEALED BY THREE-DIMENSIONAL SYNCHROTRON VIRTUAL PALEOHISTOLOGY

CHEN, Donglei, Uppsala Univ, Uppsala, Sweden; AHLBERG, Per, Uppsala Univ, Uppsala, Sweden; BLOM, Henning, Uppsala Univ, Uppsala, Sweden; SANCHEZ, Sophie, Uppsala Univ, Uppsala, Sweden

Andreolepis hedei from the Late Silurian of Gotland, Sweden is one of the oldest putative osteichthyans known to date. Based on isolated bone fragments, scales and teeth, *Andreolepis* has traditionally been identified as a primitive actinopterygian. However, the recent discovery of fragments of osteichthyan-like marginal dermal jawbones, which lack the typical shedding tooth organization of crown osteichthyans, has suggested that it is in fact a stem osteichthyan. The jawbones appear to exhibit a gradual transition between marginal tooth-like denticles and external ornamentation. The marginal denticles of *Andreolepis* have recently been interpreted both as true teeth and as tooth-shaped dermal tubercles; a comprehensive insight into their organization and growth pattern is crucial for resolving the origin of the osteichthyan dentition. Previous studies have been limited to external morphology and two-dimensional histology, but here we reconstruct the three-dimensional histological architecture of a marginal jawbone of *Andreolepis* from a propagation phase contrast synchrotron microtomography scan with sub-micron resolution. The overall morphology of the dermal ornamentation is the result of the intercalation of successive generations of non-shedding odontodes. Even though the odontodes lack enamel, the successive overgrowth surfaces, growth-arrest surfaces and resorption surfaces are clearly visible and allow the sequence of developmental events to be inferred. In the transitional region between facial lamina and biting margin, the first generation of odontodes are arranged in regular rows, and obliquely conical towards the biting margin. They were probably functional “teeth”, since they often have the tip chipped off, most likely as a result of biting action. Subsequently these tooth-like odontodes were partially or fully overgrown by bone and tubercular odontodes, as the jawbone grew labially. The buried odontodes and the surrounding bone tissue show evidence of partial resorption from above, instead of from the root below, leading to vascular loops from the overlying soft tissue making new connections to the pulp cavities of the preceding odontodes. The new developmental model of *Andreolepis* dentition is in striking contrast to that of most osteichthyans, and will contribute to a more detailed understanding of the acquisition of the osteichthyan body plan.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A LATE EOCENE *PROCYPRIS*-LIKE CYPRINID (TELEOSTEI, PISCES) FROM SOUTH CHINA

CHEN, Gengjiao, Natural History Museum of Guangxi, Nanning, China; CHANG, Mee-Man, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; LIU, Huangzhang, Institute of Hydrobiology, Wuhan, China

Fossil cyprinids from the upper part of the late Eocene Youganwo Formation of Maoming, Guangdong Province, South China were first studied by Liu in 1957. The author referred the specimen to genus *Cyprinus* as a new species, *C. maomingensis*. Unfortunately, this specimen is poorly preserved and reveals no more morphological information than its serrated last unbranched dorsal and anal fin rays. In fact, we are unable to observe any character from the specimen that seems to warrant its assignment to *Cyprinus*. Recently, some new specimens were unearthed from the same locality. These specimens show that its body is rather deep, the last unbranched dorsal and anal fin rays are strong, with serrations on their posterior edge, the origin of the dorsal fin is anterior to the insertion of the pelvic fin, the dorsal fin base is relatively short, with 9 branched rays, the origin of the anal fin is posterior to the end of the dorsal fin base, the pharyngeal bone is arc-like, broad and bent in the middle of the bone, its length to width ratio is about 4, its anterior limb is shorter than the posterior one, which is laterally compressed, tapering to a blunt point as in other species of the Cypininae, the anterior limb is pointed at the tip, the anterior angle is round and protrudes slightly, the posterior angle is obsolescent, two rows of pharyngeal teeth are preserved, the shape of all teeth

except A1 is spoon-like, the number of teeth in the main row is four, A1 is obviously larger than the other teeth, A2 is larger than A3, A4 and the tooth on B row. Morphologically, the pattern and shape of the pharyngeal teeth of these specimens obviously differ from those of *Cyprinus* but resemble those of *Procypris*. However, the number of branched dorsal fin rays and the number of vertebrae of the specimens from Maoming are obviously less than that in *Procypris*, i.e., 9 or 10 vs. 14–22 and about 35 vs. 40-43, respectively. Consequently, these specimens are closer to *Procypris* than to *Cyprinus*. This is the first report of fossil *Procypris*-like fish, and it implies that *Procypris*-like fish are an early members of the Cyprinini tribe and the origin of this group can be traced back at least to the late Eocene.

Technical Session I (Wednesday, October 30, 2013, 10:45 AM)

INCORPORATING FOSSILS, MORPHOLOGY AND MOLECULES: COMBINED PHYLOGENETIC ANALYSES OF THE CRYPTOBRANCHOIDEA (AMPHIBIA: URODELA)

CHEN, Jianye, American Museum of Natural History, New York, NY, United States, 10023; JIA, Jia, Peking University, Beijing, China; GAO, Ke-Qin, Peking University, Beijing, China

Cryptobranchoidea are a suborder of salamanders (Urodela), consisting of two distinct families: small and metamorphic salamanders of the Hynobiidae, and large and neotenic forms of the Cryptobranchidae. They are long considered primitive in salamander phylogeny due to generalized morphology and lack of derived features seen in Salamandroidea. Early fossil salamanders from the Mesozoic of China have been reported to have cryptobranchoid affiliations, but their exact relationships with living species remain unclear. Besides, inter-relationships of extant hynobiids are hotly debated due to incongruence of results from various data types. To address these problems, we conducted combined analyses of the Cryptobranchoidea, incorporating fossils, and combining both morphology and molecular data. We coded 51 morphological characters over 32 living and fossil species, and retrieved 13 mitochondrial DNA sequences (over 10000 base pairs) of 27 living species from Genbank. *Ambystoma tigrinum* was chosen as the outgroup. Separate morphological and molecular analyses, and combined analyses were all performed using the software POY 4 under the maximum parsimony criterion. The strict consensus tree of the combined analysis is similar with the molecular trees, whereas the morphological trees yield a polytomy at the base of the Hynobiidae. Monophyly of both families and each genus was confirmed by the combined analysis. The three living species of giant salamanders form a well-supported clade, while the Jurassic *Chunerpeton* and Paleocene *Aviturus* occupy basal positions in the Cryptobranchidae. Relationships within the Hynobiidae are largely in congruence with previous molecular studies, except for the placement of *Pachyhynobius* at a basal position only higher than *Onychodactylus*. Jurassic *Pangerpeton* and Cretaceous *Liaoxitriton* are shown to be basal crown-group hynobiids, closely related to *Pachyhynobius*. The occurrence of crown-group cryptobranchoids in the Jurassic indicates a long evolutionary history of the group. Favorable paleoclimatic and paleo-environmental conditions in the Jurassic of northeast China may have had a significant impact on the early evolution of the Cryptobranchoidea.

Technical Session XVIII (Saturday, November 2, 2013, 2:45 PM)

MORPHOMETRIC ANALYSIS OF LOCOMOTOR SPECIALIZATION IN THE CRETACEOUS MAMMAL *YANOCONODON*: IMPLICATIONS FOR ECOMORPHOLOGICAL DIVERSIFICATION WITHIN EUTRICONODONT MAMMALS

CHEN, Meng, University of Washington, Seattle, WA, United States, 98195-1800; LUO, Zhe-Xi, University of Chicago, Chicago, IL, United States; WILSON, Gregory, University of Washington, Seattle, WA, United States

The postcranial skeletal features of the *Yanoconodon allini* (Eutriconodonta, Jeholodentidae) from the Lower Cretaceous of China suggest that it was a generalized terrestrial mammal. Its humerus has a spindle-shaped head, an indistinct neck, and a broad and shallow intertubercular groove, all of which resemble those of non-therian mammaliaforms or cynodonts that have been inferred as having engaged in terrestrial locomotion, or like those of terrestrial monotremes. The olecranon process of the ulna is short and the semilunar notch is widely open. Styloid processes, which restrict mediolateral movement of the hands, are absent from the distal ends of the ulna and radius. The phalanges are relatively short and stout. The femur has a spherical head with a very short neck. The greater trochanter is small and is not vertically oriented. The distal ends of both the tibia and fibula lack malleoli that stabilize the movement of the upper ankle joint in a parasagittal plane. The astragalus and calcaneus are juxtaposed on each other and morphologically similar to those of premammalian cynodonts. We interpret that both the forelimb and hindlimb had a sprawling posture based on the articulations with the pectoral and the pelvic girdles, respectively. The scapula is triangular-shaped and has a mobile articulation with the clavicle, suggesting that *Yanoconodon* had a shoulder-muscle arrangement common in extant mammals with some climbing abilities. To quantitatively assess the locomotor abilities of *Yanoconodon*, we incorporated 26 linear measurements of preserved appendicular elements into a discriminant function analysis that is based on a database of 107 extant small-bodied mammals grouped into eight locomotor categories. The analysis classified *Yanoconodon* as a terrestrial mammal, whereas *Jeholodens jenkinsi*, a sister taxon that exhibits some features indicative of a climbing locomotion, was classified as a scansorial form. Our results imply that ecomorphological diversification occurred within the Eutriconodonta. This pattern resembles the evolution of ecomorphological differences among closely-related trechnotherian species from the Early Cretaceous. These results confirm that ecomorphological diversification occurred at the generic level in Mesozoic mammal families like in many extant therian groups, prior to trechnotherians that includes modern marsupials and placentals.

Technical Session X (Friday, November 1, 2013, 8:15 AM)

NO OBSERVED EFFECTS OF CLIMATE CHANGE ON SNOWMASS MASTODON TUSK GROWTH

CHERNEY, Michael, University of Michigan, Ann Arbor, MI, United States, 48103; CALAMARI, Zachary, , Ann Arbor, MI, United States; FISHER, Daniel, Univ of Michigan, Ann Arbor, MI, United States

The Snowmass site in central Colorado has yielded remains of a diverse Pleistocene fauna in deposits that range from approximately 130ka to 50ka, based on OSL dating. The fossil assemblage is dominated by remains of about three dozen mastodons that derive from an interval of pronounced climate change extending from the Sangamon interglacial (MIS 5e) through part of an extended period (MIS 5a-d and MIS 4) marked by a cooling trend into glacial conditions. This was of course not the first climate challenge for mastodons. They persisted in North America from the late Miocene through the Pleistocene, during which they survived many transitions between glacial and interglacial periods before their extinction near the Pleistocene-Holocene boundary. The climate transition recorded at Snowmass is opposite in direction compared to the end-Pleistocene event (from interglacial to glacial, rather than the reverse), but it enables valuable insight for understanding the contributions of climate change to mastodon extinction, because its age effectively allows us to rule out human influence as contributing to any changes in mastodon growth history we observe. We have thus far studied mastodon mandibular tusks from the lower half of the stratigraphic sequence at Snowmass, derived from a roughly 35ka interval between about 125ka and 90ka. We have analyzed tusk growth rates (by microCT and sectioning) and stable isotope profiles (through multi-year serial sampling). If Snowmass mastodons were negatively impacted by environmental changes, we would expect to observe among these tusks declining growth rates, increasing growth variability, and serial isotope records consistent with increased nutritional stress and more variable environments. Early analyses of more than ten individuals fail to reveal any such effects. Further collaborative efforts will attempt to place individual growth records in the context of Snowmass-specific environmental reconstructions. This work does not provide a direct test of end-Pleistocene extinction hypotheses, but it will help frame expectations for assessing environmental pressures on terminal Pleistocene populations.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEARLY COMPLETE SKELETON OF THE EARLY EOCENE *TINIMOMYS GRAYBULLIENSIS* (PRIMATES, MICROMOMYIDAE)

CHESTER, Stephen, Yale University, New Haven, CT, United States, 06511; SARGIS, Eric, Yale Peabody Museum, New Haven, CT, United States; BLOCH, Jonathan, Univ of Florida, Gainesville, FL, United States; BOYER, Doug, Duke University, Durham, NC, United States

Micromomyid plesiadapiforms are diminutive euarchontan mammals known from the late Paleocene to the early Eocene of western North America. Recent comprehensive phylogenetic analyses support micromomyids as the most basal stem primates other than the oldest known plesiadapiform, *Purgatorius*. These results coupled with recent observations that tarsals of *Purgatorius* are uniquely similar to those of micromomyids suggest that partial skeletons of micromomyids represent the best current evidence for understanding the postcranial skeletal morphology of the ancestral primate. A dentally-associated partial skeleton of the micromomyid *Tinimomys graybulliensis* (USNM 461201) from a freshwater limestone nodule from the early Eocene of the Willwood Formation, Clarks Fork Basin, Wyoming, was known to include partial scapulae, humeri, ulnae, a radius, and a partial vertebral column with ribs. It was thought that no hind limb elements were preserved and that a relatively long intermediate phalanx belonged to the manus, suggesting that micromomyids had a dermopteran-like gliding membrane with interdigital patagia. Here we report that recent preparation of the same limestone nodule yielded many hind limb and additional elements clearly associated with USNM 461201 including innominates, femora, tibiae, fibulae, tarsals, an articulated series of lumbar, sacral, and caudal vertebrae, the other radius, and phalanges. Comparisons of the phalanges of *T. graybulliensis* to those of other euarchontans, including the fairly complete manus and pes of the micromomyid *Dryomomys szalayi*, demonstrate that these micromomyids did not have elongate intermediate manual phalanges like those of dermopterans. The USNM 461201 specimen was used to assess many previous attributions of isolated postcranial elements to micromomyids. Isolated humeri previously attributed to early Eocene micromomyids *T. graybulliensis* and *Chalicomomys antelucanus* differ significantly in morphology from dentally-associated humeri of *T. graybulliensis* and *D. szalayi*, which suggests they do not belong to Micromomyidae. Body mass estimates for USNM 461201 derived from dental and postcranial regression equations suggest average values of 21 and 23 grams, respectively. The postcranial morphology of *Tinimomys* is very similar to that of the arboreal and most basally divergent treeshrew, *Ptilocercus lowii*, and suggests that the most primitive primates were claw-climbing arborealists that used orthograde postures on vertical supports.

Technical Session XVII (Saturday, November 2, 2013, 3:45 PM)

PROFILE OF A DEVONIAN KILLER: *EUSTHENOPTERON FOORDI*, TOP-PREDATOR OF THE ESCUMINAC FISH ASSEMBLAGE

CHEVRINAIS, Marion, Université du Québec à Rimouski, Rimouski, QC, Canada, G5L 3A1; CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QC, Canada; BÉCHARD, Isabelle, Université du Québec à Rimouski, Rimouski, QC, Canada

In recent ecosystems, opportunistic predators restrain community interactions by applying a top-down control on interspecific relationships. The Upper Devonian Miguasha Fossil-Lagerstätte (Quebec, eastern Canada) provides the opportunity to describe part of the ecological structure of this paleocommunity owing to the exceptional

state of preservation and the high concentration of fossil fishes. The Escuminac assemblage includes 20 vertebrate species belonging to anaspids, osteostracans, placoderms, acanthodians, actinopterygians and sarcopterygians. Ecomorphological (based on non-metric multidimensional scaling) and 3D modelling approaches on all Escuminac fish species provided (1) a structural pattern for the predator-prey relationships and (2) new elements (i.e., bottom-up versus top-down control on interspecific relationships) to understand the paleoecological persistence of the ecosystem through time. Among the 20 vertebrate species, the osteolepiform *Eusthenopteron foordi* is interpreted as the top-predator of the assemblage. Digestive tract contents have been observed in 66 specimens of *E. foordi* of which 36% contain identifiable preys. Evidence of foraging by *E. foordi* has been recorded on five vertebrate species (i.e., *Bothriolepis canadensis*, *Homalacanthus concinnus*, *Cheirolepis canadensis*, *Scaumenacia curta* and *E. foordi*) and on conchostracans. The preservation of full-size ingested prey items provides new insights on the anatomy of the gastrointestinal tract of *E. foordi* and its capacity to contain large prey items (up to 86% of the predator length). The predation mode of *E. foordi* shows behavioral and morphological similarities with extant aquatic top-predators. Opportunistic predation and the abundance and richness of lower trophic level in aquatic Devonian ecosystems, such as the Escuminac paleoestuary, constrained the trophic structure of the fish biota.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

MAMMALIAN FAUNAL RESPONSE TO THE ETM2 AND H2 HYPERTHERMAL EVENTS IN THE CENTRAL PART OF THE BIGHORN BASIN, WY

CHEW, Amy, Western University of Health Sciences, Pomona, CA, United States, 91766

Multiple perturbations in marine isotope records indicate that global climate increased (~2-7 ºC) rapidly (<1 myr) several times during the early Eocene. The largest of these 'hyperthermals' is the Paleocene/Eocene Thermal Maximum, which has been identified on land and to which mammalian response has been thoroughly documented. The carbon isotope excursions (CIEs) of two subsequent, smaller hyperthermals (ETM2 and H2) have been recently identified in the McCullough Peaks (MP) area of Wyoming's Bighorn Basin. However steep exposures in the MP constrain testing of their influence on existing faunas. Large samples from relatively flat exposures tied to a high-resolution stratigraphic record in the Fifteenmile Creek (FC) area of the central part of the Bighorn Basin are ideal for this purpose. The position of the MP CIEs relative to a geomagnetic reversal and biostratigraphic events suggest that ETM2 and H2 occurred between 370 m and 455 m in the FC stratigraphic column (maximum likelihood of ETM2 at ~410-420m and H2 at ~430-440 m). Fossil mammal samples (>30,000 specimens) were compiled from the USGS-Johns Hopkins collections (1975-2010) across this interval (290-509 m) for high-resolution (1-8 m, ~6-48 kyr) paleoecological analysis. Standardized parameters include rates of species first (F) and last (L) appearances and turnover (T), alpha (A), beta (B) and gamma (G) richness, and evenness (E), dominance (D) and community structure (S). Parameters are compared by meter level and across four sets of minimum length data bins (5-8 m thick). Three concurrent, statistically significant (Kolmogorov-Smirnov comparisons with randomized data, all $p<0.05$) parameter shifts occur with decreasing magnitude at 374-392 m, 403-414 m and 435-445 m. The earliest, largest shift has been described in previous analysis as a major faunal event, Biohorizon B (BB). The end of BB was not well constrained but was thought to be ~410 m. It is now apparent that previous (>15 m, ~100 kyr resolution) analysis combined two separate, significant shifts in paleoecological parameters into BB. The middle event is distinct from BB, separated from it by a ~10 meter-thick interval of (often significantly) low parameter values. The middle and latest shifts are smaller than BB, different in nature (major shifts in B and L compared with major shifts in A, F and E at BB) and situated very close to expectation for ETM2 and H2 based on the position of the MP CIEs. If related to the ETM2 and H2 hyperthermals, these parameter shifts suggest a linear relationship between climate and mammal faunal dynamics.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PROYECTO DINOSAURIOS – A MENTOR-CENTERED APPROACH TO ENGAGING UNDER-REPRESENTED STUDENTS IN PALEONTOLOGICAL RESEARCH

CHIAPPE, Luis, Natural History Museum of LA County, Los Angeles, CA, United States, 90007; BELL, Alyssa, Natural History Museum of Los Angeles County, Los Angeles, CA, United States; KISIEL, Jim, California State University Long Beach, Long Beach, CA, United States

Community colleges are key targets to mitigate the severe underrepresentation of ethnic minorities in the geosciences. "Proyecto Dinosaurios" is a National Science Foundation-funded project of the Opportunities for Enhancing Diversity in the Geosciences (OEDG) program that aims at building a network of cooperation between community colleges in Los Angeles, the Dinosaur Institute, and the University of Southern California, and to use the appeal of dinosaurs to engage underrepresented undergraduates in geoscience research. The main goals of "Proyecto Dinosaurios" are to: (1) expose minority (primarily Hispanic) American students to academic activities of graduate students, professional paleontologists, and supporting staff; (2) help students recognize career and schooling options within the geosciences; (3) encourage students to transfer to a 4-year college and continue onto graduate studies; and (4) create awareness, familiarity, and increase understanding about the nature of science. Over two years, Proyecto Dinosaurios successfully recruited seven minority community college students, each of whom conducted an independent research project. Students presented their results at CalPaleo, a conference geared toward undergraduate research. Students also participated in numerous field expeditions throughout the American West. Today, all participants have continued their undergraduate education and either have transferred or plan to transfer to 4-year school, with the majority majoring in a STEM field.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A ROBUST DESMOSTYLID FROM HOKKAIDO, JAPAN, AND THE FEEDING STYLE OF DESMOSTYLIDS

CHIBA, Kentaro, Hokkaido University, Sapporo, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan; JACOBS, Louis, Southern Methodist Univ, Dallas, TX, United States; GRAF, John, Southern Methodist Univ, Dallas, TX, United States; TANAKA, Kohei, University of Calgary, Calgary, Canada

In 2000, a desmostylid, right mandible with two partial molars and a large canine, was discovered in the Miocene Chikubetsu Formation from the Sunjussen River, Hokkaido, Japan. This specimen is characterized by having an enormously robust mandible as well as the bonded-columnar molars typical of desmostylids that have proven difficult to be interpreted functionally. Phylogenetic analysis demonstrates that the Sanjussen desmostylid forms an unresolved polytomy with *Desmostylus* and *Vanderhoofius*. This clade is supported by two synapomorphies: hypsodont molars and swelling of the mandible. Absence of incisors supports a clade containing the Sanjussen desmostylid and *Vanderhoofius* in some most parsimonious trees. Among Desmostylus, Vanderhoofius, and the Sanjussen desmostylid, the degree of mandibular swelling in the Sanjussen specimen is the largest. The maximum width of the mandibular body in the Sanjussen desmostylid is approximately 2.9 times wider than the molar width (1.2 in juvenile to 2.2 in the largest *Desmostylus* individual) and the level of the dorsal margin of the swelling along the horizontal ramus is equal to or higher than the worn occlusal surface of the molars, demonstrating that swelling increases through ontogeny by the addition of bone. Observation of the cross section and micro-CT of the bone swelling shows dense bone innerstructure. The effect of increasing the amount of dense bone through mandibular swelling results in the increase of the cranial mass. Spongy microstructure in postcrania is present in derived desmostylids (*Cornwalius* and *Desmostylus*), indicating the Sanjussen desmostylid may have had a similar condition based on its phylogenetic position. The ontogenetic increase in cranial mass as a biological feature of desmostylids may have evolved concurrently with acquisition of spongy inner structure in postcrania, functioning as ballast such that relatively heavier crania compared to postcrania in desmostylids, which suggests an adaptation in buoyancy control for bottom feeding, similar to extant walrus and the fossil walrus-like cetacean *Odobenocetops*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

EVIDENCE OF FUNGAL ATTACK ON THE BONES OF A PERMIAN THERAPSID

CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa

Bone histology is known to provide a host of information pertaining to the various aspects of the life history and growth dynamics of vertebrates and has been extensively used to assess the biology of extinct animals. However, on occasion, besides the biological signals recorded in bone, other fortuitous ecological indicators are also evident in thin sections. For example, a fragment of *Podocarpus* wood within the marrow cavity of a dinosaur bone provided clues about the paleoenvironment of the time. Here we report the occurrence of saprophytic fungi in a Permian-aged therapsid from South Africa. Several long bones (humerus, radius, ulna, femur, tibia, and fibula) of a scylacosaurid from the *Pristerognathus* Assemblage Zone of the Karoo Basin were thin sectioned. All the bones sampled show extensive degradation of the bone microstructure. In some areas of the thin sections, the damage was severe, whereas in others parts of the same section the bone still preserved its histological integrity. Distinctive clumps of dark matter were associated with the channels in the bone, but also extended into the surrounding bone matrix and appeared to be concentrated in the perimedullary regions. In some areas, under high magnification, short, branching structures that measured about 4–10 microns in width were observed. Under polarized light the structures showed a birefringence which suggests that they have mineral deposits in their walls. It appears that these structures are Wedl tunnels which are caused by saprophytic (saprobe) fungi. The distinctive birefringence observed in the tunnel structures suggested that they contained mineral deposits. Analysis of the walls of the Wedl tunnels using scanning electron microscope energy dispersive spectroscopy (SEM probe analyses) revealed the presence of calcium and carbon, but that unlike the surrounding bone they lacked phosphorous and fluorine. This finding indicated the presence of calcium carbonate in the Wedl tunnel walls, which may have been deposited as a byproduct of fungal metabolism of the phosphates in the bone. Our histological findings and the elemental composition of the Wedl tunnel structures suggests evidence of fungal decomposition in a Permian-aged bone

Technical Session XIII (Friday, November 1, 2013, 1:45 PM)

A NEW OSTEICHTHYAN FROM THE LATE SILURIAN OF YUNNAN, CHINA AND THE OLDEST GNATHOSTOME-DOMINATED VERTEBRATE FAUNA

CHOO, Brian, IVPP, Beijing, China; ZHU, Min, IVPP Academia Sinica, Beijing, China; QU, Qingming, Uppsala University, Uppsala, Sweden; YU, Xiaobo, Kean University, Milburn, NJ, United States

The Late Silurian (Ludlow) Kuanti Formation at Qujing, Yunnan offers a priceless glimpse

into early gnathostome evolution. Ongoing fossil discoveries have revealed a marine fauna with a hitherto unsuspected diversity of pre-Devonian jawed fishes, including the oldest articulated osteichthyans. These fossils offer insights in the origins and early divergence of the bony fishes and have greatly reduced the morphological gaps between the major osteichthyan lineages (actinopterygians and sarcopterygians).

A newly prepared partial postcranium from the Kuanti Formation represents a novel taxon of bony fish. The specimen displays a combination of scale and dermal surface

features that ally it with the contemporaneous *Guiyu oneiros* and *Psarolepis romeri*, taxa that are resolved in different analyses as either stem-osteichthyans or very primitive sarcopterygians. The three Kuanti osteichthyans share large spine-bearing pectoral girdles and dorsal plates, combined with a placoderm-like dermal pelvic girdle, the only known crown-gnathostomes to possess this archaic structure. The new fish has coarse enamel ridges covering all dermal surfaces, with large surface pore openings present on the dermal bones and ridge scutes, but absent from the scales. The rhombic scales combine the the ridged ornament of *Guiyu* with a prominent neck separating the crown and base, as seen in *Psarolepis*. The anterior flank scales of the new fish are striking, being exceptionally tall and displaying, in addition to the typical early osteicthyan peg-and-socket articulation, a separate dermal interlocking system.

The abundance and diversity of fossil gnathostomes from the Late Silurian of Yunnan alludes to a high degree of trophic specialization in these animals well before the advent of the Devonian "Age of Fishes". The South China block may well have been one of the earliest centers of diversification for the jawed vertebrates.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NON-ANGUIMORPH LIZARDS FROM THE LATE OLIGOCENE AND EARLY MIOCENE OF NORTHERN FLORIDA, USA AND IMPLICATIONS FOR NEW WORLD SQUAMATE BIOGEOGRAPHY

CHOVANEC, Kevin, East Tennessee State University, Johnson City, TN, United States, 37614; SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, United States; MEAD, Jim, East Tennessee State University, Johnson City, TN, United States

Five paleokarst deposits from the medial Arikareean (Brooksville 2, Buda, Live Oak, and White Springs) and early Hemingfordian (Miller) of northern Florida preserve undescribed herpetofaunal remains. Here we describe and discuss the non-anguimorph lizard diversity from the two most fossiliferous localities, Brooksville 2 and Miller, and comment on the paleobiogeographic significance of all five. Preliminary identifications indicate that taxa present at Brooksville 2 include an anole, specimens referable either to *Leiocephalus* or the subfamily Iguaninae, an iguanid of uncertain phylogenetic affinities, a scincid, a gekkotan, and a rhineurid amphisbaenian. The Miller site preserves an anole, a corytophanine closely resembling *Basiliscus*, a diminutive phrynosomatine, an iguanine, a scincid, and a “cnemidophorine” teiid. Although anoles from Brooskville 2 and Miller represent two distinct taxa, both appear to lie outside the modern *Anolis carolinensis* subgroup radiation. Fossils from Brooksville 2 highlight the difficulties in distinguishing *Leiocephalus* from some iguanines based on dentaries alone, and we agree with other authors who have suggested previous records of *Leiocephalus* in the continental United States may be unreliable. Scincids from both sites compare favorably with modern *Plestiodon*. Their presence at Brooksville 2, if confirmed, would represent an early occurrence of the genus. Although fossils of rhineurid amphisbaenians are known from the Paleogene and early Neogene of much of mid-continental and western North America, their occurrence in the Arikareean of Florida represents a substantial temporal range extension within the confines of a highly restricted present-day geographic distribution. The conspicuous absence of “cnemidophorine” teiids from all four Arikareean sites, their sudden appearance in the Hemingfordian at Miller and in the previously described Thomas Farm local fauna, and their persistent presence in all subsequent North American Land Mammal Ages lend paleontological support to molecular estimates suggesting an early Miocene date of an intercontinental dispersal event of the group into North America. Our results indicate that at least some “tropical” lizard taxa with more northerly distributions in the Eocene (e.g., polychrotines and corytophanines) lingered at lower latitudes in the United States well after the climatic deterioration of the early Oligocene, and that southeastern herpetofaunas were not yet modern in composition by the early Miocene.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ISOTOPIC INDICATORS OF MONSOON-INDUCED TERRESTRIAL ECOSYSTEM CHANGE IN THE TURKANA BASIN, KENYA: IMPLICATIONS FOR THE FOSSIL RECORD

CHRITZ, Kendra, University of Utah, Salt Lake City, UT, United States, 84112; CERLING, Thure, University of Utah, Salt Lake CIty, UT, United States

Variation in the strength of the East African monsoon, resulting from climate change due to Milankovitch forcing, is often cited as an important driver of mammalian evolution in the tropics. However, the response of East African terrestrial ecosystems to changes in the monsoon system is not well understood. Stable isotope analysis of mammalian tooth enamel is used to investigate the impact of changing insolation during the Holocene (11.5 Kya–present) on local climate and terrestrial ecology in the Turkana Basin, Kenya. We present paleoenvironmental reconstructions using δ13C and δ18O of mammalian tooth enamel from archaeological sites spanning the early Holocene “strong monsoon” period to the later Holocene “weak monsoon” period. Initial results indicate a distinct humid-to-arid climatic change, in accordance with insolation forcing and proxies from other sites in East Africa, as well as a floral change showing an increase in C_3 diet component in more arid periods. These data are relevant for understanding East African climatic and ecological variability in the past at high resolution, and can inform interpretations of isotope data from mammalian tooth enamel in older sequences in light of orbital forcing and issues of temporal resolution. Finally, this analysis highlights potential blurring of ecological information that may characterize older faunal assemblages in the fossil record.

Technical Session XV (Saturday, November 2, 2013, 9:00 AM)

EVIDENCE FOR PIERCE FEEDING IN *ENALIARCTOS* (CARNIVORA, PINNIPEDIMORPHA) FROM TOOTH SPACING AND CROWN SIZE

CHURCHILL, Morgan, University of Wyoming, Laramie, WY, United States, 82070; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, United States

Loss of oral processing of prey is prevalent among carnivorous marine mammals, including all extant pinnipeds (seals and walruses). It is unclear, however, when loss of oral processing first occurred within pinnipeds. Associated with changes in mastication are simplification of tooth crown morphology, an increase in homodonty, and an increase in spacing of the postcanine teeth. Dentitions of early diverging pinnipedimorphs such as *Enaliarctos*, show a mix of these traits, some of which are found in later diverging pinnipeds (simplified dentitions) and others in terrestrial carnivores (occlusal wear facets, complicated cusp morphology), which suggests that *Enaliarctos* may have possessed a form of oral processing intermediate between fissiped and pinniped carnivorans. Our study examined the evolution of oral processing within arctoid carnivorans by examining the tooth spacing and crown size of over 300 carnivorans, representing all extant families of arctoid carnivore and nearly every species of extant pinniped, as well as *Enaliarctos emlongi*. Contributions of tooth spacing and crown length to tooth row length were also analyzed using Principal Components Analysis (PCA) to define a tooth morphospace for arctoid carnivorans. In agreement with prior studies, *Enaliarctos* dentition had characteristics in common with both fissiped and pinniped carnivorans: limited tooth spacing as seen in fissipeds, postcanine sizes between those typical of fissiped and pinniped carnivores, and reduced heterodonty characteristic of pinnipeds. PCA of tooth characters clearly segregated fissiped and pinniped carnivores, indicating that loss of oral processing was the main driver of morphospace segregation. Surprisingly, when *Enaliarctos* was included in this analysis, it did not plot between these two groups, but was instead placed firmly within the pinniped cluster. Our study provides evidence that mastication was lost early in pinniped phylogeny and suggests that further changes in tooth spacing and crown size are likely related to the loss of functional constraints on mastication. We also found that variation in tooth size and spacing may be a simple and effective metric of oral processing abilities of mammals, and may provide important insight on the evolution and loss of oral processing in other mammalian taxa.

Technical Session I (Wednesday, October 30, 2013, 12:00 PM)

DREPANOSAURS IN THE DESERT: MULTIPLE SKELETONS OF A NEW DREPANOSAURID FROM THE EOLIAN NUGGET SANDSTONE (?LATE TRIASSIC - EARLY JURASSIC), SAINTS AND SINNERS QUARRY, UTAH: MORPHOLOGY, RELATIONSHIPS, AND BIOSTRATIGRAPHIC IMPLICATIONS

CHURE, Daniel, Dinosaur National Monument, Jensen, UT, United States, 84035; BRITT, Brooks, Brigham Young Univ, Provo, UT, United States; ENGELMANN, George, Univ of Nebraska Omaha, Omaha, NE, United States; ANDRUS, Austin, Brigham Young Univ, Provo, UT, United States; SCHEETZ, Rodney, Brigham Young Univ, Provo, UT, United States

Drepanosaurids are enigmatic diapsids from the Late Triassic of Asia, Europe, and North America. Their remains have been found in floodplain, fissure fill, rift valley lacustrine, and carbonate platform island settings. Here we report on a new form from the Nugget Sandstone based on multiple three-dimensional, articulated skeletons with disarticulated skulls, found lying side-by-side. They provide significant new insight into the morphology and ecology of the group.

The new taxon combines diagnostic features of other drepanosaurids (*Dolabrosaurus*, *Megalancosaurus*, and *Drepanosaurus*.) The Nugget form is most closely related to *Drepanosaurus*. Synapomorphies with that genus include 1) short, plate-like ulna, 2) greatly elongated radiale and ulnare replacing the ulna and forming part of the forearm, 3) hypertrophied manual ungual II. Striking autapomorphies of the new taxon are 1) large maxillary and dentary teeth reminiscent of *Trilophosaurus* in being tall, much wider than long, and bearing small labiolingually arranged apical cusps, 2) manual digit I opposable and bearing hypertrophied ungual at least as large as that on II, 3) large, well defined pleurocoels on posterior dorsal centra, 4) dorsal vertebrae prezygapophyses fused into a narrow, midline process at the neural spine base. Striking dimorphism is seen in the pes, with an abbreviated opposable digit I in some specimens but not others. This dimorphism is not ontogenetic but may be sexual.

Drepanosaurids are generally viewed as arboreal and chameleon-like, but many specializations in the Nugget taxon (and *Drepanosaurus*) are similar to adaptations for burrowing and digging in extant small mammals and suggest a similar habit. In addition, these are the first drepanosaurids from an erg environment, indicating drepanosaur ecology was more diverse than previously envisioned.

The age of the Early Jurassic erg deposits in western North America is poorly constrained due to lack of age diagnostic fossils or datable crystals. The Saints and Sinners Quarry is approximately 55 m above the base of the eolian part of the Nugget, within interdunal sediments situated between large cross-bedded eolian packages. Elsewhere, drepanosaurids are restricted to the Late Carnian through Late Norian. These Nugget drepanosaurids suggest that either a significant part of the formation is Triassic or that the group extended into the Jurassic. In either case, the Nugget material is likely the geologically youngest record of the group.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DESCRIPTION OF NINE NEW SPECIMENS OF *MOURASUCHUS NATIVUS* (ALLIGATOROIDEA, CAIMANINAE), AND COMMENTS ON ONTOGENETIC DEVELOPMENT AND INTRASPECIFIC VARIATION OF THE SKULL TABLE

CIDADE, Giovanne, Universidade de São Paulo, Ribeirão Preto, Brazil; RIFF, Douglas, Universidade Federal de Uberlândia, Uberlândia, Brazil; SOUZA-FILHO, Jonas Pereira, Universidade Federal do Acre, Rio Branco, Brazil; HSIOU, Annie Schmatlz, Universidade de São Paulo, Ribeirão Preto, Brazil; MONTEFELTRO, Felipe, Universidade de Sao Paulo, Ribeirao Preto, Brazil

The South American endemic Miocene crocodilian group *Mourasuchus* is characterized by a unique long, broad and dorsoventrally flattened skull. *Mourasuchus nativus* was originally described based on skull tables of the Argentinean Miocene deposits of the Ituzaingó Formation. Among the four species of the genus, *M. nativus* has a more unusual skull, with a highly hypertrophied squamosal forming a "horn" and a well marked medial crest in the parietal bone, which are both also considered autapomorphies of the species. We present a preliminary description of nine new partial skulls of *M. nativus* (five juveniles, one subadult and three adults) from the Late Miocene Solimões Formation of Brazil. The new specimens offer new insights into the morphology of these traits based on morphometric analysis of the squamosal, which was performed by measuring the hypertrophies in three dimensions: anteroposterior thickness, lateromedial width and dorsoventral height. We found that the "horns" have two growth stages during ontogenetic development: they grow first in width and thickness, and secondly in height. These results argue against a hypothesis of sexual dimorphism to explain these differences in the squamosal size of this species. The parietal crest, in its turn, does not show the morphology originally described in all specimens; in fact, in five of them, the crest is represented only by a slight, rounded salience. This may indicate that the presence of the parietal crest has individual variation, although the hypothesis that this feature may be the result of taphonomic processes is not excluded. In addition, one of the new specimens (Universidade Federal do Acre UFAC-2515) preserved the caudolateral bridge of the laterosphenoid, a structure that separates the maxillary and mandibular nerves of the exit of the trigeminal ganglion, and may represent a neomorphy in the crocodilian braincase. In the context of these results, the present work offers an in depth analysis of skulls of *M. nativus* from Brazil for the first time, and may shed light on the anatomy, physiology and phylogenetic position of this species and the genus *Mourasuchus*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC UTILITY OF HADROSAURID DINOSAUR (ORNITHISCHIA: ORNITHOPODA) INTEGUMENTARY IMPRESSIONS

CLAYTON, Katherine, Natural History Museum of Utah, Salt Lake City, UT, United States, 84108; LOEWEN, Mark, Univ of Utah, Salt Lake City, UT, United States; IRMIS, Randall, Univ of Utah, Salt Lake City, UT, United States

Hadrosaurid dinosaur integumentary impressions are known from Late Cretaceous sites in Asia (Mongolia) and along the east coast of Laramidia (western North America) from New Mexico to Canada. Once considered rare, these skin impressions are now frequently recognized during excavation and preserved, resulting in a more complete understanding of the superficial anatomy of hadrosaurids. We surveyed all reported occurrences of integumentary impressions, including newly discovered specimens from southern Utah, with a focus on those assignable to a position on the body through osteological association. We assessed morphological variation across body regions and between taxa to determine whether skin impressions display taxonomically informative characters.

Adult hadrosaurid integumentary structures comprise non-imbricating polygonal to rounded tubercles. The hadrosaurines *Gryposaurus*, *Saurolophus*, and *Edmontosaurus* possess corrugated tubercles ornamented with ridges, which are not present in the hadrosaurine *Brachylophosaurus* or the lambeosaurines *Lambeosaurus* and *Corythosaurus*. Distinct tubercle patterns (contrasting bands or clusters of similarly sized tubercles) are present in the hadrosaurines *Edmontosaurus*, *Saurolophus angustirostris*, and *S. osborni*. The trunk of *Corythosaurus* and tail of *Lambeosaurus*, *Gryposaurus*, and *S. osborni* have graded tubercle size distributions. Average tubercle diameter increases distally in the tail of *Gryposaurus*, whereas it decreases in size in *Lambeosaurus* and *S. osborni*. Tubercles from the forelimbs of *Edmontosaurus* and *Brachylophosaurus* are larger (~10 mm in diameter) than tubercles from axial regions. Discrete oversized tubercles (>1 cm in diameter) are present in all species except *Edmontosaurus* and *Brachylophosaurus*, with the largest (~4 cm) in *Corythosaurus*, *Lambeosaurus*, and *S. osborni*. These oversize tubercles are randomly dispersed except in *Corythosaurus*, which has parallel rows across the abdomen. Large, midsagittal features may be the most taxonomically informative; they include folded frills from *Corythosaurus* and *Edmontosaurus annectens* (Wyoming), segmented frills from *S. angustirostris* and *Edmontosaurus sp.* (Montana), ovoid raised scutes in *Gryposaurus notabilis* (Alberta), and heart-shaped raised scutes from *Gryposaurus sp.* (Utah). Because tubercle morphology is similar among hadrosaurines, distinctive patterns and larger features are the most systematically informative features.

Technical Session XV (Saturday, November 2, 2013, 9:15 AM)

ESTIMATING THE STRENGTH OF SIRENIAN AND SEAGRASS ASSOCIATIONS OVER THE CENOZOIC THROUGH PHYLOGENETIC AND STABLE ISOTOPE ANALYSES

CLEMENTZ, Mark, University of Wyoming, Laramie, WY, United States, 82071; VELEZ-JUARBE, Jorge, Smithsonian Institution, Washington, DC, United States

Seagrasses are important primary producers in coastal areas, providing food and shelter for consumers in shallow, oligotrophic waters. Sirenians (manatees, dugongs, sea cows) are primary consumers of seagrasses today, and their fossils are commonly used as proxies for ancient seagrass meadows. Prior stable isotopic and sedimentalogical evidence support a close association between sirenians and seagrasses since the middle Eocene, but the initiation and extent of this association have not been resolved. Here, we have combined previously reported and newly acquired stable isotope evidence with a new phylogenetic analysis of Sirenia to provide a better estimate of when this relationship was established and whether certain clades of sirenians increased their preference for seagrasses over time. Carbon isotope values for tooth enamel from fossil and extant sirenian species (n = 166) were compiled and combined with new material from USA and Israel. The dataset comprised representatives of all major families of sirenians as well as extensive sampling of three subfamilies (Dugonginae, Halitheriinae, Trichechinae). Enamel $\delta^{13}C$ values were converted to estimates of seagrass contribution to diet using the programs IsoError v1_04 and SIAR after correcting values to account for variation in $\delta^{13}C$ values due to latitude and for variation in the carbon isotopic composition of atmospheric CO_2 through the Cenozoic. Diet estimates were then incorporated into a new sirenian phylogeny using the program Mesquite. Our results show a clear association between sirenians and seagrasses since the early Eocene; for over 90% of the specimens sampled, including members of the most basal family Prorastomidae, seagrasses were estimated to make up over 50% of the diet. Within later diverging clades, dugongines showed the greatest preference for seagrasses (mean = 95 ± 7%), whereas halitheriines (mean = 76 ± 17%) and trichechines (mean = 58 ± 31%) were found to have consumed seagrasses less often and more variably. These differences in seagrass consumption support hypotheses of niche partitioning among sympatric species in the past. The demise and decrease in diversity of these large seagrass consumers, in particular the dugongines, in the late Neogene, doubtless led to changes in the community structure of seagrass meadows which we are now only beginning to understand.

Technical Session I (Wednesday, October 30, 2013, 8:00 AM)

A NEW PIECE OF THE DEVONIAN FISH-TO-TETRAPOD PUZZLE: THE DISCOVERY OF A COMPLETE SPECIMEN OF *ELPISTOSTEGE*

CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QC, Canada, G5L 3A1; BÉCHARD, Isabelle, Université du Québec à Rimouski, Rimouski, QC, Canada

Recent hypotheses on the origin of tetrapods rely heavily on the anatomy of only a few tetrapod-like fossils from the Middle-Upper Devonian. These tetrapod-like taxa, referred to as elpistostegalians, constitute a paraphyletic group including *Panderichthys rhombolepis* from the late Givetian of Latvia, *Elpistostege watsoni* from the middle Frasnian of Quebec, and *Tiktaalik roseae* from the early-middle Frasnian of Arctic Canada. Although of uncertain phylogenetic position, *Gogonasus andrewsaea* from the early Frasnian of Western Australia and *Livoniana multidentata* from the late Givetian of Latvia and Estonia have also been suggested to be closely related to elpistostegalians. With the exception of *Livoniana* (fragments of lower jaw) and *Elpistostege* (two partial skulls and a small trunk segment), the anatomy of *Panderichthys* and *Tiktaalik* is fairly well documented. The recent discovery of a 1.56 m-long, completely articulated specimen of *Elpistostege watsoni* from the Escuminac Formation (Miguasha) is filling out a major gap of anatomical information with respect to the fish-to-tetrapod transition. *Elpistostege* has elongated trunk and caudal regions with oversized pectoral fins. A high-energy CT-scan investigation of the complete specimen reveals internal cranial and paired fin anatomy. This makes it the most complete elpistostegalian known allowing us to reinvestigate its phylogenetic position. *Elpistostege* is unambiguously more closely related to *Tiktaalik* and early tetrapods than to *Panderichthys*.

Symposium 3 (Friday, November 1, 2013, 11:30 AM)

NEW MAGNETOSTRATIGRAPHIC AND RADIOISOTOPIC RESULTS FROM THE RÍO CHICO GROUP IN THE LAS FLORES AREA OF THE SAN JORGE BASIN (PATAGONIA, ARGENTINA); IMPLICATIONS FOR THE TEMPORAL CALIBRATION OF PALEOGENE SOUTH AMERICAN LAND MAMMAL AGES

CLYDE, William, University of New Hampshire, Durham, NH, United States, 03824; BARNUM, Timothy, University of New Hampshire, Durham, NH, United States; KRAUSE, J. Marcelo, Museo Paleontológico Egidio Feruglio (CONICET-UNPSJB), Trelew, Argentina; IBAÑEZ-MEJIA, Mauricio, University of Arizona, Tucson, AZ, United States

The Río Chico Group in the San Jorge Basin of Patagonia (Argentina) preserves some of the most important records of Paleogene biotas in South America. The Itaboraian and Riochican South American Land Mammal Ages (SALMAs), and the less well defined "*Carodnia Zone*", are based, at least in part, on fossil assemblages collected from the Río Chico Group. The precise age of the Río Chico formations, and thus their faunas, is poorly resolved making it difficult to know how Paleogene SALMAs correlate to the geological timescale and to land mammal age frameworks on other continents. For instance, it is not known whether Paleogene mammalian turnovers in the southern hemisphere coincided with those in the holarctic. Precisely dating these units is hindered by the fact that the mammal faunas themselves are highly endemic and the deposits are exposed across ~300 km distance, creating the possibility for significant diachroneity from one part of the basin to the other. Here we report new paleomagnetic and geochronological results from the Río Chico Group in the Las Flores area of the western San Jorge Basin. We collected 171 paleomagnetic samples from 40 sites within a 115 meter stratigraphic section spanning the upper Peñas Coloradas, Las Flores and Koluel Kaike formations of the Río Chico Group. Measurements of dual frequency magnetic susceptibility, three-axis isothermal remanent magnetization, and characteristic remanent magnetization via step-wise demagnetization were used to develop a reliable magnetostratigraphy for this section. Four apparent volcanic ashes were also sampled from the section (in addition to one more from a nearby section) for U/Pb dating using laser ablation HR-MC-ICP-MS. Magnetostratigraphic results show that the upper Peñas Coloradas Fm. is characterized by reversed polarity with a change to normal polarity within the base of the Las Flores Fm. The Las Flores Fm. is characterized by normal

polarity, however many of the samples in this part of the section exhibited superparamagnetic behavior and thus did not provide a reliable polarity determination. Samples from the Koluel Kaike Fm. exhibited very stable paleomagnetic behavior and clearly record three polarity reversals in that unit. These magnetostratigraphic results will be combined with the new U/Pb ages and recent chronostratigraphic results from the underlying Salamanca Formation to correlate the Río Chico units to the Geomagnetic Polarity Timescale and better constrain the correlation of the associated SALMAs to land mammal age frameworks on other continents.

Technical Session XIII (Friday, November 1, 2013, 3:30 PM)

WARDIE NODULES UNPACKED: COMPUTED TOMOGRAPHIC INVESTIGATION OF NEWLY RECOGNIZED SPECIMENS OF *TRISTYCHIUS*, A PIVOTAL TAXON IN CHONDRICHTHYAN PHYLOGENY

COATES, Michael, University of Chicago, Chicago, IL, United States, 60637; CRISWELL, Katharine, , Chicago, IL, United States; VERNER, Ellen, University of Chicago, Chicago, IL, United States

Clay-ironstone nodules have been collected from the Wardie Shales of the Viséan Lower Oil Shale Group (Edinburgh, Scotland) since the early 19th century. These nodules have yielded numerous fishes, some of which are preserved almost three-dimensionally intact. However, most specimens are pyritized and mechanical preparation is difficult. Wardie chondrichthyans found by the Scottish fossil collector Mr. S. P. Wood in the early 1970s formed the basis of John Dick's classic study of early sharks. At that time, certain nodules were left unprepared, anticipating future, less destructive techniques. A CT-scan of one such nodule, catalogued in 1974 as containing a ctenacanth, has revealed the near complete, articulated skeleton of the gill arches, jaws, braincase and part of the pectoral girdle of *Tristychius arcuatus*: an anomalous dogfish-like species of uncertain phylogenetic affinities. This discovery prompted further exploratory CT-scans of Wardie nodules, including uncatalogued material collected in 1870 as well as several specimens studied by Dick. Results contribute to significantly enhanced data coverage of the *T. arcuatus* neurocranium, corroborating Dick's reconstruction, but showing that estimated proportions are dorsoventrally too compressed. New data also reveal a hybodont-like otico-occipital region with paired dorsal ridges flanking an occipital crest; an elaborate articulation area for the palatoquadrate exposed on the ventral face of the postorbital process; that the postorbital process joins the braincase anterior to the otic capsule; that the otic labyrinth is separated from the main endocranial cavity by a median capsular wall. Recent phylogenies place *T. arcuatus* close to the base of, and perhaps external to, the chondrichthyan crown clade, indicating that it lacks synapomorphies uniting holocephalans and early neoselachians. Data presented here show that *T. arcuatus* is markedly neoselachian: it belongs within the chondrichthyan crown. Moreover, the quality of data now available on *T. arcuatus* underlines the specialized skeletal anatomy of this early Mississippian selachian. Finally, Wardie nodules re-examined under (literally) a new light show that this long-known locality is a potentially rich source of data on early chondrichthyans in the post-Devonian world.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

CONTRIBUTION OF THE SHUNGURA FORMATION (3.6 MA - 1.05 MA) TO EASTERN AFRICAN EQUID EVOLUTION AND PALEODIET

COILLOT, Tiphaine, Université de Poitiers, Poitiers, France; BERNOR, Raymond, Howard University, Washington, DC, United States; BOISSERIE, Jean-Renaud, CNRS / Université de Poitiers, Poitiers, France

The eastern African fossil equid record is undergoing a major systematic revision. African equids are first known to occur in Algeria and Ethiopia at 10.5 Ma. Hipparions became endemic in Africa by the very latest Miocene with the genus *Eurygnathohippus* that had undergone a radiation in the Plio-Pleistocene. In eastern Africa, the late Miocene Lothagam sequence includes "*Sivalhippus*" *turkanensis* and *Eurygnathohippus feibeli* (7.4 Ma - 6.0 Ma). The Middle Awash sequence exhibits gradual evolution in the *Eu. feibeli* lineage from 5.8 Ma - 4.9 Ma. At Aramis, *Eurygnathohippus* n. sp. is evolutionarily intermediate between *Eu. feibeli* and Hadar *Eu. hasumense* (3.6 - 3.0 Ma). Hipparionines coexisted with *Equus* that appeared in Africa around 2.3 Ma and evolved into a diverse, pan-African clade. This first sub-Saharan apparition of *Equus* is recorded in the Shungura Formation, Ethiopia (noted below "SF") that has the most continuous and precisely dated fossiliferous section in Africa from 3.6 Ma to 1.05 Ma. Divided into 13 members and 101 stratigraphic units, it recorded dramatic climatic changes and faunal responses. SF hipparion sequence is critical for eastern Africa equid studies, due to the very high precision of its chronostratigraphic frame. It includes *Eu.* aff. *hasumense*, the *Eu.* "*ethiopicus*" - *Eu. cornelianus* lineage, and likely a smaller hipparionine species. Hooijer recognized only one species of *Equus*, *Eq. oldowayensis*, whereas Eisenmann identified at least 4 different species of *Equus* from Members G to L (2.27 Ma - 1.05 Ma). We present herein a preliminary revision of SF equid systematics and evolution. This revision is in part grounded on the discovery of new material by the Omo Group Research Expedition. It should ultimately enable us to fully assess the equid chronostratigraphy for eastern Africa, based on correlations of equid evolutionary events between the SF and other major sites, in particular the Middle Awash sequence that has yielded an exceptional hominid record. The SF notably records global climatic changes around 2.8 Ma according to several studies, including recent ones involving bovids and suids. In the near future these data will be compared to those derived from equids, thanks to further analyses on mesowear and microwear combined with isotopic data.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ACCOUNTING FOR SAMPLE SIZE BIASES IN ANALYSES OF ONTOGENETIC SEQUENCES

COLBERT, Matthew, The University of Texas at Austin, Austin, TX, United States, 78712-1722; MORRIS, Zachary, The University of Texas at Austin, Austin, TX, United States

It has long been known that the resolution of hypothesized ontogenetic sequences within a taxon or population depends largely on the sample size of specimens and the number of considered events. In general, is it theoretically impossible to garner complete resolution (i.e., the position of every event resolved relative to every other event) unless one has more sampled individuals than events. Typically one needs to include considerably more individuals than events: because multiple individuals can represent the same semaphoront (i.e., the state of event transformations for considered events at a particular instant), and because event-order can be variable (the basis of sequence evolution). Inadequate sampling leads to predictable consequences that serve as a rationale for judging the robustness of hypotheses of sequence order within a taxon or population, as well as for the advisability of sequence comparison between taxa or populations.

Ontogenetic Sequence Analysis (OSA) is one method that can help identify the adequacy of sequence resolution - pinpointing under-sampled regions of 'sequence-space' (these regions generally correspond to particular levels of maturity). Knowledge of under-sampled regions of sequence space not only informs the suitability of sequence comparison between taxa, but presents a rationale for targeted sampling to address the identified sampling biases. The impact of inadequate sampling to sequence comparison between taxa is also predictable, having two main effects related to sample size. First, gross under-sampling results in the application of an 'average' sequence position to unresolved events that essentially inappropriately assumes that characters are synchronous. Second, sample biases that are less severe tend to mask the occurrence of sequence polymorphism, potentially leading to incorrect assumptions about fixed sequence order differences between taxa. This problem is compounded when the different taxa being compared are all under-sampled, as is generally the case in paleontology and often in developmental biology. This is not to say that attempts to establish ontogenetic sequences are futile with limited samples, but rather that the effect of sampling on results needs to be evaluated and considered in every analysis. An estimation of the topological differences in ontogenetic sequence space is considered the most promising avenue for development of a method that can interpret ontogenetic sequence evolution while accounting for sequence sampling artifacts.

Technical Session V (Wednesday, October 30, 2013, 3:00 PM)

SKELETON OF A HEAVILY ARMORED AND LONG LEGGED MIDDLE JURASSIC LIZARD (SQUAMATA, REPTILIA)

CONRAD, Jack L., NYIT College of Osteopathic Medicine, Old Westbury, NY, United States, 11568; WANG, Yuan, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; PYRON, Alexander, George Washington University, Washington, DC, United States; CLARK, James, George Washington Univ, Washington, DC, United States

The last three decades has seen a dramatic increase in our knowledge regarding the earliest evolution of the major squamate clades, but most known fossils are Cretaceous or younger. The earliest known squamates are the incompletely known *Parviraptor*, Eichstaettisauridae, *Ardeosaurus*, and the Paramacellodidae with their osteodermal armor. We report on a new late Middle Jurassic lizard from the Shishugou Formation of China representing the oldest complete squamate skeleton. The animal possesses vomerine teeth, a rectangular frontal, and incipient cusps on its marginal teeth. The preserved hind limb is very elongate. The entire body was encased in osteoderms. Cranial osteoderms are large and platelike dorsally, but small and rounded ventrally. The postcranial osteoderms are rectangular, noncompound, and overlapping. Those on the tail show mediolateral fusion across the midline such that many rows have five or more fused osteoderms. Our phylogenetic analysis of 836 morphological characters along with molecular data (RAG1, BDNF, and Cmos; 4591 base pairs) surveyed 175 lepidosauriform species. Molecular data were were downloaded from GenBank for 22 exemplar species from across the tree, including *Sphenodon* and 21 squamates. The resultant phylogenetic hypothesis finds a "gecko-morphotype" (unarmored, relatively large-eyed, morphs with limbs of intermediate length and simple, insectivore-style teeth) to be ancestral for squamates. Our new lizard is recovered as a basal episquamate, related to lateratans, anguimorphs, and iguanomorphs. The Late Jurassic saw the rise of therian mammals and coelurosaurian dinosaurs. At the same time, squamates enter the fossil record in both the gecko-morphotype and armored forms (e.g., *Paramacellodus* and our new taxon). We suggest that the selective pressure from this changing fauna may have helped "push" squamates into new morphotypes. Many known Late Jurassic and Cretaceous episquamates possess long legs (e.g., *Bavarisaurus*, *Saichangurvel*) and/or extensive osteodermal armor (e.g. *Paramacellodus*). These pressures may have contributed to the marginalization of the previously diverse and widespread rhynchocephalians.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

HYSTRICOGNATHOUS RODENT ASSEMBLAGE FROM A NEW EARLY OLIGOCENE VERTEBRATE LOCALITY: ZALLAH 7, SIRT BASIN, LIBYA

COSTER, Pauline, Carnegie Museum of Natural History, Pittsburgh, PA, United States, 15213; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, United States; CHAIMANEE, Yaowalak, Université de Poitiers, Poitiers, France; SALEM, Mustafa, University of Tripoli, Tripoli, Libya; JAEGER, Jean-Jacques, Univ of Poitiers, Poitiers Cedex, France

Several fossiliferous sites have been documented in the Oligocene 'Continental and Transitional Marine Deposits' in the vicinity of Zallah Oasis, southern Sirt Basin, central Libya. The Paleogene sequence exposed in this area corresponds to nearshore to continental late Paleogene sediments overlying the marine Eocene Wadi Thamat Formation. The survey conducted in January 2013 near Zallah resulted in the discovery of several new localities. Our most productive locality, Zallah 7, which is also called the Incision Locality, has yielded a diverse vertebrate fauna including sharks, rays, bony fishes, crocodilians, sirenians, hyracoids, an anthracothere, a parapithecid anthropoid, a miacoid carnivoran and hystricognathous rodents.

About 200 micromammal teeth have been recovered after screenwashing the fossiliferous level. Among the more common mammals represented at Zallah 7 are primitive members of the rodent clade Hystricognathi. Here we document the presence of two genera and species of early phiomorph rodents (*Metaphiomys* and *Neophiomys*) on the basis of numerous isolated teeth. Surprisingly, the Gaudeamuridae, a distinctive clade of early African hystricognaths that is abundantly represented at the nearby Zallah 5R Locality, are not yet represented at our new locality. Zallah 7 has produced isolated teeth of *Metaphiomys schaubi*, which is also known from the Jebel Qatrani Formation in Fayum (Egypt), where it ranges from Lower Sequence Quarries E, B to quarry G of the Upper Sequence. Specimens of *Neophiomys paraphiomyoides*, similar in size and morphological pattern to the Libyan ones, were described at Quarry G of the Upper Sequence in Fayum. A similar assemblage of phiomorphs has been described from the Taqah Locality in Oman and from the nearby Fejfar Locality in the Sirt Basin, dated from the Rupelian based on foraminiferal *(Bolivina meletica, Nummulites fichtelli*) and selachian assemblages.

The new Libyan locality combines taxa (rodents, primates, and others) that are typical of the Jebel Qatrani upper sequence, in particular Quarries G and V (31-32 Ma). Given the regional scarcity of sites of this age, the richly fossiliferous Paleogene terrestrial deposits in the Zallah area may prove critical for understanding the biogeography and evolutionary history of rodents and other vertebrates in Afro-Arabia.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DRAG FORCES AND WAKE PRODUCTION IN THE SPINE BRUSH COMPLEX OF STETHACANTHID SHARKS

CRISWELL, Katharine E., University of Chicago, Chicago, IL, United States, 60637; COATES, Michael I., University of Chicago, Chicago, IL, United States; LABARBERA, Michael, University of Chicago, Chicago, IL, United States

The enigmatic "spine brush" projecting from the dorsal surface of Paleozoic stethacanthid sharks is composed of a broad, dentinous spine, and a rigid, dorsally expanded bundle of calcified cartilage fibers supporting a closely-packed platform of monocuspid denticles with extended crowns. Unsurprisingly, this structure has long been a subject of interest and speculation, resulting in suggestions that it might have functioned as a defense mechanism or as a remora-like hitching device, and/or served as a sexual display. Irrespective of these possible roles, it has been hypothesized that this large outgrowth produced considerably more drag than a conventionally shaped dorsal fin, raising questions about the possible handicap to the spine brush bearer. In order to determine how biomechanically costly the spine brush actually was we built models based on the measurements of the spine brush of the stethacanthid shark *Akmonistion zangerli*. These models were propelled through still water in a large towing tank at speeds of one half meter per second and one meter per second. We used a force transducer with four strain gauges to measure the drag forces generated by the spine brush, and compared those measurements to the forces produced by a generalized dorsal fin. The wake generated by the spine brush and the fin was visualized by recording video of the fin models moving through fluorescein and rhodamine dye trails. Unexpectedly, our results refuted the hypothesis: drag measurements were only slightly higher for the spine brush than for the model dorsal fin. The wake generated by the conventional dorsal fin showed asymmetrical vortex production in the form of a Von Kármán vortex street, but the wake of the spine brush complex was wider, comprising simultaneously shed vortex pairs, which is consistent with the higher drag values measured. Stethacanthid fossils are known from deposits ranging from the Devonian to the Permian, suggesting that this clade persisted successfully for approximately 180 million years, despite having a drag-inducing dorsal fin. So although the spine brush does increase drag, the negative effect was not substantial enough to impact the fitness and longevity of this group. This study is the first to actually test the functional consequences of the spine brush, and highlights the potential for empirical tests of function in paleontological specimens.

Technical Session IV (Wednesday, October 30, 2013, 1:45 PM)

NEW SPECIES, LOCAL FAUNAS, AND PALEOENVIRONMENTAL DATA FOR THE MIDDLE MIOCENE QUEBRADA HONDA FAUNA, BOLIVIA

CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States, 44106-4930; ANAYA, Federico, Universidad Autónoma Tomás Frías, Potosí, Bolivia; CATENA, Angeline M., Case Western Reserve University, Cleveland, OH, United States; CIANCIO, Martín R., Museo de La Plata, La Plata, Argentina; ENGELMAN, Russell K., Case Western Reserve University, Cleveland, OH, United States

The late middle Miocene site of Quebrada Honda, Bolivia is one of the few sites in the South American tropics that has produced abundant fossil mammal remains. Our team's ongoing field research in the area has cataloged more than 700 specimens from both traditional collecting areas (Quebrada Honda, Río Rosario) and newly discovered sites. New sites are located north of Río Rosario (closer to Papachacra), 5 km northeast of Quebrada Honda, and near Huayllajara (5 km south of Quebrada Honda). We report the first ichnofossils from the area, including *Pallichnus* and *Coprinisphaera* (dung beetle brood balls) and *Celliforma* and *Cellicalichnus* (ground-dwelling bee/wasp nests), suggesting an open or wooded grassland habitat for Quebrada Honda. We also report the first birds from Quebrada Honda, a phorusrhacid and at least two other species. Sparassodonts are represented by a new very small species and a partial skeleton of *Acyon* that supports previous assertions that this species is the largest hathliacynid. Paucituberculatan remains likely pertain to three species and include the first mandibular remains of *Acdestis maddeni*. Xenarthran specimens include two new dasypodids (one eutatin, one euphractin), at least three glyptodonts (a lomaphorin, a hoplophorin, and a plohophorin), and at least four sloths (a new megatheriine, a nothrotheriid, an indeterminate megatherioid, and a mylodontid). The xenarthrans show high endemicity and appear to be most closely related species from the middle to late Miocene of low and middle latitude Argentina, Chile, and Bolivia. The first remains of chinchilline chinchillids from Quebrada Honda provide a new biogeographic link between this site, Chucal, Chile (late early Miocene), and Nazareno, Bolivia (early middle Miocene?), but chinchillines are much rarer at Quebrada Honda than at either of these other sites. The most abundant rodents at Quebrada Honda are the lagostomine chinchillid *Prolagostomus*, the caviid *Guiomys*, and the octodontoid *Acarechimys*. Among ungulates, no additional remains of the interatheriid *Miocochilius* and only two fragmentary specimens of the mesotheriid *Plesiotypotherium* have been recovered, highlighting the rarity of these taxa in the fauna. Partial macraucheniid litoptern skeletons reinforce the small size of the Quebrada Honda species relative to Santacrucian *Theosodon*. Additional ongoing research focuses on temporal correlations between localities in the Quebrada Honda area and the geological and environmental contexts in which these fossil remains were preserved.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

SYSTEMATICS OF THE 32 MY OLD AGGREGATION OF SNAKES FROM THE WHITE RIVER FORMATION: REDEFINING THE ERYCINAE WITHIN BOOIDEA

CROGHAN, Jasmine, University of Alberta, Edmonton, AB, Canada, T6J 0H6; PALCI, Alessandro, University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada; BREITHAUPT, Brent H., BLM - Wyoming, Laramie, WY, United States

A 32 million year old aggregation of snakes from the Oligocene White River Formation includes four largely complete and articulated individuals that have been considered to be erycine snakes. Detailed observations, obtained using a variety of methodologies including light microscopy and computed tomography, have resulted in the collection of invaluable new morphological data on this unique quartet of Oligocene snakes. These data permit precise interrogation of primary homology hypotheses in the current literature, leading to important changes in secondary homology statements arising post-analysis. Recoding of existing characters and character states, specifically those presented in two previous studies, has resulted in conflicting results for several obvious reasons: 1) The first data set systematized all snakes, with a terminal unit referred to as the "Erycinae" that was characterized by a large number of polymorphic character state assignments; coding the fossil taxon (White River Taxon) into this matrix found it to be in the sistergroup position to this uninformative "Erycinae". 2) The second data set was a smaller study focused on New and Old World erycines only, as well as the putative python *Calabaria*; the addition of the White River Assemblage resulted in 26 most parsimonious trees (MPTs), where the White River Taxon was in the sistergroup position to the Old World erycines in 13 trees, versus the 13 trees where the Taxon was in the sistergroup position to both Old and New World forms. Noting important problems with the uncritical inclusion of the White River Taxon into either of these data sets, we elected to modify the first data set by expanding the "Erycinae" to include the two extant genera (*Charina* and *Eryx*) to which the 13 extant species are assigned. Analysis found the Old World genus *Eryx* to be in the sistergroup position to the Booidae (pythonines and boines). A new clade formed by the White River aggregation and *Charina* was found to be the sistergroup to the clade formed by *Eryx* and the Booidae. The two MPTs of this analysis merely rearranged the relations of the two most complete White River specimens with *Charina*. These data, utilizing new information from the White River specimens, support the splitting of the uninformative "Erycinae" into two entities.

Technical Session VIII (Thursday, October 31, 2013, 3:30 PM)

RECONSTRUCTION OF THE NASAL REGION IN NON-MAMMALIAN CYNODONTS AND MAMMALIAFORMES SUGGESTS ABSENCE OF INTRANARIAL LARYNX AND A COMPROMISED COUNTERCURRENT EXCHANGE AT RESPIRATORY TURBINATES

CROMPTON, A.W., Harvard Univ., Cambridge, MA, United States, 02138; MUSINSKY, Catherine, Harvard University, Cambridge, MA, United States; OWERKOWICZ, Tomasz, California State University, San Bernardino, CA, United States

Extant mammals are characterised by a higher-than-ambient body temperature and regular breathing rate. Ability to breathe while feeding is key to supporting a high metabolic rate, which necessitates respiratory airflow via the nasal cavity. Loss of heat and water in expired air is reduced by maxilloturbinals, which provide a large surface area for temporal countercurrent exchange (CCE). Effective CCE during feeding depends on the intranarial position of the larynx, so that food is not aspirated and air does not exit via the mouth. Speculations on the origin of endothermy in advanced non-mammalian

therapsids are often based upon the presumed presence of ossified respiratory turbinates, but no study has determined the position of the larynx. We collected microCT scans to reconstruct skulls of two non-mammalian cynodonts (*Massetognathus* and *Probainognathus*) and one mammaliaform (*Morganucodon*), and infer their nasal and laryngeal anatomy. The entire nasal capsule remained cartilaginous, but ridges on the internal surface of the maxillae suggest presence of cartilaginous maxilloturbinals. All three taxa possessed a well-defined pterygoid process that maintained an intimate contact with the lower jaw. This would have prevented transverse jaw movements and ruled out the origin of trigeminal musculature from the ventral surface of the pterygoid. We conclude that the soft palate with its associated muscles was not in place to hold and seal the larynx within the nasopharynx. In the absence of an intranarial larynx, the initial role of respiratory turbinates was probably to provide an expanded surface area for evaporative cooling. Coupling of narial inspiration and oral expiration has been observed in extant mammals under ambient heat stress or during increased activity. This mechanism acts to selectively reduce brain temperature at the cost of increased respiratory evaporative water loss. The combination of a large nasal cavity, cartilaginous turbinates and pharyngeal position of the larynx suggests that non-mammalian synapsids did not breathe while feeding, but might have enjoyed elevated body temperatures during activity. Mammalian endothermy and a regular breathing rate probably arose only once the maxilloturbinals ossified, extralaryngeal musculature was differentiated and complex jaw movements were possible.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

SOLVING THE SYNONYMY ISSUE IN *CONCAVENATOR CORCOVATUS* AND *BECKLESPINAX ALTISPINAX*, TWO DISTINCT THEROPODS FROM THE LOWER CRETACEOUS OF EUROPE

CUESTA , Elena, Universidad Autonoma de Madrid, Madrid, Spain; ORTEGA, Francisco, Universidad Nacional de Educación a Distancia, Madrid, Spain; SANZ, José Luis, Universidad Autonoma de Madrid, Madrid, Spain

The record of theropod dinosaurs with long neural spines has expanded significantly in recent years, mostly within the spinosaurid and carcharodontosaurid clades. *Concavenator corcovatus* and *Becklespinax altispinax* are two representatives of long-spined theropods from the Lower Cretaceous of Western Europe. Both taxa show a comparable elongation of the neural spines of some of the last dorsal vertebrae, and, somehow, this might suggest a close relationship, or even the synonymy between the two taxa. Therefore, we compared the type material of *Becklespinax altispinax* (Natural History Museum specimen NHMUK R1828), consisting of three posterior dorsal vertebrae with the tenth, eleventh and twelfth dorsal vertebrae of *Concavenator corcovatus* (Museo de las Ciencias de Castilla-La Mancha specimen MCCM-LH 6666).

Anatomical comparison indicates the existence of substantial differences between the two taxa. *Concavenator* shows a constriction of the vertebral centra like *Neovenator* or *Acrocanthosaurus*, and clearly different from *Baryonyx* and *Becklespinax*. The neural spines of both taxa differ in their orientation, because the spines of *Becklespinax* show an anterior orientation in contrast with the spines of *Concavenator* that are posteriorly directed. Moreover, the spines of *Becklespinax* widen toward their apices and are considerably mediolaterally broader than the spines of *Concavenator*. In addition, *Becklespinax* shows at least three elongated neurapophyses instead of only two as in *Concavenator*.

Both a Cluster Analysis based on discrete characters, and a Principal Components Analysis (PCA) based on 20 measures on each vertebra and 23 distinct ratios on such measures were performed. In both analyses the sample space was expanded with other significant theropods. Within the cluster analysis, the two compared genera belong to groups clearly separated, indicating that *Concavenator* is more related to others carcharodontosaurids than to *Becklespinax*. On the other hand, the PCAs show that there is not a marked interspecific biometric variability in the vertebrae except those ones with hypertrophied spines that are separated in morphometric space, where *Becklespinax* and *Concavenator* occupy a different location.

In conclusion, results obtained from different information sources and various methodologies allow discarding the synonymy between *Concavenator* and *Becklespinax*, despite being relatively close both chronostratigraphically and geographically.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FUNCTIONAL MECHANICS OF ORNITHOMIMOSAURS

CUFF, Andrew, University of Bristol, Bristol, United Kingdom

Ornithomimosaurs are a rather enigmatic group of theropods due to the edentulous nature of derived members. Their possession of keratinous rhamphotheca, large orbits, lightweight skulls and elongate necks and legs has led to comparisons with ostriches and other extant palaeognaths. Understanding the evolution of this group has implications for that of theropods in general and dietary shifts from carnivory to herbivory.

The skulls of three ornithomimosaurs (*Garudimimus* and the ornithomimids *Struthiomimus* and *Ornithomimus*) were digitally reconstructed using CT scan data. Virtual muscles were recreated using osteological correlates, from which bite forces were calculated. Hypothetical beaks that cover the rostrum were created based on known fossils and modern birds to study their effects. Finite element models were run using the muscle loads to compare the more primitive *Garudimimus* to the derived ornithomimids.

Further work on postcranial material involved a reanalysis of limb elements from most of the ornithomimosaurs to study modular evolution of fore- and hind limbs with respect to the crania. The limb elements were measured traditionally (e.g. length, proportions, mid-shaft diameters) and using functional measures (e.g. muscle scar sizes, distance between muscle insertion and origination, moment arms). The individual modules were used to produce phylogenies, with each of these being compared to the overall phylogeny to see which characters affected it most.

Results show that the crania strain similarly to each other, but the ornithomimids are more similar to each other than to the more primitive *Garudimimus*. This trend is also followed with the limb elements (both traditional and biomechanically), with more primitive ornithomimosaurs performing more variably. This may be linked to their changes in diet and a shift in ecospace.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A VERTEBRATE MICROFOSSIL SITE WITH A TERRESTRIAL-DOMINATED FAUNAL ASSEMBLAGE FROM THE UPPER FOREMOST FORMATION (CAMPANIAN) OF ALBERTA

CULLEN, Thomas, University of Toronto, Toronto, ON, Canada, M5S 2C6; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, United States; CAPOBIANCO, Christopher, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; NEWBREY, Michael, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

Vertebrate microsites contain abundant fossil material of small and large bodied animals recruited from the local paleocommunity that can provide important information for reconstructing regional paleoecology. The Foremost Formation is the oldest unit of the Belly River Group, and records the transition from the fully marine shales of the Pakowki Formation to the non-marine strata of the relatively well sampled Oldman and Dinosaur Park formations. The Belly River Group spans an important interval in the evolution of many dinosaur clades. Although the Foremost Formation has relatively limited exposure and is generally depauperate in vertebrate fossil material, it does contain some of Larimidia's earliest and most important records of later major clades (e.g., ceratopsians). Most previous paleontological studies have focused on the lower half of the formation, which has yielded vertebrate microfossil assemblages with strong marine influences, as indicated by an abundance of guitarfish teeth.

Here we document a new microfossil locality from the upper Foremost Formation that shows a significant terrestrial influence, including turtle, crocodile, champsosaurs, and dinosaurs. The latter includes large fragments of pachycephalosaurid crania as well as the more typical assortment of teeth. While some marine vertebrates are present (e.g., the lamniform sharks *Archaeolamna* sp. and *Synodontaspis* sp.), their presence is reduced relative to marine microvertebrate assemblages in the lower Foremost Formation, particularly in the case of guitarfish material. Two significant specimens have been recovered from the site: a large, complete, cephalic spine of the hybodont shark *Hybodus*, and a small, partially preserved dinosaur egg. Hybodont remains are common in the Western Interior Seaway, but they are generally known from their teeth and fin spines. The new specimen represents the first known complete cephalic spine of a hybodont shark from the Foremost Formation of southern Alberta, and one of three from the Late Cretaceous of North America. The dinosaur egg fragment can be assigned to Theropoda based on the shell thickness and surface texture morphology. It represents the first record of egg material in the Foremost Formation, and adds evidence to the hypothesis that dinosaurs did not preferentially nest in drier, upland environments.

Technical Session II (Wednesday, October 30, 2013, 11:45 AM)

WISDOM OF THE BONES: HOW PATTERNS OF TRAUMA AND PATHOLOGY IN A WILD LEMUR COMMUNITY INFORM THE PALEOECOLOGY OF MADAGASCAR'S RECENTLY EXTINCT LEMURS AND EARLIER EOCENE LEMURIFORM PRIMATES

CUOZZO, Frank, University of North Dakota, Grand Forks, ND, United States, 58202; SAUTHER, Michelle, University of Colorado-Boulder, Boulder, CO, United States

Thorough assessment of the ecology and behavior of extinct primates requires comparative data from living analogues, or better, extant relatives of these extinct forms. This is the case when attempting to understand the recently extinct subfossil lemurs of Madagascar and more distant lemuriform primates from the Eocene Epoch. Our decade-long study of a living, wild lemur community at the Beza Mahafaly Special Reserve, Madagascar, and the subsequent analyses of skeletal material from these individuals provide such a context. In a sample of 274 living ring-tailed lemurs (*Lemur catta*) captured between 2003 and 2012, more than 15% of the population exhibits some form of healed skeletal trauma, ranging from broken tails to more debilitating injuries such as broken femora, humeri, and ulnae. Of significance, a number of these lemurs have survived many years (as much a decade) with these healed injuries, while exhibiting normal ranges of behavior. The skeletal sample housed at Beza Mahafaly includes material from all four lemur species endemic to the region. This sample includes evidence of healed long-bone fractures in both *Lemur catta* and Verreaux's sifaka (*Propithecus verreauxi*). Data from this sample also illustrate frequent dental abscesses in both species (more than 30% in *Propithecus*). These abscesses are linked to consuming specific foods, and thus provide a template for interpreting their presence in related, subfossil lemurs. For example, 15% of extinct *Paleopropithecus* and 7% of extinct *Archaeolemur* we have examined in American and European museum collections exhibit distinct abscesses similar to these living lemurs, likely the result of processing similar foods. This comparison therefore provides a template for interpreting the ecology of these extinct forms. Finally, recent interpretations of the paleopathology and behavior of the type specimen of middle Eocene *Darwinius massilae* assert that broken wrist bones resulted in an inability to climb, thus leading to the rapid demise of this individual. Our data from living primates and their skeletal remains illustrate that lemurs frequently survive, sometimes as long as a decade, with severe trauma, thus indicating that *Darwinius* did not necessarily succumb to this injury. The data we present herein illustrate the value of studying wild, living primates and their skeletal remains for assessing primate paleoecology.

Technical Session III (Wednesday, October 30, 2013, 3:15 PM)

THE SMALLEST, ARTICULATED CERATOPSID (DINOSAURIA)

CURRIE, Philip, University of Alberta, Edmonton, AB, Canada, T6G 2E9; HOLMES, Robert, University of Alberta, Edmonton, AB, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, United States; COY, Clive, University of Alberta, Edmonton, AB, Canada; KOPPELHUS, Eva, University of Alberta, Edmonton, AB, Canada

The smallest known articulated ceratopsid skeleton (lacking only the forelimbs) is a juvenile chasmosaurine that was collected in 2010 from the lowermost part of the Dinosaur Park Formation in Dinosaur Provincial Park, Alberta. At 1.5 m in total length, it falls below the size range of even adult basal neoceratopsians and large psittacosaurids. Cranial bones have striated, porous bone texture; many are coossified despite its small size. The frill is relatively short and narrow. The back of the frill is rectangular, lacks a posterior embayment, and is relatively narrower than those of either equivalent-sized basal neoceratopsians or adult ceratopsids. There are no cranial epiossifications, and the squamosal is capped at the posterolateral corner by the parietal. The margins of the elongate squamosals are thick and scalloped. Narrow and elongate openings may represent the parietal fenestrae, and there is a pronounced midline sagittal crest that extends almost to the back of the frill. The preserved short, knoblike postorbital horn has a round base and there is no development of sinuses from below. An incipient horncore is present on the nasals over the posterior one-half of the external nares. There are 18 maxillary tooth positions, which is at least four more than in any similar-sized basal neoceratopsians, but is fewer than what is found in more mature ceratopsids. All of the cranial features are consistent with its identification as *Chasmosaurus* sp. Postcranially, skin on the flank of the body comprised a basement of pebbles with large feature scales. The syncervical is composed of three fused vertebrae. There are 32 articulated caudals, of which the fifth to twentieth appear to have short, robust, free caudal ribs. The narrow pelvis suggests the body was tall and narrow. Ossified tendons are present in the neck and trunk. The pedal unguals are broad but taper acutely. Ontogenetic hind limb proportions scale isometrically, and as in more mature ceratopsids, the tibia/fibula and metatarsals are relatively short in contrast with those of more basal ceratopsians. Recovery in the phylogenetic analysis of the specimen as a basal chasmosaurine is a reflection of juvenile characters that have a significant impact on character coding. For example, as in basal ceratopsians the palpebral is not fully incorporated into the orbital rim. Those characters used in phylogenetic analyses of ceratopsids that are size or age-dependent can now be identified, redefined to be more useful, or dropped.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A THREE-DIMENSIONAL STUDY OF PARANASAL SINUSES IN CARNIVORA

CURTIS, Abigail, University of California, Los Angeles, Los Angeles, CA, United States, 90095; VAN VALKENBURGH, Blaire, Univ of California Los Angeles, Los Angeles, CA, United States

A common feature of many mammal skulls is the presence of air-filled chambers called paranasal sinuses. Paranasal sinuses form when the nasal epithelium and an associated osteoclastic capillary bed escape the nasal chamber and invade adjacent bones, including the frontal, maxilla, sphenoid, and ethmoid. Paranasal sinuses are widespread and exhibit striking disparity among mammals, but few studies have quantified sinus morphology, and their function is still debated. Furthermore, mammals appear to have gained and lost sinuses multiple times throughout their evolutionary history. Previous studies were limited by the fact that paranasal sinuses are hidden within skulls and inaccessible without using destructive methods. We conducted the first quantitative study of frontal sinus morphology for the mammalian order Carnivora using non-destructive CT technology, which can also be used on fossils. We included 64 individuals representing 38 species of hyaenids, canids, and felids. Carnivorans offered an excellent comparative sample because they span a range of skull size and shape disparity, and have gained and lost sinuses multiple times. We focused on frontal sinuses because they vary greatly among species compared to the other paranasal sinuses. Additionally, frontal sinuses are often the best-preserved sinuses in fossil mammal skulls, which makes it possible to extend this study to the fossil record. We constructed volumetric models of frontal sinuses from CT scans using specialized visualization software and applied a novel shape quantification technique called spherical harmonics (SPHARM) to characterize three-dimensional shape disparity among species. Skull size and shape were quantified using three-dimensional geometric morphometrics. We examined the relationship between sinus size and shape and skull size and shape within a phylogenetic context to test the hypothesis that sinuses form where bone is mechanically unnecessary. Results indicate that sinus volume scales similarly with skull size in all three families. Sinus shape shows convergence in that distantly related species with similarly shaped skulls have comparably shaped sinuses. Our results suggest that sinuses develop where bone is not mechanically necessary, and allow for expansion of the feeding apparatus with minimal materials.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

CONSERVING AND UNDERSTANDING A MAMMALIAN "LIVING FOSSIL" *SOLENODON PARADOXUS*, THROUGH PALEONTOLOGICAL OUTREACH IN THE DOMINICAN REPUBLIC

CUSSEN, Laura, Stanford University, Stanford, CA, United States, 94309; MYCHAJLIW, Alexis, Stanford University, Stanford, CA, United States; HADLY, Elizabeth, Stanford University, Stanford, CA, United States

The West Indies is renowned for its complex geological and climatic history, which yielded a highly unique endemic biota. The Hispaniolan solenodon, *Solenodon paradoxus*, is one of two extant mammals endemic to the island, and is listed as endangered by the International Union for Conservation of Nature. Considered a ″living fossil″ due to its deep evolutionary history, it provides an exceptional opportunity to bring fossils to life in a region whose native biota has been decimated in both geologic and modern time. Using modern and fossil solenodons, we will use this group as a vehicle to explore Caribbean paleoecological and geologic history, and to contextualize modern extinction threats within past extinction events. We will do so by producing a children′s book about the evolutionary history of the Hispaniolan solenodon, tracing its survival through ancient catastrophes and reactions to modern survival threats. We will integrate known conservation ecology of solenodons and fossils from Hispaniola′s paleocommunity with local ecological knowledge and local children′s perceptions of the solenodon into the book′s plot. By using empirical results of personal surveys in the Dominican Republic we hope to better engage and educate children, and to emphasize actions a child can take to contribute to the solenodon′s conservation. We will distribute copies through grassroots conservation groups in the Dominican Republic, particularly The Last Survivors and Grupo Jaragua, and through our collaborators at the zoo and natural history museum in Santo Domingo. A prototype of the book will be available in September 2013. We will evaluate its success by engaging schools in the Dominican Republic following publication.

Technical Session XI (Friday, November 1, 2013, 3:00 PM)

MAMMALIAN DWARFISM ASSOCIATED WITH THE EARLY EOCENE ETM2 HYPERTHERMAL EVENT, BIGHORN BASIN, WYOMING

D'AMBROSIA, Abigail, University of New Hampshire, Durham, NH, United States, 03820; CLYDE, William, University of New Hampshire, Durham, NH, United States; FRICKE, Henry, Colorado College, Colorado Springs, CO, United States; SNELL, Kathryn, California Institute of Technology, Pasadena, CA, United States; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, United States

During the early Paleogene, Earth experienced a series of extreme global warming events known as hyperthermals, which were characterized by global atmospheric carbon isotope excursions (CIEs). The largest hyperthermal, known as the Paleocene-Eocene Thermal Maximum (PETM), was also characterized by transient mammalian dwarfism. Studies suggest that decrease in mammal body size during the PETM was an evolutionary response to rising atmospheric temperatures and/or increased levels of atmospheric CO_2. Understanding hyperthermals and their effects on terrestrial biota is important for predicting future ecological changes in response to present day CO_2 and temperature increases. To better understand the relationship between mammal body size, temperature change, and atmospheric CO_2 levels, it is important to analyze these variables across multiple hyperthermals. Until recently, hyperthermals other than the PETM have only been recorded in marine sediments. However, recent analysis of paleosol carbonates from stratigraphic sections in the McCullough Peaks region of the Bighorn Basin (Wyoming) has uncovered continental records of two smaller magnitude early Eocene hyperthermals known as ETM2 and H2. To investigate how mammal body size changed during ETM2 and H2, mammal fossils were intensively collected from the Gilmore Hill and White Temple sections in the McCullough Peaks. Changes in body size of well-sampled mammal lineages were tracked by measuring the crown area of lower cheek teeth, which is known to correlate with adult body size. Geochemical analysis of paleosol carbonates from the same sections provided direct evidence of the CIEs and, via clumped isotope paleothermometry, associated changes in summer soil temperature. Results show that *Hyracotherium*, *Diacodexis*, and *Cantius* all experience a clear decrease in body size during ETM2. For example, estimates of *Hyracotherium* mean body size decrease by ~22% from pre-ETM2 to mid-ETM2, coinciding with a -3.8‰ CIE and increase in summer soil temperature of ~10°C. Body size and temperatures revert to pre-ETM2 levels when background carbon isotope values reappear. This pattern is quite similar to the PETM when *Hyracotherium* body size decreased ~30%, coinciding with a -5.9‰ CIE and increase in summer soil temperature of ~10°C. *Hyracotherium* rebounded to even larger sizes after the PETM. Decrease in mammal body size seems to be a common evolutionary response to early Paleogene hyperthermals, and thus may be a predictable natural response for some lineages to future global warming.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

USING GEOMETRIC MORPHOMETRICS TO QUANTIFY SHAPE-SIZE HETERODONTY IN NON-MAMMALIAN TAXA: A CASE STUDY INVESTIGATING DENTAL ONTOGENY IN THE NILE MONITOR, *VARANUS NILOTICUS*

D'AMORE, Domenic, Daemen College, Amherst, NY, United States, 14226

Many recent attempts have been made to quantify heterodonty in non-mammalian vertebrates, both extinct and extant, but the majority of these are limited by Euclidian measurements. Groups often investigated include elasmobranchs (sharks), lizards, crocodylians, and theropod dinosaurs. One taxon frequently investigated is *Varanus niloticus*, the Nile monitor, noteworthy for an ontogenetic shift towards molariformy. The purpose of this study is to present a novel geometric morphometric method to quantify *V. niloticus* heterodonty through ontogeny that may be applied to other non-mammalian taxa. Data were collected from both photographs and caliper measures of the entire tooth row of 19 dry skull specimens. A semi-landmark analysis was conducted on the outline of the teeth and size, shape, and growth rate and heterodonty metrics were created using multivariate statistical analyses. The results confirm and expand upon the findings of previous authors, showing measurable shape-size heterondonty in the species. The size and shape value ranges for each tooth position in the sample were significantly different from one another. All teeth increase in width as size increases. As body size increases, size increases at all tooth positions and the rate of this growth increases as one moves distally. The teeth of the mesial half of the tooth rows show no significant shape change with growth. Distal teeth become more molariform with age, and the rate of this change increases with more distal positions as well. Concerning both shape and size, heterodonty increases in separate degrees along the cranial and mandibular arcades with age. Wear

and host bone contours affected shape slightly. Changes in heterodonty are speculated to be the result of function and mechanical constraint, although it is unclear to what degree *V. niloticus* is a durophagy specialist. The geometric morphometric method proposed here, although not without its own limitations, has several advantages over other methods, and may be ideal for use with a number of modern and fossil dental morphotypes in the future.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

STHENURINES — WHY THE SHORT FACE? CRANIODENTAL MORPHOLOGY IN RELATION TO DIET IN LIVING AND FOSSIL KANGAROOS

DAMUTH, John, University of California, Santa Barbara, Santa Barbara, CA, United States, 93106; JANIS, Christine, Brown Univ, Providence, RI, United States; TRAVOUILLON, Kenny, University of Queensland, St. Lucia, Australia; FIGUEIRIDO, Borja, Universidad de Málaga, 29071-Málaga, Spain

Multivariate analyses (Principle Components Analysis [PCA] and Canonical Variates Analysis [CVA]) of 13 craniodental measurements of 43 species of extant macropodoids (kangaroos and rat kangaroos) showed good discrimination (81% correct classification) among dietary categories (omnivore, browser, mixed feeder and grazer). Tropical forest browsers (*Dendrolagus* and *Dorcopsis* spp.) clustered separately from the other browsers, which clustered closer to mixed feeders; grazers (large *Macropus* spp.) clustered separately. Eleven fossil taxa were then included: two small (bettong-size) Oligo-Miocene taxa, one late Miocene sthenurine (*Rhizosthenurus*, wallaby size), seven Pleistocene sthenurines (representing five species of *Sthenurus*), and one Pleistocene protemnodontine (*Protemnodon anak*). Sthenurines (aka "short-faced browsing kangaroos") and protemnodontines are extinct lineages that achieved very large size in the Pleistocene. In all analyses, the Oligo-Miocene forms clustered with the modern browsers. In the PCA the Pleistocene sthenurines had high values on PC1 (due to their large size), and also high values on PC2, clustering with the extant tropical forest browsers, distinguished by a broad muzzle, a long premolar, low-crowned molars, and low rates of molar wear. However, in the CVAs the Pleistocene sthenurines did not group with any modern dietary class. In a CVA excluding omnivores the species of *Sthenurus* occupied their own portion of the morphospace, largely relating to the possession of a very deep angle of the jaw. *Rhizosthenurus* and *Protemnodon* fell in the space between the *Sthenurus* cluster and the extant tropical forest browsers. A similar pattern emerged in an analysis where grazers and mixed feeders were lumped in a single category, but here the sthenurines were distinguished by a very deep zygomatic arch. Derived sthenurines had a distinct set of craniodental adaptations unlike those of any other browsing kangaroos. Although the morphological features in the analysis included both total skull length and length of the face, it is interesting that neither of these features was selected by the CVA to distinguish sthenurines. Rather, sthenurines are distinguished by features relating to the size of the masseter muscle, either a broad zygoma for its origin, or a deep angle of the jaw for its insertion. The implication is that the short face (which is itself a derived feature) is related to some aspect of skull shape to accommodate a large masseter muscle, possibly related to the exertion of greater force with the incisors.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PALEOAERIE: MULTIPLE AVENUES BRINGING EVOLUTION EDUCATION TO FORMAL AND INFORMAL EDUCATORS AND THE PUBLIC AT THE SAME TIME

DANIEL, Joseph, University of Arkansas for Medical Sciences, Little Rock, AR, United States, 72205

Evolution is central to modern biological thought, yet it is not accepted by a large segment of the population and is often not taught in schools due to ignorance and misperceptions of what evolutionary theory actually states, a weak understanding of the nature of science, and an overall resistance to change, the defining characteristic of evolution. This problem is especially acute in Arkansas, which has a higher than average percentage of avowed creationists and unqualified science teachers, combined with a lack of sufficient resources to educators. The Arkansas Educational Resource Initiative for Evolution (AERIE) addresses this problem in two ways. First, it provides professionally vetted information. Because fossils, and especially dinosaurs, are widely popular, many of the resources use them as a hook to begin discussion of a wide variety of topics. As such, the project is known as PALEOAERIE. Secondly, it brings content experts, informal and formal educators, and the public together in unique educational environments.

Several methods are utilized for this project. A public website (paleoaerie.org) and several social media outlets supply original material (including discussions of Arkansas fossils) and serve as portals to high quality web resources. An educator workshop series provides information on evolution, the nature of science, and teaching techniques. They also serve as a platform for bringing informal and formal educators together to forge new collaborative opportunities. A series of public presentations promote evolutionary concepts to a broad audience. Finally, an extended trip to museums in New York and Washington, D.C. will be undertaken with a group of content experts, formal and informal educators, middle school aged students identified as being from an underserved population, and their parents. The students and their parents will work together on projects designed to encourage examination and discussion of evolutionary concepts and evidence for them, which will increase parental involvement while also educating the parent. They will be assisted by the educators and content experts who will themselves gain new information on science and evolution. Teaching techniques will be discussed, with the educators from different environments sharing expertise, and further collaborations may be forged. The novel environment, combined with diverse individuals from multiple educational paths, will inspire greater knowledge of and appreciation for evolutionary concepts and create lasting bonds between participants.

Technical Session XVI (Saturday, November 2, 2013, 3:00 PM)

NEW DATA ON A XINJIANGCHELYID TURTLE FROM THE MIDDLE JURASSIC OF SIBERIA, RUSSIA

DANILOV, Igor, Zoological Institution of the Russian Academy of Sciences, St. Petersburg, Russia; OBRAZTSOVA, Ekaterina, St. Petersburg State University, St. Petersburg, Russia; SYROMYATNIKOVA, Elena, Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia; KRASNOLUTSKII, Sergei, Sharypovo Regional Museum, Sharypovo, Russia

Over the last decade, abundant turtle material was collected from the upper part of the Middle Jurassic (Bathonian) Itat Formation of Berezovsk Quarry, Krasnoyarsk Territory, West Siberia, Russia. This material consists of thousands of isolated bones and several more complete specimens, including a partial braincase and larger portions of the shell. This material belongs to a single taxon, which probably represents a new species of Xinjiangchelyidae. The attribution of this turtle to Xinjiangchelyidae is based on a combination of the following characters: canals for internal carotids partially or completely opened ventrally; absence of basisphenoid pits; anterior peripherals with prominent guttered edges, middle marginals extend onto costals; dorsal processes of epiplastra present; entoplastron longer than wide; mesoplastra absent; formed cervical articulations absent. This taxon was also characterized by midline contact of costal 7, vertebrals 2 and 3 narrower than vertebral 1, ligamentous plastron-carapace connection, pectorals and abdominals similar in length, a sinuous midline sulcus of the plastron, and fusion of carapacial bones at the carapace length about 20 cm. In addition, it demonstrates variation in the formula of anterior neurals, number of suprapygals, length of thoracic rib 1, which can span less than or more than half of costal 1, position and shape of sulcus between vertebrals 2 and 3; and presence/absence of an anal overlap onto the hypoplastron. We performed a cladistic analysis of this taxon within the Xinjiangchelyidae (Xinjiangchelyidae + Bashuchelyidae are considered to represent a monophyletic group, and *Kayentachelys aprix* was used as an outgroup) resulted in its position in one clade with *Annemys latiens* and *A. levensis* (both from the Late Jurassic of Mongolia), supported by two synapomorphies (vertebrals 2 and 3 narrower than vertebral 1 and sulcus between vertebrals 3 and 4 V-shaped). The relationships of the new taxon within the *Annemys* clade remain unresolved. The xinjiangchelyid from Berezovsk Quarry is peculiar in that it is the oldest well dated and the northernmost record of this group in Asia. It is also the dominant taxon in the vertebrate assemblage of Berezovsk Quarry. The low taxonomic diversity of the turtle assemblage of Berezovsk Quarry resembles xinjiangchelyid dominated localities of the Callovian – Oxfordian Shishugou Formation of the Junggar Basin of China and Callovian Balabansai Formation of Kyrgyzstan. The paleoecological significance of this pattern is uncertain.

Technical Session XI (Friday, November 1, 2013, 2:30 PM)

PALEOCENE-EOCENE EVOLUTION OF BETA-DIVERSITY AMONG UNGULATE MAMMALS IN NORTH AMERICA

DARROCH, Simon, Yale University, New Haven, CT, United States, 06511; LONGRICH, Nicholas, Yale University, New Haven, CT, United States; WEBB, Amelinda, Yale University, New Haven, CT, United States; BELMAKER, Jonathan, Tel Aviv University, Tel Aviv, Israel

The Paleocene-late Eocene transition in North America marks a critical interval in the evolution and diversification of land mammals, including adaptive radiation in the Paleocene, and repeated waves of immigration over land bridges at the Paleocene-Eocene boundary. We investigate the fossil record of ungulate mammals over this period to understand the effects of immigration and faunal exchange on local (alpha), regional (gamma), and between-site (beta) diversity. We use Paleocene and Eocene records of North American ungulate mammals taken from the Paleobiology Database (PBDB), and calculate beta diversity among families and genera within the seven stages of the Cenozoic. We further reconstruct geographic range sizes for studied taxa, and test trends in these ranges against null models used to control for sampling biases. Finally, we use Mantel tests to quantify the relationship between geographic distance and faunal dissimilarity within each time slice, in order to visualize changes in the spatial complexity of mammal communities over the studied interval. Overall (gamma) diversity increases over the studied interval, with varying contributions from alpha and beta. Beta diversity increases from the Paleocene to Eocene, reflected in decreasing range size and increased correlation between reconstructed distance and faunal similarity. Increase in beta diversity over the Paleocene-Eocene transition is driven by smaller geographic ranges among putatively invasive 'immigrant' taxa; range contraction among these same groups in the middle-late Eocene leads to a peak in beta diversity in the Bartonian. High gamma diversity in the Eocene was driven by high beta, rather than alpha diversity, indicating that immigrant taxa dramatically restructured the spatial organization of mammal communities. This suggests that over longer timescales, mass immigration events can lead to greater overall richness, and greater heterogeneity, rather than homogeneity, within regional assemblages.

Technical Session XI (Friday, November 1, 2013, 3:30 PM)

WHEN WAS THE MODERN LATITUDINAL RICHNESS GRADIENT ESTABLISHED?

DAVIS, Edward, University of Oregon, Eugene, OR, United States, 97403; EMERY, Meaghan, University of Oregon, Eugene, OR, United States; FAMOSO, Nicholas, University of Oregon, Eugene, OR, United States; MCGUIRE, Jenny, University of Washington, Seattle, WA, United States

*Macroecological research has established that ecological richness decreases with latitude in a variety of modern systems, from mammals to vascular plants, and extending even to human cultural diversity. However, paleobiological research has suggested that

Eocene mammalian faunas in North America have either no latitudinal richness gradient or one in which richness increases away from the equator. Several factors have been suggested as drivers of the modern latitudinal richness gradient, with the two most important being primary productivity and latitudinal range expansion in the wake of glacial retreat since the Last Glacial Maximum (~21 ka). To test these hypotheses we investigated the onset of the modern richness gradient in the fossil record of North American mammals. We calculated species richness in 5 degree bands in each of the North American Land Mammal Age subdivisions since the middle Miocene using mammal occurrence data from the FAUNMAP II and MIOMAP databases. Miocene intervals show variable latitudinal richness gradients with significant (p<0.05) positive gradients (inverted from the modern pattern) in the early and late Barstovian and late late Hemphillian. Other Hemphillian intervals show non-significant positive gradients. Pliocene and early Pleistocene intervals (Blancan and Irvingtonian) show a consistent non-significant negative gradient, transitioning into the modern strongly-negative gradient in the late Pleistocene (Rancholabrean) and Holocene. Our results suggest that continental glaciation played an important role in the modern negative gradient and that continued global warming may dampen that gradient if species track preferred climates. However, the onset of the gradient before glacial cycling (and the inverse gradients in the late Miocene) suggest other factors are important drivers, including productivity and also long-term environmental stability.

Technical Session VIII (Thursday, October 31, 2013, 2:30 PM)

MIDDLE PERMIAN TETRAPOD BIODIVERSITY CHANGE AND THE GUADALUPIAN EXTINCTION: INSIGHTS FROM THE BEAUFORT GROUP OF SOUTH AFRICA.

DAY, Michael, BPI Palaeontology, Johannesburg, South Africa; RUBIDGE, Bruce, BPI Palaeontology, Johannesburg, South Africa

The Karoo Basin of South Africa is the world's most continuous and best exposed Permo-Triassic terrestrial sedimentary sequence and is noted for its wealth of fossil tetrapods, to the degree that it has been subdivided biostratigraphically. The end-Permian Mass Extinction, the greatest of the Phanerozoic extinction events, is well recorded in the rocks of the Beaufort Group but an even earlier Permian extinction event, known from the marine realm of East Asia, has until now not been substantiated in the terrestrial realm. Extensive stratigraphic collecting of fossil tetrapods in the Lower Beaufort Group over several decades has enabled a higher resolution understanding of the ranges of individual tetrapod taxa during the Middle Permian than has existed before. Combined with an analysis of fossil localities taken from existing collections, this provides new insight on biodiversity change in the earliest therapsid dominated faunas. In addition, new radiometric dates from the Beaufort Group constrain the timing of several major biodiversity shifts. The stratigraphic ranges of tetrapod genera are found to be more complex than previously thought, while the stratigraphic extent of the three Middle Permian biozones is also more heterogeneous. Biodiversity peaks in the upper *Tapinocephalus* Assemblage Zone but two periods of significant generic turnover occur within the succession. Furthermore, the stratigraphic ranges of fossil taxa have been related to lithostratigraphic units, comprising over 2 km of strata, which has allowed higher resolution biostratigraphic correlation around the Karoo Basin.

Preparators' Session (Thursday, October 31, 2013, 8:30 AM)

TARPOLOGY 501 - ADVANCED SHADE TARP TECHNIQUES FOR PALEONTOLOGICAL FIELD EXCAVATIONS; STRATEGIES FOR FIELD PALEONTOLOGY ON A WARMING PLANET

DE BLIEUX, Donald, Utah Geological Survey, Salt Lake City, UT, United States, 84114; KIRKLAND, James, Utah Geolocical Survey, Salt Lake City, UT, United States; MADSEN, Scott, Utah Geological Survey, Salt Lake City, UT, United States

The Utah Geological Survey has been conducting summer field excavations in Cretaceous strata throughout southern and eastern Utah for over a decade. During these excavations, air temperatures often exceed 110°F(43°C), with substantially higher ground-surface temperatures. The use of shade structures over our excavation areas has allowed us to work in these harsh conditions. For our excavation areas (quarries) we have refined a shade tarp system that is easy to transport and simple to assemble. Providing comfort and safety are the obvious advantages of using shade tarps. Heat-related medical conditions, such as heat stroke and heat exhaustion can be quite serious, particularly in remote areas. Even minor heat-induced conditions (e.g., dehydration) can greatly limit the amount of work a field crew member can accomplish. Long-term sun exposure can lead to serious skin damage, including skin cancers. Another important benefit provided by shade tarps is more even lighting, which helps to discern fossils from matrix. For enhancing visibility it is critical that only neutral color tarps, such as white, be used because other colors will adversely alter the spectrum of light, making it difficult to see. The use of colored tarps, especially the common blue tarp, is one of the reasons that some workers have shunned the use of shade tarps. We use ¾ inch shelter corner connectors and ¾ inch electrical conduits to construct 8 foot x 10 foot frames, with legs of various lengths for suspending the tarps over the work area. We have had success with two types of tarps: a heavy mesh material that we have custom made, that withstands windy conditions, and store-bought solid polyethylene tarps that provide deeper shade but do not work as well in windy conditions. For securing the tarps to the frames we use small toggle balls (bungee balls) that can be quickly wrapped around the conduit and through the tarp grommets during set-up. These also allow for easy tarp removal in the event of wind gusts. We have found it necessary to take down the tarps each night so that storms do not move the poles around damaging fossils exposed in the quarry. The solid polyethylene tarps can then be used to cover the quarry to protect it in the event of rain. For securing the tarp frames, we use ropes tied around rebar and/or 12 inch spikes pounded into the ground. Two knots that are useful are the bowline and the trucker's hitch. Once the square frames are set in place, additional tarps can be strung off the sides to enlarge the shaded area.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TESTING WING ASSISTED INCLINE RUNNING (WAIR): INVESTIGATING THE TERRESTRIAL ORIGIN OF THE AVIAN FLIGHT STROKE

DECECCHI, Alexander, University of South Dakota, Vermillion, SD, United States, 57069; HABIB, Michael, , Pittsburgh, PA, United States; LARSSON, Hans, McGill Univ, Montreal, QC, Canada

The evolution of powered flight represents a major functional and behavioral event in birds. The major catalyst for the origin of powered flight was the evolution of the flight stroke, perhaps the key innovation along the transition from non-volant to volant theropods. Here we investigate the recently proposed behaviorally-driven selective pathway towards the evolution of the flight stroke: Wing Assisted Incline Running (WAIR). WAIR is a real and quantifiable behavior seen in multiple lineages of extant birds, and has been interpreted as an adaptation for escape among juveniles that cannot fly. It has been suggested that WAIR provides a model for the functional stages within maniraptorans to a fully derived wing in avians, with ontogeny acting as a proxy for transitional evolutionary stages. Here we present a series of challenges to this framework, the assumptions made, and the data presented. We seek to create a methodology to evaluate and, if necessary, modify evolutionary narratives into testable hypotheses that can be compared to, and make predictions of, the fossil record. There are large differences in size (up to 700 fold) in between theropods proposed to have used WAIR (such as *Caudipteryx*) and the hatchling birds used as proxies. We demonstrate that due to scaling effects on pectoral mass, wing loading, and flapping frequency, the adults of relatively moderate-sized non-avian dinosaurs may have had difficulty utilizing a WAIR dynamic in life. In addition, differences in the anatomy of the avian shoulder joint, such as range of motion, the use of the acrocoracohumeral ligament in stabilization, and sternal morphology as a proxy for pectoral muscle mass, may compromise the use of extant juvenile birds as models for non-avian theropod behavioral capabilities. We conclude that WAIR, as presently proposed, is of limited value in acting as the major driver for the origin of the flight stroke within Maniraptora. Our work does not question the existence of WAIR in extant birds, nor does it preclude it from having been influential in later avian evolution, but we suggest fundamental alterations to the current WAIR model must be undertaken before it corresponds to the fossil evidence.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

PELVIC GIRDLE AND HIND LIMB MUSCULATURE OF *BAURUSUCHUS ALBERTOI*: A BIOMECHANICAL APPROACH

DELCOURT, Rafael, Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; NASCIMENTO, Paulo, Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; CARVALHO, Alberto, Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; ZAHER, Hussam, Museu de Zoologia da Universidade de Sao Paulo, Sao Paulo, Brazil

Baurusuchidae is an abundant family of the clade Notosuchia erected by Price in 1945 to allocate *Baurusuchus pachecoi* and its relatives. Among the specimens of this family, *Baurusuchus albertoi* (Museu de Zoologia da Universidade de São Paulo specimen MZSP-PV 140) is represented by a fragmentary skull and an almost complete postcranial skeleton from the Bauru Basin (Upper Cretaceous of Brazil). We reconstructed the pelvic girdle and hind limb muscles of *B. albertoi* using the Extant Phylogenetic Bracket to infer its origins and insertions. The surface bones homologies were traced from the extant taxa Crocodylia and Aves. The ischium of *B. albertoi* is unpreserved and its muscles were inferred using the undescribed baurusuchid MZSP-PV 839. The musculature of ilium is very similar to crocodilians, however the origins of the iliotibiales muscles are larger and occupy all the supracetabular crest. The iliofemoralis muscle arises from a small tubercle of the ilium wall, posterior to the acetabulum, differing from extant crocodilians. The caudofemoralis brevis muscle arises from the ventral surface of the postacetabular ala as seem in crocodilians. *B. albertoi* shows a conservative femoral musculature except for the insertion of puboischiofemoralis internus part 2 (PIFI2) muscle. Like in dinosaurs, this muscle is positioned more anteriorly than in crocodilians reducing the torsion of the femur, a condition also observed in *Stratiosuchus maxhechti*. The anterior position of the muscle PIFI2 contributed to the erect position of the hind limb, since this muscle is a very important hip flexor. The musculature of tibia, fibula and feet in *B. albertoi* is very similar to extant crocodilians, varying topologically. Baurusuchids possess some analogous features with dinosaurs, which suggest that they could keep an erect position of the hind limbs. Among these features, the iliac crest folds up laterally and forms a supracetabular crest. This crest covers the femoral head and may minimize the leg impact during speed running. In the articulated specimen MZSP-PV 839 the ilium is laterally inclined about 30° in relation to the sagittal plane, allowing the antitrocanter to be accommodated by the fossa trochanterica of the femur. This condition gave the baurusuchids a columnar posture of the hind limb, maybe allowing them to increase velocity during a run. Since the baurusuchids were a diverse group and occupied an important niche in the Upper Cretaceous of Brazil, the understanding of muscular patterns and biomechanics will provide more data to infer their ecological interactions.

Technical Session V (Wednesday, October 30, 2013, 2:15 PM)

A NEW EXTINCT SPECIES OF *BLANUS* (AMPHISBAENIA, BLANIDAE) FROM THE IBERIAN MIOCENE BASED ON THE FIRST KNOWN EUROPEAN AMPHISBAENIAN FOSSIL SKULL

DELFINO, Massimo, Università di Torino, Torino, Italy; BOLET, Arnau, Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; FORTUNY, Josep, Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; ROBLES, Josep M., Institut Català

de Paleontologia Miquel Crusafont, Barcelona, Spain; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain

The first known nearly complete amphisbaenian fossil skull from Europe was recently collected in the locality ACM/C8-A4 of the local stratigraphic series of Abocador de Can Mata (Vallès-Penedès Basin, NE Iberia), whose estimated age corresponds to 11.6 Ma (late Aragonian, MN7+8). It is embedded in a hard concretion that precludes the mechanical preparation of the small and delicate cranial remains and, therefore, was studied using computer tomography. All the elements of the right half of the cranium and lower jaw are preserved, which enabled us to evaluate the morphology of the whole undeformed skull (11.3 mm long). This specimen is clearly referable to genus *Blanus* (among other characters: 7 premaxillary, 5 maxillary, and 8 dentary pleurodont teeth; first dentary tooth smaller than the third) but differs from all known extant and extinct species by the following characters: very long, apically truncated nasal process of the premaxilla; relatively long and roughly rectangular frontals; almost straight suture between the frontals; strong interdigitation of the frontoparietal suture. The nearly 50 amphisbaenian large vertebrae recovered from the same site are morphologically congruent with those of extant blanids, and are thus tentatively referred to the new species. Both the neck and anterior trunk vertebrae are characterized by paracotylar turbercles, which might also represent a potential diagnostic character. Europe is currently inhabited by two extant species of *Blanus*, whereas two other species of this genus inhabit NW Africa, and a fifth one is widespread in Anatolia and in the NW sector of the Mediterranean Basin. Unraveling the evolutionary history of these taxa is hampered by two different factors. First, the comparative osteology of all these extant species is so poorly known that the known fossil record is of little help for unveiling their past distribution, timing of dispersal and phylogenetic relationships. Second, although the European fossil record of amphisbaenians is rather abundant, it is mostly represented by few isolated skull elements (mainly premaxillae, maxillae and dentaries) and vertebrae, whose diagnostic value is rather limited. Three Neogene blanids (*Palaeoblanus tobieni*, *Blanus antiquus*, and *Blanus gracilis*) are customarily considered valid, but their relationships with extant taxa are uncertain. The nearly complete skull from ACM/C8-A4 considerably improves the knowledge of extinct blanids and represents the first chance to evaluate their relationships with extant taxa.

Technical Session V (Wednesday, October 30, 2013, 2:45 PM)

SQUAMATE TURNOVER IN THE 2 MILLION YEARS LEADING UP TO AND ACROSS THE K-PG BOUNDARY IN NORTHEASTERN MONTANA: EVIDENCE FOR A COMPLEX EXTINCTION SCENARIO

DEMAR, David, University of Washington, Seattle, WA, United States, 98195; WILSON, Gregory, University of Washington, Seattle, WA, United States

The timing and mechanisms of the Cretaceous-Paleogene (K-Pg) mass extinction remain hotly debated. Here, we examined squamate (lizards, snakes) diversity dynamics leading up to and across the K-Pg boundary based on vertebrate microfossil assemblages from 27 temporally constrained localities spanning most of the Hell Creek Formation (HC) and the lower third of the overlying Tullock Formation (TU) in Garfield County, Montana. The sample contains hundreds of specimens diagnostic at the genus or species level. Seventeen known latest Cretaceous and earliest Paleogene squamates occur in the local section (e.g., *Leptochamops*, *Proxestops*). We also report the first record of the Late Cretaceous chamopsiid *Socognathus* from the HC. We recognize 14 novel taxa including multiple polyglyphanodontians, platynotans, and an anguid from the HC. Several known taxa (*Chamops*, *Meniscognathus*, *Parasaniwa*, *Palaeosaniwa*) span much of the HC including *Odaxosaurus* and *Exostinus*, both of which also cross the K-Pg boundary. Some taxa are restricted to the middle (*Coniophis*) or upper third (*Peneteius*, *Haptosphenus*) of the HC. Most novel taxa and *Socognathus* only occur in the lower half of the HC. Squamate richness, which we based on range-through occurrences, fluctuated but remained relatively stable (~7 taxa) from localities spanning ~71.2 m of the ~89.5 m-thickness of the HC. Turnover rates also remained relatively stable with minor fluctuations in appearance and disappearance rates. Moderate levels of disappearances (12.5%) occurred at ca. 800-900 thousand years (ky) before the end of the Cretaceous, but the true rate may be underestimated based on 10 lower HC singleton taxa not included in the calculations. Through the uppermost 20 m of the HC, which corresponds to the last ca. 400 ky of the Cretaceous, disappearance rates progressively increase from ~12% to 50% culminating in 70% species-level extinction across the K-Pg boundary. The timing and, to a larger extent, magnitude of squamate turnover mirrors the pattern of amphibian turnover from the study area; together, they provide support for a multiple-cause extinction scenario.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

BONE HISTOLOGY OF SAUROPOD DINOSAURS FROM NIGER

D'EMIC, Michael, Stony Brook University, Stony Brook, NY, United States, 11794; SERENO, Paul, University of Chicago, Chicago, IL, United States

The bone histology of sauropod dinosaurs is of particular interest given their exceptionally large adult body mass. Two problems surrounding sauropod bone histology are currently manifest—the rarity of lines of arrested growth in sauropod long bones and sampling gaps across this very diverse, long-lived clade. We present stylopodial and costal bone histology from two sauropods from Niger, *Jobaria tiguidensis* and *Nigersaurus taqueti*, to sample non-neosauropods and rebbachisaurid diplodocoids, respectively. *Jobaria* was one of the largest sauropods, whereas *Nigersaurus* was one of the smallest. The two species also diverged greatly in cranial anatomy: for example, *Jobaria* had stout, leaf-shaped teeth, whereas *Nigersaurus* had a highly derived battery of pencil-shaped teeth. Despite these and other differences, the stylopodial bone histology of both *Jobaria* and *Nigersaurus* is similar and resembles that of most sauropods. Laminar fibrolamellar bone predominates, with growth lines limited to the outermost cortex adjacent to an external fundamental system, and remodeling appears only late in life. This finding is surprising for *Nigersaurus*, because unusual histology might be expected given its very small adult body mass and derived anatomy. The costal histology of a large adult *Jobaria* specimen indicates an age of less than 30 years at death with asymptotic adult body size achieved in about 20 years. We analyze sauropod bone histology in the context of body size evolution, highlighting the histological features that distinguish particular clades.

Technical Session II (Wednesday, October 30, 2013, 11:30 AM)

EVIDENCE FOR ECO-MORPH DIVERSITY WITHIN OLIGO-MIOCENE MACROPODIFORMS

DEN BOER, Wendy, Uppsala University, Uppsala, Sweden; KEAR, Benjamin, South Australian Museum, Uppsala, Sweden

Despite being uniquely specialized towards bipedal hopping, extant kangaroos and rat-kangaroos (Macropodiformes) are known to utilize a spectrum of locomotive modes, including slow ‘pentapedal’ progression with the tail, quadrupedal bounding, burrowing, and climbing. Nevertheless, phylogenetic evidence indicates that all these gaits are manifest within a single monophyletic radiation, which diversified following the onset of aridity in Australia during the late Miocene. Prior to this timeframe, a completely separate stem clade – Balbaridae – proliferated in late Oligocene-middle Miocene forested environments, and is thought to have been primarily quadrupedal based on a single documented postcranial skeleton from the Riversleigh World Heritage Area of Queensland. However, the chance discovery of other isolated macropodiform elements amongst bulk acid processed bones from Riversleigh has revealed a potentially different eco-morph, displaying loosely articulated tibiae and fibulae, a rotatable pes, enhanced mobility between the metatarsals, and sharply curved pedal unguals that are convergent upon living tree-kangaroos; although, at least one putative balbarid synapomorphy is observable on the remains. Proxy locomotive comparisons using relative warps and a principal component analysis of two-dimensional landmark data derived from pedal claw shape confirms disparity between these balbarids, which alternatively cluster with obligate bipedal saltators (e.g. *Macropus*), or modern Rock wallabies (*Petrogale*) who use their short, curved claws to grip uneven substrates. Such morphological diversity implies that variable locomotion was an early hallmark of the group, and that this adaptive advantage has been selectively maintained (probably convergently) within later surviving lineages.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

IMMERSION OF EVOLUTIONARY CONCEPTS ACROSS SCIENCE CURRICULA

DESANTIS, Derek, Ravenwood High School, Brentwood, TN, United States, 37027; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States

Evolution remains highly controversial, even in the most affluent and educated communities. While research is aimed at understanding why students are resistant to accepting cross-cutting and core ideas like evolution, student acceptance of evolution is low in certain geographic regions of the United States, including southern states where political and religious convictions may prevent students from accepting evolutionary concepts. The Next Generation Science Standards and Framework lists evolution as one of four core concepts in the life sciences and devotes numerous standards to evolution; however, with parent resistance to the teaching of evolution and recent state legislation encouraging teachers to teach the 'scientific strengths' and 'scientific weaknesses' of evolution, evolution education is jeopardized. Here, we suggest a strategy for inoculating students against anti-evolution rhetoric through the immersion of evolutionary concepts across science curricula. Specifically, science process skills can be developed while also communicating evolutionary concepts and material. We discuss two case studies in which evolutionary concepts were discussed while implementing standards pertaining to science process skills and/or skeletal anatomy. First, we replicated an experiment published in Biology Letters that demonstrates the benefit (i.e., reduced time necessary to pass marbles through a hole) of having wet wrinkled fingers as opposed to wet smooth fingers. This experiment was fairly simple, but implemented an experimental design that altered the order of various treatments. As the focus of the lesson is on experimental design and making sure that treatments occur in different orders to reduce the effect of students trying to 'beat' their prior times, concepts pertaining to evolution are discussed in a subtle manner. Despite the subtle integration of evolution, students often comment that they no longer go swimming without thinking, 'how cool it is that wrinkled fingers evolved to increase our ability to grip objects.' Second, a fairly simple lesson on skeletal anatomy was adapted to also include fossil and modern non-human specimens. Through an inquiry-based lesson, students must compare human anatomy and that of other organisms to non-humans, including non-human primates, to infer relationships. Infusion of evolutionary content into lessons focused on other science standards is an effective way to improve evolutionary understandings and help inoculate students to anti-evolution rhetoric, in K-12 classrooms.

Technical Session II (Wednesday, October 30, 2013, 8:45 AM)

DIRECT COMPARISONS OF 2D AND 3D DENTAL MICROWEAR PROXIES IN EXTANT HERBIVOROUS AND CARNIVOROUS MAMMALS: THE IMPORTANCE OF DEPTH AND OBSERVER CONSISTENCY FOR RESOLVING DIET

DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States, 37235-1805; SCOTT, Jessica, University of Arkansas at Little Rock, Little Rock, AR, United States; SCHUBERT, Blaine, East Tennessee State Univ, Johnson City, TN, United States; DONOHUE, Shelly, Vanderbilt University, Nashville, TN, United States; MCCRAY, Brian, Vanderbilt University, Nashville, TN, United States

The analysis of dental microwear is commonly used by paleontologists and anthropologists to clarify the diets of extinct species, including herbivorous and carnivorous mammals. Currently, there are numerous methods, varying in the types of microscopes used, magnifications, and the characterization of wear in both two-dimensions (2D) and three-dimensions (3D). Results from studies utilizing differing methods are not directly comparable and human quantification of wear features (e.g., pits and scratches) introduces interobserver error, with higher error being produced by less experienced individuals. Dental microwear texture analysis (DMTA), which analyzes microwear features in 3D, alleviates some of the problems surrounding 2D microwear methods by reducing observer bias. Here, we directly compare 2D and 3D dental microwear features of extant herbivorous and carnivorous mammals at 100x magnification. Specifically, we generated 2D microwear data from photosimulations of DMTA 3D point clouds (i.e., identical scanned areas) of extant African bovids (4 species) and carnivorans (3 species). We analyzed taxa with similar dental morphology (within each group) representing distinct dietary niches, to address the following questions: (1) do 2D and 3D microwear studies produce accurate and comparable dietary interpretations of extant taxa with known feeding behavior, (2) how does the inclusion of depth alter or improve dental microwear interpretations, and (3) can different observers generate comparable data using 2D wear feature counting methods in herbivorous and carnivorous mammals? Dental microwear features quantified in 2D were able to separate grazing and frugivorous bovids using scratch frequency (ANOVA, $p<0.0001$) and flesh consuming cheetahs from durophagous spotted hyenas using the number of scratches and coarse scratches (ANOVA, $p=0.017$ and $p=0.004$, respectively), but DMTA variables were better able to discriminate between disparate dietary niches in both herbivorous and carnivorous mammals. Further, results demonstrate significant interobserver differences in 2D microwear data (mean percent differences of ~45 and ~49% in bovids and ~61 and ~169% in carnivoran scratches and pits, respectively) with the microwear index remaining the least variable between experienced observers, consistent with prior research. Our results highlight the importance of reducing observer error and analyzing dental microwear in 3D in order to consistently and accurately interpret modern and ancient diets.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

UNIVERSITY STUDENTS' ACCEPTANCE OF CLIMATE CHANGE AND EVOLUTION: ARE SKEPTICS JUST ANTI-SCIENCE?

DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States, 37235-1805; LASHINSKY, Nick, Vanderbilt University, Nashville, TN, United States; ROMER, Jennifer, Vanderbilt University, Nashville, TN, United States; GRESHKO, Michael, Vanderbilt University, Nashville, TN, United States; LOFFREDO, Lucas, Vanderbilt University, Nashville, TN, United States

Evolution and global warming are among the most politically controversial topics discussed in the media and in public audiences, despite the overwhelming acceptance of these ideas by the scientific community. While evolution has sparked debate since the inception of the idea by Charles Darwin in 1859, the passage of the Butler Act in 1925 made the teaching of evolution illegal in Tennessee public schools and was challenged in the Scopes Monkey Trial, although not repealed until 1967. As Tennessee has been a focus of past and current debates regarding the teaching of evolution and global warming in public schools, we here assess University students' acceptance of evolution and climate change in a Tennessee private university. Specifically, we test the following hypotheses: (1) anti-evolution and anti-climate change individuals are the same individuals; (2) acceptance of evolution and climate change are dependent on strength of religious and political convictions; and

(3) a student's science background and/or interest in science affects their acceptance of evolution and climate change. Further, we aim to assess if there are any correlations between gender, age, family income, parents' education, and other demographic variables with acceptance of evolution, climate change, and other scientific theories. Although we expected political affiliation and one's belief in God(s)/commitment to religion to be predictive of acceptance of climate change and evolution, respectively, we found that political affiliation is correlated with 98% of all relevant response metrics for both evolution and climate change, while religious convictions were correlated with 100% of evolution metrics and 83% of climate change metrics. Further, acceptance of evolution and climate change are significantly correlated in 95% of all response variables, suggesting that anti-evolution and anti-climate change individuals are the same individuals. Surprisingly, prior science content (i.e., if evolution, human evolution, creationism, or intelligent design was taught) and background (i.e., number and types of courses taken) is less predictive of one's acceptance of evolution and climate change. However, an increased interest in science (i.e., if one keeps up with scientific discoveries in the news) is significantly related to a student's increased acceptance of these theories. As paleontologists, we have a unique opportunity and responsibility to increase student interest in science through the communication of scientific discoveries to public and student audiences.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DIGITAL MODELING AND 3D VISUALIZATION OF THE AXIAL SKELETON OF THE EARLY PERMIAN CAPTORHINID REPTILE *LABIDOSAURUS*

DEVLIN, Kathleen, California State University San Bernardino, San Bernardino, CA, United States, 92407; JEFCOAT, Brian, DreamWorks Feature Animation, Glendale, CA, United States; SUMIDA, Stuart, California State Univ San Bernardino, San Bernardino, CA, United States

The basal captorhinid reptile *Labidosaurus* is known from Early Permian deposits in Baylor County, north-central Texas (Clear Fork Group undivided, formerly Arroyo Formation). Its postcranial skeleton has been previously studied and partially illustrated. However, because the most completely articulated specimens could not be fully prepared it has never been fully reconstructed and body outline interpretations remained speculative. Newly examined specimens and additional preparation of previously described specimens has allowed for 3D laser surface scanning of the entire presacral column and subsequent digital modeling of the complete axial skeleton using the computer modeling and animation software package Maya. A movable 3D reconstruction of the axial skeleton was then possible. Well preserved individual elements from the same locality (Olson's "*Labidosaurus* pocket") were also scanned and digitally resized to allow more complete reconstruction of sections of the column that remained inaccessible due to matrix. Damage due to cracks could be removed while retaining the exact measure and proportions of each individual vertebral element. A confident estimation of the spacing of the skeletal elements in the completely articulated specimens could be made. The complete presacral column is barely twice the length of the skull. Reconstruction of the life-positions of the ribs indicates that *Labidosaurus* did not have a large, barrel shaped body suggestive of high-fiber herbivory. Further, its body outline was probably narrower than the width of caudal margin of its large heart-shaped head.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CAN SKULL SHAPE INDICATE AGGRESSIVE BEHAVIOR IN SEALS?

DEWAR, Eric, Suffolk Univ, Boston, MA, United States, 02114; CROCKER, Carly, Suffolk University, Boston, MA, United States

Many living seal species show varying degrees of aggression and other intraspecies displays. Could skull shape dimorphism be related to aggression in seals? We tested the hypothesis that more aggressive species (and sexes) would have different skull proportions than less aggressive ones. We characterized living seals as "highly" or "less" aggressive species, based on behaviors reported for them in the literature. Highly-aggressive species were identified throughout the Phocidae, so we believed that any differences in morphology would be due to behavior or ecology rather than phylogeny. We photographed skulls of 14 species of living and extinct seals ($n = 76$) and measured each skull's total length, cranial length, facial length, cranial width, and zygomatic arch width to seek indicators of dimorphism.

We found that the most aggressive species were not necessarily the largest individuals. As a group, individuals of the highly-aggressive species had relatively wider zygomatic arches for their skull size than less-aggressive species ($t_{69(1)} = 4.29$, $p < 0.0001$). The zygomatic arches of more aggressive species were also wider than their crania ($t_{69(1)} = 3.99$, $p < 0.0001$). Together, these morphologies probably reflect the emplacement of larger jaw-closing muscles that could be used in biting and holding during combat. More aggressive species also had larger nuchal crests regardless of their absolute skull size, which is probably an indication of rear-and-slam behaviors.

In our sample, only one highly aggressive species (*Crystophora crista*) had individuals that had been identified to sex. We found that males had wider zygomatic arches than their crania ($t_{3(1)} = 3.15$, $p = 0.03$) and a longer face than cranium ($t_{3(1)} = 3.63$, $p = 0.03$). Less aggressive species did not differ in these measures. From these observations, we were able to hypothesize the relative degree of aggression of the extinct species such as the Caribbean monk seal *Monachus tropicalis*, which fell within the highly-aggressive group.

Symposium 1 (Wednesday, October 30, 2013, 11:45 AM)

FUNCTION OF RUDIMENTARY LOCOMOTOR STRUCTURES IN THE ECOLOGY OF BIRDS: EVOLUTIONARY IMPLICATIONS

DIAL, Kenneth P., Univeristy of Montana, Missoula, MT, United States, 59812

Charles Darwin's theory of natural selection revolutionized the way we think about life and its history. From the beginning, however, one major challenge for Darwin was "organs of extreme perfection and complication". Natural selection could explain how small phenotypic differences that already existed within a population might confer greater fitness and be selected for, but how do complex structures actually appear in the first place? How do incipient, transitional, or morphing structures function? Answering these types of questions is central to understanding major transformations, such as the developmental or evolutionary acquisition of flight in birds. Yet the functional utility of incipient or "rudimentary" (evolving, developing, or secondarily reduced) structures, even among extant species negotiating their natural habitats, is largely unknown. This general lack of understanding may result from an assumption that underdeveloped and vestigial structures are functionally useless. However, studies examining the ontogenetic locomotor behavior of extant avian species (ranging from basal to derived) show that during the developmental acquisition of powered flight, immature birds transition between terrestrial, aquatic, and aerial media by using their incipient wings and legs cooperatively. Such behaviors are also relevant to adult birds with secondarily reduced wings. Here, I present results from recent lab and field studies on the locomotor development of avian species with different life history trajectories and different habitat preferences. Results to date suggest that: (1) there are tradeoffs between wing and leg investment and locomotor performance, which may be ameliorated by the cooperative use of wings and legs, and (2) differential predation pressure is correlated with wing and leg investment and fast versus slow developmental life history trajectories. Studies of post-natal locomotor development and recruitment of secondarily reduced structures offer unique opportunities to experimentally explore form-function relationships and ecologically relevant behaviors of transitional stages in many groups, and thereby enhance our understanding of evolutionary transformations.

Technical Session I (Wednesday, October 30, 2013, 10:15 AM)

PHYLOGENETIC ANALYSIS AND PALAEOBIOGEOGRAPHY OF THE PANGAEAN LOWER TRIASSIC LYDEKKERINIDAE (TEMNOSPONDYLI, STEREOSPONDYLI)

DIAS-DA-SILVA, Sérgio, Universidade Federal do Pampa, São Gabriel, Brazil; HEWISON, Robin, Universidade Federal do Pampa (invited colaborator), São Gabriel, Brazil

The composition of the Lower Triassic Lydekkerinidae and its taxonomic relationships remain poorly understood, despite much research. In this contribution, the first comprehensive computer-based parsimony analysis of all taxa that have been previously regarded as lydekkerinids (excepting the fragmentary, taxonomically doubtful, and uninformative *Cryobatrachus* and *Indobentosuchus*), together with a wide range of other taxa purported to have taxonomic affinities with them is performed. The phylogenetic analysis involved 154 characters and 31 terminal species, and aimed to provide a 'robust' phylogeny of the family and its phylogenetic relationships to other stereospondyls. Lydekkerinidae was found to be a monophyletic group (consisting of ten taxa) divided into two monophyletic subfamilies: subfamily A comprising *Limnoiketes paludinatans*, *Putterillia platyceps, Deltacephalus whitei, Lydekkerina huxleyi, Eolydekkerina magna*, and *Broomulus dutoiti*) and subfamily B comprising *Lydekkerina panchetensis, Chomatobatrachus halei, Luzocephalus blomi*, and *Luzocephalus kochi*). *Lapillopsis nana* was found to be the sister taxon of the Lydekkerinidae. The phylogenetic analysis also recovered a congruent palaeobioeogeographic distribution of the lydekkerinids: subfamily B is divided into two less inclusive clades, one including Indian and Australian taxa, and the other including European forms. On the other hand, the more inclusive subfamily A includes five South African taxa plus Deltacephalus from Madagascar. Unexpectedly, the recovered strict consensus tree did not support lydekkerinids as offspring of the Rhinesuchidae as stated in many previous contributions. Instead, a controversial result places Lydekkerinidae as a derived clade in a sister group relationship with a clade that embraces brachyopoids and dvinosaurians. As the basal rhinesuchoid stereospondyl *Rhineceps nyasensis* and several non-lydekkerinid stereospondyls included in the ingroup come from South Africa (and also the rhinesuchid-like *Arachana nigra* and other basal forms from Uruguay and Brazil), a western Gondwanan origin for Stereospondyli is fully supported in this contribution.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

MICROWEAR PATTERNS OF THE TITANOSAURIAN TEETH FROM THE LATE CRETACEOUS OF "LO HUECO" (CUENCA, SPAIN)

DÍEZ DÍAZ, Verónica, Universidad del País Vasco/Euskal Herriko Unibertsitatea, Bilbao, Spain; ORTEGA, Francisco, UNED, Madrid, Spain; SANZ, José Luis, Universidad Autónoma de Madrid, Madrid, Spain

The microwear patterns on the apical facets of sauropod teeth are interesting as a source of complementary information for the study of diets, and ontogenetic or interspecific niche partitioning. Some wear analyses have been developed for titanosaurian teeth (i.e., in Argentina and southwestern Europe). For the Spanish record, these analyses were carried out on samples from the Laño fossil-site (Condado de Treviño) attributed to the titanosaur *Lirainosaurus astibiae*. In these samples, teeth interpreted as belonging to adults present a microwear pattern in the apical wear facet with a high ratio of pits, which could be explained by the ingestion of tougher vegetation and/or grit. On the other hand, several teeth from the French fossil site of Fox-Amphoux-Métisson (département de Var) show an apical wear facet with a predominance of scratches, probably because of a diet based on soft vegetation with little ingestion of abrasive dust.

In the Upper Cretaceous fossil site of "Lo Hueco" (Cuenca, Spain), two different titanosaurian tooth morphotypes are found: a robust one, characterized by asymmetric crowns with an almost D-shaped cross-section; and a slender morphotype, characterized by cylindrical crowns with mesial and distal ridges, and a "lemon-shaped" cross-section. Both morphotypes show different microwear patterns on their apical wear facets. The robust morphotype presents smooth scratches, most oriented subparallel to the apico-basal axis, while the slender morphotype shows a coarser pattern, with well-marked scratches ending in deep pits (similar to a "meteor shower"). In this morphotype the scratches are regularly oriented parallel to the apico-basal axis of the apical wear facet. These microwear divergences could be explained as the intake of different diets for both "Lo Hueco" titanosaurian morphotypes.

In addition, microwear patterns and crown morphology of the robust morphotype are similar to that found in teeth from Fox-Amphoux-Métisson (France), but also in the French fossil-site of Massecaps (département d'Hérault). On the other hand, the general crown morphology of the slender morphotype is fairly similar to the one attributed to *Atsinganosaurus velauciensis* from Velaux (department de Var, France), but further study of more titanosaurian cranial and postcranial remains from "Lo Hueco" has to be carried out for a more accurate determination of its titanosaurian fauna.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE CARPUS AND TARSUS OF TEMNOSPONDYLI

DILKES, David, Univ of Wisconsin Oshkosh, Oshkosh, WI, United States, 54901

Carpals and tarsals are among the most poorly known bones of the skeleton in early tetrapods because the bones are either completely cartilage and not preserved, partially ossified revealing little details of their original shape, or simply absent in known specimens. Temnospondyls typically have the best preserved carpal and tarsal bones, and the carpus of *Eryops megacephalus* and tarsus of *Acheloma cumminsi* are the most thoroughly described and illustrated for early tetrapods. A new study of the carpus of *Eryops* confirms only four digits and no evidence of a prepollex, postminimus, or a distal carpal 5. The surface on the distal end of centrale 1 supposedly for a prepollex is a portion of the contact surface for metacarpal 1 that included distal carpal 1. A notch in the intermedium does not articulate with a corner of the radius as previously thought. A section at the distal end of the ulna interpreted as a surface for a postminimus contacts the ulnare. Preparation of the tarsus and digits of the type of *Trematops milleri* (junior synonym of *Acheloma cumminsi*) revealed an oval fibulare with a v-shaped distal end, contact between the tibiale and centrale 2, and a ventrally concave centrale 4 with an expanded articular surface for the tibiale that continues onto the ventral side and a narrower contact for the fibulare. Restudy of the carpus and tarsus of the dissorophoid temnospondyls *Dissorophus multicinctus* and *Cacops aspidephorus*, the carpus of *Acheloma*, and study of an undescribed tarsus of *Eryops* has provided phylogenetic data. Centrale 4 of the carpus of temnospondyls, except for stereospondyls with typically less ossified carpals and tarsals, has a triangular shape consisting of a broad contact with centralia 3 and 4 and distal carpal 3 tapering to a blunt tip between the ulnare and metacarpal 4. The shape of centrale 4 in the tarsus noted for *Eryops* and a contact with distal tarsal 4 are present in other temnospondyls including the stereospondyl *Sclerocephalus*. Non-temnospondyls such as *Greererpeton* and *Proterogyrinus* have a centrale 4 with a diamond shape that lacks contact with distal tarsal 4.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CROCODYLIFORM BITE MARKS ON AN ARTICULATED *GRYPOSAURUS* (DINOSAURIA: HADROSAURIDAE) CRANIUM FROM THE UPPER CRETACEOUS OF SOUTHERN UTAH

DINTER, Cory, University of Utah, Salt Lake City, UT, United States, 84112; IRMIS, Randall, University of Utah, Salt Lake City, UT, United States

The feeding behavior of extinct vertebrate animals rarely leaves direct evidence in the fossil record. Bite marks and other tooth traces are a noteworthy exception; they are an unambiguous record of trophic relationships. Among Mesozoic terrestrial vertebrate fossils, most studies have focused on traces made by theropod dinosaurs on postcranial elements such as ribs and limb bones. A newly discovered cranium of the hadrosaurid ornithopod dinosaur *Gryposaurus*, from the upper Campanian Kaiparowits Formation of southern Utah, possesses multiple tooth traces. Bite marks are observed in two sets: four shallow, parallel mediolaterally-oriented scores on the dorsal surface of the skull roof across the nasal/prefrontal, and three deeper mediolaterally-oriented parallel scores on the ventral surface of the right dentary. The alignment of the traces indicates that they were inflicted upon a still-articulated skull and jaw, despite the fact that the lower jaws were disarticulated before final burial. This might suggest the possibility that these bite marks record an act of predation on a live animal, although scavenging cannot be ruled out. Only two known vertebrate carnivores in the Kaiparowits assemblage were large enough to have inflicted these wounds: tyrannosaurid theropod dinosaurs and large crocodyliforms. The marks preserved on the *Gryposaurus* skull and jaw are long, shallow scores with a U-shaped cross-section, nearly identical to those made by extant crocodylians. In contrast, tyrannosaurids and other theropods leave deeper and narrower scores with V-shaped cross-sections. These new data therefore provide rare direct fossil evidence of a Late Cretaceous crocodyliform biting the head of large-bodied prey, either during a predation event or post-mortem during feeding or scavenging.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ICHTHYOFAUNA OF THE CYPRESS HILLS FORMATION (LATE EOCENE–EARLY OLIGOCENE), EASTEND AREA, SASKATCHEWAN, CANADA

DIVAY, Julien, Univ of Alberta, Edmonton, AB, Canada, T6G 2E9; MURRAY, Alison, Univ of Alberta, Edmonton, AB, Canada

The Cypress Hills Formation of southwestern Saskatchewan, Canada, has been the focus of considerable attention for its mammalian local faunas, and its herpetofauna has also been described. However, little has been reported on the fossil fishes found in these beds. Here, we describe material recovered from localities in the Eastend area of the formation, mostly corresponding to the Calf Creek local mammalian fauna. The fossils were identified based on comparisons with modern and fossil material. The ichthyofauna is diverse, comprising at least fourteen taxa recognized at various taxonomic levels. It includes Lepisosteidae (gars), Amiinae (bowfins), Hiodontidae (mooneyes), a large probable ostariophysan, at least three cypriniforms (among which are an unidentified taxon, a catostomid sucker and a large leusiscine minnow), at least two ictalurid catfishes, one of which is the largest fish of the assemblage, a probable protacanthopterygian (?pike), an amblyopsid-like percopsiform (cave and troutperches), a ?Moronidae (temperate basses), at least two perciforms including one or more Centrarchidae (sunfishes), and several more taxa that remain indeterminate. This fauna is indicative of a diversity of fluvial lowland environments, corroborating sendimentological evidence that the formation was deposited on a braided river system floodplain. The abundance of small catfish material suggests that most deposits were laid in shallow, relatively sluggish backwaters, but the fauna as a whole includes indications of well-oxygenated conditions, deep water environments, abundant aquatic vegetation and a variety of flow strengths and water clarities. The ichthyofauna also corroborates the palaeoclimatic reconstructions based on the herpetofauna of the formation. Subtropical temperatures similar to those of the Gulf Coast of the United States are indicated by the composition of this fauna, as well as by the large sizes attained by some taxa. There are a number of significant elements in this material, including the earliest occurrence of a moronid in North America, the most northerly occurrence of an amblyopsid, and a case of climatically-driven gigantism in the Ictaluridae.

Technical Session XV (Saturday, November 2, 2013, 9:45 AM)

THE SIRENIAN GENUS *METAXYTHERIUM*: WHAT'S UP WITH THOSE ANIMALS??

DOMNING, Daryl, Howard Univ., Washington, DC, United States, 20059; VELEZ-JUARBE, Jorge, Florida Museum of Natural History, Gainesville, FL, United States

Metaxytherium (Mammalia, Dugongidae) is one of the most widespread, long-lived, species-rich, commonly fossilized – and taxonomically troublesome – genera of Sirenia. Its morphologically conservative nature had, until recently, made it difficult to properly define this genus. In recent years, however, much has been done to clarify its contents, relationships, and eventful evolutionary history. Originally known only from the Miocene and Pliocene, its presence in the New World late Oligocene is now established, along with that of a new, early Oligocene genus likely ancestral to it. An apparently anagenetic lineage of West Atlantic-East Pacific species persisted into the late Miocene. A parallel European-Mediterranean lineage may also have begun in the late Oligocene, and ended only in the mid-Pliocene. Both showed a tendency towards increasing body size. However, the zoogeographic connections between these lineages are unclear, and the early to late Miocene members of both lineages exhibit near-stasis in morphology – something not seen elsewhere in the Sirenia. The latest Miocene and Pliocene Mediterranean species, in contrast, display relatively rapid evolution, along with ecophenotypic dwarfing during the Messinian Salinity Crisis. A long-standing puzzle, the mid-Miocene (Badenian) "*M. petersi*" from the Vienna Basin, seems to be at most a peripheral variant of the western European type species *M. medium*. At the opposite, East Pacific end of the genus' range, *M. arctodites* is the sister group and structural ancestor of the Hydrodamalinae (*Dusisiren* + *Hydrodamalis*), rendering the halitheriine genus *Metaxytherium* paraphyletic.

For the most part, these tropical marine herbivores may have owed their success to being ecological generalists that fed on seagrass leaves and the rhizomes of the smaller seagrass species. For most of their history, they coexisted with more diverse and morphologically flamboyant but more specialized and shorter-lived species of Dugonginae, which evidently ate larger and tougher rhizomes. Notably conservative in retaining small tusks through most of the Miocene, *Metaxytherium* then diversified surprisingly, in opposite directions: losing tusks altogether as they evolved into hydrodamalines in the Pacific, but growing much larger, dugongine-like tusks in the Mediterranean species *M. serresii* and *M. subapenninum*. Clearly, past evolutionary performance is no guarantee of future results!

Technical Session II (Wednesday, October 30, 2013, 8:15 AM)

WAS THE GIANT SHORT-FACED BEAR *ARCTODUS SIMUS* A HYPER-SCAVENGER? A NEW APPROACH TO THE DIETARY STUDY OF URSIDS USING DENTAL MICROWEAR TEXTURES

DONOHUE, Shelly, Vanderbilt University, Nashville, TN, United States, 37235; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States; SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, United States; UNGAR, Peter, University of Arkansas, Fayetteville, AR, United States

The Pleistocene short-faced bear, *Arctodus simus* was the largest member of the order Carnivora to traverse North America, yet whether this giant was primarily an active predator, opportunistic omnivore, or bone crushing hyper-scavenger remains unknown. Dental microwear has the potential to offer new insight into this debate. Here, we investigate the application of dental microwear texture analysis to bears through compiling a baseline that correlates microwear attributes of lower first and second molars (m1 and m2, respectively) to known feeding behavior in modern bears. Resulting baseline data is then used to evaluate the hypothesis that *Ar. simus* was a bone consuming hyper-scavenger at Rancho La Brea, California. Results of texture analysis evince significant variation along the tooth row, with the crushing/grinding functionality of the m2 serving as a better dietary recorder than the slicing/shearing m1 carnassial. Texture analysis of the m2 shows significant variation among extant species that correlates with physical properties of known diets. Microwear complexity (*Asfc*) is significantly higher, and more variable for carnivorous and omnivorous ursids (*Ursus maritimus*, mean *Asfc* = 8.49; *U. americanus*, mean *Asfc* = 7.85) in comparison to more herbivorous bears (*Ailuropoda melanoleuca*, mean *Asfc* = 1.996; *Tremarctos ornatus*, mean *Asfc* = 4.172; *U. malayanus*, mean *Asfc* = 3.96). High anisotropy (*epLsar*) further differentiates *A. melanoleuca* (*epLsar* = 0.0039) from *U. maritimus* (*epLsar* = 0.0022) and *U. americanus* (*epLsar* = 0.0022). *Arctodus simus* exhibits wear attributes most similar to its closest living relative (*T. ornatus*), with significant differences ($p<0.05$) in at least one microwear attribute differentiating it from other extant bears. Our results indicate that *Ar. simus* was not consuming hard objects (e.g., bone) at Rancho La Brea, and are thus inconsistent with the hypothesis that short-faced bears were bone crunching hyper-scavengers across their range. Collectively, our work demonstrates the potential of dental microwear texture analysis to reveal the dietary ecology of extant and extinct bears across diverse geographic regions and through deep time.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DESCRIPTION OF A NEW MIOCENE HEGETOTHERIID NOTOUNGULATE FROM CERDAS, BOLIVIA

DREW, Nicholas, Case Western Reserve University, Cleveland, OH, United States, 44106; CROFT, Darin A, Case Western Reserve University, Cleveland, OH, United States; ANAYA, Federico, Universidad Autonoma Tomas Frias, Potosi, Bolivia

Notoungulates are extinct, endemic South America herbivores that ranged throughout South America during most of the Cenozoic. This study focuses on the typothere family Hegetotheriidae, a group of rodent or rabbit-like notoungulates that lived in South America from the early Oligocene through early Pleistocene. In particular, we describe hegetotheriid remains from the ~16 million-year-old site of Cerdas, Bolivia, which is situated on the eastern Bolivian Altiplano (21° 52' S, 66° 19' W), several kilometers southeast of the village of Cerdas (approx. 60 km southeast of Uyuni). Eight specimens were studied including several partial mandibles preserving posterior premolars and molars, a partial maxilla with P3-P4, two fragmentary dentaries preserving alveoli of the anterior dentition, several isolated cheek teeth, an upper incisor, and two calcanei. The specimens are referred to the Hegetotheriinae based on the absence of a strongly trilobed m3 talonid, lack of conspicuous diastemata among i2-p2 alveoli, and a relatively small I1. A Hegetotheriine affinity is supported by the two Cerdas calcanei, which are more similar to *Hegetotherium* than *Pachyrukhos* in having a circular sustentacular facet, a large navicular facet, and an only moderately rugose tuber. The Cerdas species differs from *Prohegetotherium* in lacking a labial groove near the anterior margin of the upper cheek teeth. The p3 of the Cerdas species differs from that of *Sallatherium* in having the trigonid shorter than the talonid; the opposite is true in *Sallatherium*. It differs from *Hemihegetotherium* in having upper and lower cheek teeth with flat rather than convex lingual faces and in having a more rounded molar trigonid. The Cerdas species is conservatively referred to the genus *Hegetotherium* based on its generally rectangular upper cheek teeth and semi-elliptical talonids. However, the lack of a shallow buccal groove on the m3 talonid suggests it may pertain to a distinct genus. A phylogenetic analysis testing this proposition is in progress. Linear measurements of the Cerdas specimens are 20–30% smaller than those of other hegetotheriines and fall outside the range of variation of 120 *Hegetotherium mirabile* specimens from Santa Cruz, Argentina. Thus, it clearly represents a distinct species. The absence of pachyrukhines from early and middle Miocene faunas of northern Chile and Bolivia suggests that small hegetotheriines such as the new Cerdas species may have occupied a pachyrukhine-like ecological niche in the middle latitudes of South America during this interval.

Romer Prize Session (Thursday, October 31, 2013, 8:45 AM)

QUANTIFYING PERIODS OF DIFFUSION IN MARINE AND TERRESTRIAL MAMMALIAN VERTEBRATE FOSSILS USING RARE EARTH ELEMENTS

DREWICZ, Amanda, Boise State University, Boise, ID, United States, 83702

Rare earth (REE), trace elements (TE) and isotopes in vertebrate fossils have been used to study taphonomy/reworking, stratigraphic correlation, paleoenvironment reconstruction and fossilization processes. REE/TE/isotopes diffuse into bone during fossilization. The period of diffusion limits the temporal resolution of paleoenvironmental interpretations made from REE/TE/isotopes. Periods of incorporation have been calculated in only a few studies and additional measurements will better refine temporal resolution of geochemically based paleoenvironmental reconstructions. Five Late Eocene brontothere bones from the White River Group and four Miocene marine mammals from the Atlantic Coastal Plain were analyzed for REE/TE concentrations using Laser Ablation Inductively Coupled Plasma Mass Spectrometry. Of the five brontothere bones, four were from the same bonebed. An outer circumferential layer (OCL) was preserved on the margin in two brontothere bones and had lower concentrations than underlying bone, suggesting a lack of REE/TE incorporation into the OCL or subsequent leaching. Elevated concentrations were noted surrounding some osteon channels, indicating that Haversian systems may act as fluid conduits, bringing unreacted fluid into bone. REE depth fractionation tends to be less pronounced in marine bones (when compared to terrestrial bones) which may result from a greater influence of secondary diffusion pathways (Haversian systems). Diffusion periods for six REE were internally consistent and ranged from 0.9+/-0.2 to 2.8+/-0.6 ka in marine bones and 2.2+/-0.5 to 54.8+/-1.5 ka for terrestrial bones. Faster diffusion periods within marine bones suggest that fossilization occurs over a shorter timespan in saturated environments. Diffusion periods differed in brontothere bones from a single bonebed, which has implications for the fidelity of bulk sample analyses regarding temporal resolution of REE/TE/isotopes in paleoenvironmental reconstructions. Previous studies have reported soft tissue preservation within fossil bone and concluded that the rate of diffusion must have outpaced the rate of decay in order to preserve soft tissue. Rates of REE/TE diffusion suggest that biomolecule preservation in deep time would be favored in saturated environments (marine, lacustrine, channel).

Symposium 4 (Saturday, November 2, 2013, 10:30 AM)

EVIDENCE FOR A DISTINCT EARLY MAASTRICHTIAN POLAR DINOSAUR FAUNA FROM THE PRINCE CREEK FORMATION OF NORTHERN ALASKA

DRUCKENMILLER, Patrick, University of Alaska Museum, Fairbanks, AK, United States, 99775; ERICKSON, Gregory, Florida State University, Tallahassee, FL, United States; BRINKMAN, Donald, Royal Tyrrell Museum, Drumheller, AB, Canada; BROWN, Caleb, University of Toronto, Toronto, ON, Canada; MORI, Hirotsugu, University of Alaska Museum, Fairbanks, AK, United States

Dinosaur biogeography in Laramidia, a Late Cretaceous landmass with an area approximately 20% that of present North America, remains controversial. While some recent studies of Campanian-aged faunas posit the existence of multiple distinct, latitudinally arrayed provinces and/or areas of regional endemism, others argue that Maastrichtian dinosaur faunas as a whole were largely homogenous. A major limitation of these studies has been that a robust data set on faunal composition from Arctic paleolatitudes of Laramidia has been lacking. A second problem has stemmed from the lack of temporal resolution between fossiliferous formations used in biogeographic analyses. We address the question of dinosaur endemism in the Western Interior through latitudinal comparisons of a polar fauna, the early Maastrichtian Prince Creek Formation (PCF) of northern Alaska, with a contemporaneous lower latitude fauna from the upper Horseshoe Canyon Formation of southern Alberta, Canada. The PCF was deposited on a low gradient, Arctic coastal plain environment at approximately 80°N – as far north as land existed at that time – while the Horseshoe Canyon Formation was deposited at approximately 58°N. Faunal composition data for the PCF is based on a taxonomic

reanalysis of known material and new data derived from macro- and microfossils. Our comparisons indicate that while several PCF dinosaurs are congeneric with taxa known from lower latitudes, there exists a high degree of species-level endemism in the formation among both ornithischians and theropods, including *Pachyrhinosaurus*, *Edmontosaurus*, *Parksosaurus*?, *Orodromeus*?, *Richardoestesia*, and *Troodon*. An endemic genus of pachycephalosaur, *Alaskacephale*, is also present, and the taxonomic status of two dromaeosaurids and a tyrannosaurid remains unclear. The high degree of endemism present in the PCF suggests the existence of a distinctive, northern-most early Maastrichtian North American fauna that we provisionally refer to as the Paanaqtat Province.

Romer Prize Session (Thursday, October 31, 2013, 9:00 AM)

PHYLOGENETIC TAPHONOMY: SYNTHESIZING BITE MARK DATASETS USING STATISTICAL AND CLADISTIC METHODS

DRUMHELLER, Stephanie, The University of Tennessee, Knoxville, TN, United States, 37996-1410

Extant proxies used in experimental taphonomy often are selected based on morphological similarities and phylogenetic relationships, but typically few exemplars are used in any given analysis. The potential role of phylogeny in informing the expansion of comparative taphonomic data remains underexplored. Here I present patterns of bite marks made by crocodylians and explore statistical and phylogenetic methods for synthesizing bite mark datasets. I compared and contrasted rates of mark type between two datasets, a previously published survey of *Crocodylus niloticus* and new research on *Alligator mississippiensis*. Bite mark types found in the *C. niloticus* sample, previously argued to be diagnostic of crocodylians, were found in my study in similar rates on bones modified by members of *A. mississippiensis*. I also found more destructive bone modifications, not observed in the *C. niloticus* study, in the *A. mississippiensis* sample. This illustrates the potential pitfalls of applying patterns from one exemplar across a diverse clade, since *A. mississippiensis* seems to utilize a slightly different feeding strategy from *C. niloticus*. To further explore clade-wide patterns of bite mark types in Crocodylia, I surveyed traces made by 21 of the 23 generally recognized species of extant crocodylians. Bones modified by members of each species were coded for presence or absence of potentially diagnostic mark types. Statistical tests for correlation were performed on bite mark types, animal vital statistics, and experimental collection protocols. Diagnostic mark types were mapped as character states on a well-supported eusuchian phylogeny. The success of predictions of the types of marks expected in extinct groups was then tested using previously published examples from the fossil record. Presence of expected mark types was accurately predicted in those case studies. The phylogeny also provided a framework for when and where this method might best be applied, highlighting clades with distinct dental morphologies, and possibly corresponding behaviors, not observed in extant groups. Inclusion of fossil bite marks which have been positively associated with extinct species allow this method to be expanded beyond the crown group. The results of this study illustrate the informative value phylogeny holds as a predictive tool in taphonomic studies.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A LARGE NEW CROCODYLOMORPH (SUCHIA, ARCHOSAURIA) WITH BIZARRE SKULL MORPHOLOGY FROM THE UPPER TRIASSIC OF NORTH CAROLINA

DRYMALA, Susan, North Carolina State University, Raleigh, NC, United States, 27606; ZANNO, Lindsay, North Carolina Museum of Natural Sciences, Raleigh, NC, United States; NESBITT, Sterling, Field Museum of Natural History, Chicago, IL, United States; SCHNEIDER, Vincent, North Carolina Museum of Natural Sciences, Raleigh, NC, United States

Triassic crocodylomorphs existed as small, gracile forms ('sphenosuchians') and were the only crocodile-line archosaurs to survive the end-Triassic extinction. Recent analyses suggest that their closest relatives were a group of large-bodied predators known as 'rauisuchians'. However, a large morphological disparity remains between crocodylomorphs and other pseudosuchian clades. Here we present a bizarre new archosaur from the Upper Triassic Pekin Formation of North Carolina, USA that displays a mosaic of crocodylomorph, rauisuchid, and dinosaurian characters, as well as bizarre ornamentation on the lateral surface of the jugal and lacrimal. The specimen (North Carolina Museum of Natural Sciences specimen NCSM 21588) is represented by a partial skull (premaxilla, partial maxilla, lacrimal, jugal, articular, and angular) and several postcranial elements (cervical neural arch, dorsal neural arch, distal caudal centrum, several ribs, and the majority of the right humerus). The skull of NCSM 21588 is estimated at over 50 cm in length, suggesting that it is one of the largest Triassic crocodylomorphs discovered to date. Our phylogenetic analysis of 61 archosauromorphs and 412 characters (1775 most parsimonious trees [MPTs], 1145 steps) recovers NCSM 21588 as the most basal crocodylomorph with a monophyletic Rauisuchidae as the sister-taxon to Crocodylomorpha. Characters shared between NCSM 21588 and Rauisuchidae include presence of ectepicondylar groove on distal humerus (shared with other pseudosuchians), deep groove on articular separating the glenoid and posterior process, and hyposphene-hypantrum articulations on posterior cervical vertebrae. Characters uniting NCSM 21588 with Crocodylomorpha include 5 premaxillary teeth, unfused interdental plates, lacrimal extending the full height of the orbit, and distinct concavity on the posterodorsal surface of the posterior process of articular. NCSM 21588 also possesses a bifurcated posterior process of the jugal, a characteristic shared with Dinosauria. The novel combination of skeletal characteristics shared with other Triassic carnivores, unique skull shape of NCSM 21588, and unusually large body size documents an unexpected step in Late Triassic paracrocodylomorph evolution.

Technical Session VI (Thursday, October 31, 2013, 9:30 AM)

NEW PRIMATE POSTCRANIA FROM THE EARLY EOCENE OF VASTAN MINE, GUJARAT, INDIA

DUNN, Rachel, University of Missouri, Columbia, MO, United States, 65212; ROSE, Kenneth, Johns Hopkins Univ, Baltimore, MD, United States; KUMAR, Kishor, Wadia Institute of Himalayan Geology, Uttarakhand, India; RANA, Rajendra, HNB Garhwal University, Uttarakhand, India; SMITH, Thierry, Institut Royal des Science Naturelles de Belgique, Brussels, Belgium

The Cambay Formation at Vastan Mine in Gujarat yields the oldest fossil primates known from India. New age estimates suggest that the fossils date from approximately 54.5 Ma (early Ypresian), about 2 million years older than initially thought and comparable in age to early Wasatchian Wa-4 faunas from North America. The Vastan primate fauna comprises predominantly the asiadapine adapoids *Marcgodinotius* and *Asiadapis*. Two species of omomyid primates, *Vastanomys gracilis* and *V. major*, are much rarer, each known from a single dental specimen. In addition to primate dental remains, Vastan Mine has produced the best preserved early Eocene primate postcranial elements known from anywhere in the world. Here we present new limb bones, including humeri, ulnae, femora, tibiae, and a talus, from three of the recognized primate species. They include the first omomyid postcrania from India: two femora, a talus, and a potential proximal tibia. We also report additional asiadapine postcrania: a pristine femur of *Marcgodinotius* and the first complete tibia of *Asiadapis*. Five new humeri (two complete) consist of one asiadapine and four that lack specializations of either group, making allocation difficult. Two ulnae are attributed to indeterminate euprimates due to lack of adequate comparative material. The elements attributed to *Vastanomys* are more primitive than any other known omomyid postcrania and are only subtly different from those of asiadapines, in contrast to the more distinct postcranial bones of their middle and late Eocene relatives. The femora attributed to *Vastanomys* exhibit features suggestive of leaping behavior (cylindrical femoral heads, lateral condyle higher than medial, proximal position of the third trochanter), as in other omomyids. However, while the talus of *Vastanomys* resembles those of omomyids more than those of other primates, features such as the relatively short, medially angled neck, and oval rather than spherical head suggest that *Vastanomys* was not as specialized for leaping as younger omomyids. Although asiadapines have been described as close to notharctids in morphology, the relatively wider distal femur and symmetrical condyles of *Marcgodinotius* resemble adapids more than notharctids and may also reflect less leaping. The revised age of the fossils, together with the similarity in morphology of omomyid and asiadapine postcrania, suggests that the postcrania, like the teeth of the most primitive members of each family, are converging toward a common morphology as we approach the base of the Eocene.

Technical Session XIII (Friday, November 1, 2013, 2:30 PM)

THE ORIGIN OF THE JAWED VERTEBRATE FACE: NEW INSIGHTS FROM A SYNCHROTRON SCANNED SKULL OF THE PRIMITIVE PLACODERM *ROMUNDINA*

DUPRET, Vincent, Uppsala University, Uppsala, Sweden; SANCHEZ, Sophie, Uppsala University, Uppsala, Sweden; GOUJET, Daniel, Museum National d'Histoire Naturelle, Paris, France; TAFFOREAU, Paul, European Synchrotron Radiation Facility, Grenoble, France; AHLBERG, Per, Uppsala University, Uppsala, Sweden

Jawless cyclostomes and jawed gnathostomes show very different face patterns. Cyclostomes have a single median nasohypophysial duct, an anterior hypophysis and a short telencephalon, while gnathostomes have a pair of nasal sacs opening externally, a more posterior separate hypophysis opening in the palate and a longer telencephalon. Embryonic processes differ as well. In cyclostomes, infraorbital premandibular crest cells migrate forwards either side of the nasohypophysial placode to form the upper lip; in gnathostomes they migrate between the hypophysial and nasal placodes to form the trabecular-ethmoid region. Supraoptic neural crest remains posterior to the nasohypophysial duct in cyclostomes; it moves forward to create the nasal capsules in gnathostomes. Some fossil forms illustrate a sequenced transition between these two patterns. The Silurian galeaspid (jawless stem gnathostome) *Shuyu* has a nasohypophysial duct, a short telencephalon, and an anteriorly oriented hypophysis, but the paired nasal sacs and hypophysis are separated by a rudimentary trabecula. A synchrotron scanned skull of the primitive Early Devonian placoderm (jawed stem gnathostome) *Romundina* shows a cranial cavity reminiscent of that of *Shuyu* (anteriorly directed hypophysis, very short telencephalon). The trabecular-ethmoid region is long and wide, extending anterior to the small nasal capsule which is located just in front of the orbits. We interpret these features as uniquely primitive among gnathostomes. In size and position the trabecular-ethmoid region of *Romundina* resembles the upper lip of cyclostomes and *Shuyu*, suggesting a cyclostome-like pattern of proliferation coupled with a gnathostome-like migration path for the premandibular crest. The position of the nasal capsule suggests that the supraoptic crest had not migrated forwards. A new phylogenetic analysis suggests that the evolutionary sequence for the creation of the extant gnathostome face from a cyclostome ancestral pattern involved 1) separation of the nasal and hypophysial placodes (galeaspids: *Shuyu*), 2) loss of the nasohypophysial duct (basal placoderms: antiarchs, *Brindabellaspis*, *Romundina*), 3) shortening and narrowing of the trabecular-ethmoid region, the nasal capsule becoming anterior (derived placoderms such as arthrodires); 4) lengthening of the telencephalon (crown gnathostomes). Galeaspid facial anatomy appears closer to gnathostomes than that of osteostracans, but it is unclear whether osteostracans are primitive or autapomorphic in this respect.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

MAPPING THE ORAL BIOLOGY OF THE AQUATIC TO TERRESTRIAL TRANSITION: DENTAL PATHOLOGIES AS A FUNCTION OF DIET, FEEDING LOCATION AND BEHAVIOR IN OTTERS, SEALS, AND SEA LIONS

DURRANI, Muhammad, NYIT College of Osteopathic Medicine, Old Westbury, NY, United States, 11568; BEATTY, Brian, NYIT College of Osteopathic Medicine, Old Westbury, NY, United States

The transition from terrestrial to aquatic among amniotes has happened many times, and each time they have adapted to the variety of physical and chemical variables of riparian, lacustrine, coastal, and marine environments. Examples of living animals whose species live in this variety of transitional environments are the Lutrinae and Pinnipedia. There are otters on most continents and pinnipeds in every large body of water. In this way, the modern diversity of otters and pinnipeds mirrors what one might expect to have occurred in the early transitional forms of whales and other aquatic amniotes. The oral environment of marine mammals is flush with water on a regular basis, having an effect on oral chemistry. Oral chemistry mediates the proliferation of bacteria and associated dental pathologies.

To explore the comparative effects of this, we studied 637 specimens of otters (Lutrinae), seals (Phocidae), sea lions (Otariidae) and walruses (Odobenidae) for osteological indicators of dental pathology. Pathologies such as malocclusions, caries, calculus formation, and periodontal disease (including alveolar bone erosion, periapical abscesses, and dento-alveolar abscesses) were evaluated, and logistic regressions of their frequencies between groups were analyzed to determine their correlative relationship to factors such as time spent in water, diet, feeding location (above or below water) and trophic level. This analysis indicates that feeding location affects the presence of periodontal disease, such that the fully aquatic pinnipeds (Phocidae, Otariidae, and Odobenidae) have a significantly smaller incidence of periodontal disease than more terrestrial otters. This may be more indicative of the tendency for otters to catch food underwater, but consume it on the surface, unlike pinnipeds. Among otters, diet (specifically hard-bodied prey items) correlates best with the frequency of periodontal disease, suggesting that increased frequencies of lesions to oral mucosa increase the frequency of disease. Similar patterns of pathology can be seen in the fossil and historic record of otters and pinnipeds, but sampling limitations has prevented us from comparing these frequencies. Animals transitioning to a fully aquatic lifestyle that requires swallowing food underwater, or those feeding on softer food items may reduce the risk of dental pathologies. It is unclear how much of a selective advantage this would provide, or whether similar transitional states existed in the evolution of cetaceans or other aquatic amniotes.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

AERODYNAMIC PERFORMANCE OF THE FEATHERED DINOSAUR *MICRORAPTOR* AND ITS IMPLICATIONS FOR THE EVOLUTION OF FEATHERED FLIGHT

DYKE, Gareth, University of Southampton, Southampton, United Kingdom; DE KAT, Roeland, University of Southampton, Southampton, United Kingdom; PALMER, Colin, University of Bristol, Bristol, United Kingdom; NAISH, Darren, University of Southampton, Southampton, United Kingdom; GANAPATHISUBRAMANI, Bharatham, University of Southampton, Southampton, United Kingdom

Increasing numbers of feathered non-avialan dinosaurs have revolutionized our understanding of the origin of bird flight. The fossil record shows that a variety of paravians closely related to, but outside, the avialan lineage possessed feathered flight surfaces. Among the best represented is the Early Cretaceous Chinese dromaeosaurid *Microraptor*. This small dinosaur possessed elongated arm, leg and tail feathers, an anatomical configuration that has resurrected an older idea that avialan flight passed through a four-winged ('tetrapteryx') gliding phase. Using wind tunnel experiments, we show that *Microraptor* would have been most stable when gliding at high lift coefficients (CL) (and consequently low lift/drag ratios; L/D). Flight simulations show that sustaining a high lift coefficient at the expense of high drag (low L/D) would have been the most efficient strategy when gliding from, and between, low elevations (i.e., <20-30 m trees). Analyses also demonstrate that anatomically plausible changes in wing configuration and leg position would have made little difference to aerodynamic performance; it is most likely, however, that *Microraptor* flew with its legs hanging vertically from beneath its body. Most significant to the evolution of flight, we show that this dinosaur did not require a sophisticated, 'modern' wing morphology to undertake effective glides. This is congruent with the hypothesis that both symmetric and asymmetric 'flight' feathers first evolved in dinosaurs for non-aerodynamic functions and were later adapted to form lifting surfaces.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

LARGE- AND MEGA-DIAMETER STRUCTURES OF PROBABLE VERTEBRATE ORIGIN FROM THE LOWER PERMIAN (WOLFCAMPIAN) CEDAR MESA SANDSTONE OF SOUTHEASTERN UTAH, USA

DZENOWSKI, Nicole, University of Kansas, Lawrence, KS, United States, 66045; HASIOTIS, Stephen, University of Kansas, Lawrence, KS, United States; RASMUSSEN, Donald, Paradox Basin Data, Longmont, CO, United States

Large- and mega-diameter structures (LS and MS) have been identified from two locations within the Lower Permian (Wolfcampian) Cedar Mesa Sandstone (CMS) of southeastern Utah. The LS and MS are found in association with rhizoliths and invertebrate burrows within pedogenically modified eolian and sabkha deposits in the CMS. Both the LS and MS are interpreted as vertebrate burrows; likely amphibian or synapsid in origin.

The overall architecture of the LS are simple. The burrows are oriented approximately 10–15 degrees from the horizontal and are up to 50 cm long. The burrows are elliptical in cross section with diameters of approximately 5–15 cm wide and approximately 2.5–5 cm high. Most burrow diameters were at the higher end of the ranges. The burrows are generally smooth walled and rarely with surficial markings. Well-preserved LS have nodular textures, scallops, and longitudinal striations, interpreted as scratch marks, are present. The overall architecture of the MS ranges from simple shafts to moderately complex branched networks. One MS specimen exhibited a horizontal, U-shaped tunnel that widened to form a chamber at the end, interpreted as a turn around. The MS are oriented approximately 5–10 degrees from the horizontal, and are up to 200 cm long. The burrows are elliptical in cross section, with burrows 25–50 cm wide and 5–10 cm high. The burrow walls range from smooth and lacking surficial markings to nodular in texture. The varying sizes of the burrows present make multiple tracemakers more likely.

Body fossils have been documented from within the CMS—including the temnospondyl *Eryops* and pelycosaur *Sphenacodon*—but these are few in number. Multiple ichnogenera of tetrapod trackways have been observed indicating that vertebrates were present and potentially inhabiting both eolian and sabkha environments. Evidence of bioturbation by vertebrates indicates an abundance of life in these marginal environments and interruption of eolian processes by wet phases. The LS and MS represent hidden biodiversity and have the potential to serve as proxies for vertebrate communities and the overall paleoecology of environments with an absence of body fossils, as well as indicators of relative moisture to infer paleoclimate.

Technical Session VII (Thursday, October 31, 2013, 2:00 PM)

MEASURING THE BODY TEMPERATURE OF A DINOSAUR? THE POTENTIAL FOR PALEOPHYSIOLOGICAL STUDIES FROM THE ANALYSIS OF ^{13}C-^{18}O BOND ORDERING IN FOSSIL BIOMINERALS

EAGLE, Robert, University of California - Los Angeles, Los Angeles, CA, United States, 90095; ENRIQUEZ, Marcus, California State University - Los Angeles, Los Angeles, CA, United States; GRELLET-TINNER, Gerald, South Dakota, Rapid City, SD, United States; TUTKEN, Thomas, University of Bonn, Bonn, Germany; EILER, John, California Institute of Technology, Pasadena, CA, United States

We present the latest results on the development and application of a new isotopic approach to reconstructing the body temperature and thermal physiology of extinct vertebrates. ^{13}C-^{18}O bond ordering in carbonate minerals is a function of the temperature at which a mineral precipitates. We have recently shown that measurements of ^{13}C-^{18}O bond abundance in the carbonate component of teeth and eggshell calcium carbonate is directly related to the body temperature of the animal in which the mineral formed. Using this measurement on a selection of modern samples, we can clearly distinguish between teeth and eggshells from warm-bodied mammals and birds and biominerals from crocodiles, alligators and sharks and can accurately reconstruct their body temperatures. Therefore, at least in principle, we should be able to use this measurement to determine the body temperature of any vertebrate in the fossil record. We present isotopic data on vertebrate fossils of a range of ages and find that whilst many specimens show petrographic and/or geochemical evidence for alteration and therefore do not record primary body temperatures, some specimens do appear to be well preserved. From apparently well-preserved teeth and eggshells from sauropod dinosaurs we measure warm temperatures of 35-40°C, but our most recent data suggests that smaller Cretaceous dinosaurs may have had significantly lower body temperatures.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

TEEN SCIENCE CAFÉS: A NOVEL WAY TO ENGAGE FUTURE SCIENTISTS

EARLY, Catherine, North Carolina Museum of Natural Sciences, Raleigh, NC, United States, 27601; HALL, Michelle, Science Education Solutions, Los Alamos, NM, United States

Many science museums and educational institutions successfully implement programs that focus on exposing children and adults to science, but they often fail to connect with members of the public who fall between the two categories. Scientists and educators alike find it difficult to engage teenagers and communicate to them the importance of the research being done in the sciences, even though teens represent the audience that would most benefit from learning about potential careers in science. Teen Science Cafés, an NSF-funded outreach program devoted to connecting teens with scientists, help researchers and institutions bridge this communication gap in a novel way. A Teen Science Café is an informal, interactive presentation given at the high school level by a scientist on their field of study, providing scientists with a new avenue for public outreach. Cafés also show kids what a career in the sciences can look like and broaden their definitions of who can be a scientist. Other integral parts of the program include training researchers to effectively communicate with teenagers and developing an activity to reinforce key concepts and further engage the teen audience in their learning. Traditional science talks involve a speaker lecturing to a quietly listening audience, but a Teen Science Café speaker's role is to get his or her audience excited about his or her field and guide their learning by engaging the audience in conversation and questions. Paleontology has proven itself to be a field that is particularly well-suited to this format, as it is a field that deeply fascinates the public and many of its research methods can be easily adapted for a hands-on learning activity; phylogenetic analysis and field mapping are two such methods which have already been successfully implemented at Teen Science Cafés in North Carolina. The Teen Science Café program is currently in its second year of implementation at the North Carolina Museum of Natural Sciences (NCMNS), the lead institution of the North Carolina-based node of the Teen Science Café Network (www.teensciencecafe.org). This node is known as the Open Minds Café, hosts Teen Science Cafés in Raleigh, Chapel Hill, and Whiteville, and serves as a model for other institutions seeking to engage their teen audience with researchers in this innovative program. The Teen Science Café Network is open to all interested in starting a Teen Science Café program.

Technical Session X (Friday, November 1, 2013, 11:15 AM)

STABLE ISOTOPE AND TRACE ELEMENT PALEOECOLOGY OF THE RUDABÁNYA FAUNA DURING THE LATE MIOCENE

EASTHAM, Laura, University of Toronto, Toronto, ON, Canada, M5S 2S2; FERANEC, Robert, Stanford Univ, Albany, NY, United States; BEGUN, David, University of Toronto, Toronto, ON, Canada; KORDOS, Laszlo, Geological Institute of Hungary, Budapest, Hungary

In Europe, the decline of forest-adapted fauna during the late Miocene occurs in correlation with environmental change as humid subtropical evergreen forests gave way to more open seasonally adapted woodlands. A humid forest refugium has been proposed in Central Europe during this period based upon an abundance of floral and faunal proxies. The faunal assemblage at Rudabánya, a Late Miocene (~10 Ma) mammalian locality in northern central Hungary, preserves an abundance of forest-dwelling taxa, including a hominoid, *Rudapithecus hungaricus*, and pliopithecoid, *Anapithecus hernyaki*. Geochemical sampling of the Rudabánya fauna further clarifies our understanding of the unique paleoecology at this spatially and temporally rare site. To evaluate forest structure, climatic regime, and resource partitioning we examine stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope and trace element (Sr/Ca) ratios in the dental enamel of ten genera of medium to large bodied mammals. $\delta^{13}C$, $\delta^{18}O$, and Sr/Ca ratios suggest the existence of a diverse wetland-forest ecosystem, with a range of habitat types from moderately dense canopied forest to more open country sedgeland. The negative $\delta^{18}O$ values found in all sampled taxa are consistent with high levels of precipitation and humidity. Serial $\delta^{18}O$ analysis reveals seasonal variation in climate, likely reflecting the shift from warm summers with high precipitation to cooler winters with lower precipitation. Interestingly, serial $\delta^{13}C$ values show little evidence of significant seasonal variation in the diets of the Rudabánya fauna. Significant differences in stable isotope and trace element ratios exist between taxa implying competition and partitioning in resource use. *Hippotherium intrans* (Equidae), *Propotamochoerus palaeochoerus* (Suidea), and *Lucentia* aff. *pierensis* (Cervidae) show more positive $\delta^{13}C$ and higher Sr/Ca ratios, suggesting mixed feeding in more open country habitats. More negative $\delta^{13}C$ and lower Sr/Ca ratios are found in *Miotragocerus* sp. (Bovidae), *Tetralophodon longirostris* (Gomphotheriidae), and *Micromeryx flourensianus* (Moschidae) indicating browsing in more densely forested habitats. Sr/Ca ratios indicate a clear stratification of taxa within the trophic level. These results support the possibility of a humid forest refugium in Central Europe during the late Miocene and provide insight into the environmental context of a highly dynamic period in mammalian evolution.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW PUERCAN FAUNA FROM WYOMING'S GREAT DIVIDE BASIN

EBERLE, Jaelyn, University of Colorado, Boulder, CO, United States, 80309; LOFGREN, Donald, Raymond Alf Museum of Paleontology, Claremont, CA, United States; HETTINGER, Robert, Geological Survey (USGS), retired, Lakewood, CO, United States; MCCOMAS, Katherine, University of Colorado, Boulder, CO, United States; SOLTIS, Chloe, The Webb Schools, Claremont, CA, United States

Earliest Paleocene (Puercan) mammalian faunas are critical to test new phylogenetic analyses that suggest placental mammals originated in the first few hundred thousand years after the Cretaceous-Paleogene boundary. Yet, few basins preserve relatively thick complete Puercan sections, and only one place – Wyoming's Hanna Basin – preserves the entirety of the Puercan NALMA (Pu1–Pu3; ca. the first million years of Paleocene time). Here, we report a new Puercan fauna from the southeastern part of the Great Divide Basin, a sub-basin of Wyoming's Greater Green River Basin (west of the Hanna Basin and Rawlins Uplift). In the Great Divide Basin, the China Butte Member of the Fort Union Formation comprises several hundred meters of strata preserving Puercan – Tiffanian mammalian fauna. Puercan localities span over 183 meters (600 ft.) of stratigraphic section in the basal China Butte Member, which overlies an angular unconformity that bevels the underlying Late Cretaceous (Lancian) fossil vertebrate-bearing strata. The stratigraphically lowest Puercan localities are approximately 46 meters (150 ft.) above the unconformity, and faunal comparison to Puercan assemblages in the Hanna and Denver Basins suggests that they may be late early Puercan (Pu1) or earliest middle Puercan (Pu2) in age. The most productive of these localities is a quarry (UCM loc. 2011035) that preserves complete jaws and isolated teeth representing a diverse fauna, including characteristic early Puercan taxa such as *Mesodma ambigua* and *Mimatuta*, in addition to the 'condylarths' *Ampliconus* and *Conacodon* cf. *C. harbourae*, both of which occur in Colorado's Littleton Local Fauna (late Pu1) and earliest Pu2 localities in the Hanna Basin. There are also several new taxa at UCM loc. 2011035, including a new species of eucosmodontid multituberculate and an unusual morphologic intermediate with affinities to both early arctocyonids and basal periptychid 'condylarths.' Higher in the stratigraphic section, *Kimbethoia campi* is known from UCM loc. 2011036, and represents the northernmost occurrence of this species. To date, the stratigraphically highest, undoubted Puercan locality in the Great Divide Basin contains *Loxolophus priscus*, an arctocyonid known from Pu2 and Pu3 localities in the Hanna and San Juan Basins. Our study of the Puercan fauna of the Great Divide Basin illuminates a new region that preserves a fauna that appears both biostratigraphically and evolutionarily intermediate between Pu1 and Pu2, similar to the Hanna and Denver Basins.

Symposium 3 (Friday, November 1, 2013, 10:45 AM)

TWENTY-THREE YEARS OF RADIOMETRIC DATING AT DINOSAUR PROVINCIAL PARK (UPPER CRETACEOUS, ALBERTA, CANADA)

EBERTH, David, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada, T0J0Y0; ROBERTS, Eric, James Cook University, Townsville, Australia; DEINO, Alan, Berkeley Geochronology Center, Berkeley, CA, United States; BOWRING, Samuel, MIT, Cambridge, MA, United States; RAMEZANI, Jahan, MIT, Cambridge, MA, United States

Dinosaur Provincial Park (DPP) yields a uniquely-rich, well-preserved late Campanian dinosaur assemblage. Stratigraphically-limited exposures (<100 m thick) in this small area (80 km^2) comprise, in ascending order, the Oldman (partial), Dinosaur Park (DPFm), and Bearpaw (partial) formations, all of which contain altered volcanic ashes (bentonites). Radiometric dating of phenocrysts from DPP's bentonites is the best means for assessing rates of faunal turnover in the section, and chronostratigraphic correlation of this section and its dinosaur assemblages with others, elsewhere. Although 13 discrete bentonites were originally documented in the section, only four have been used consistently for dating during the past 23 years. These are semi-evenly spaced through a total section of 88.5 m, and at least one occurs in each formation. K-Ar analyses of biotites (1980s) yielded promising results, but error was relatively large (±~1.0 Ma, 1). $^{40}Ar/^{39}Ar$ methods (1990s–present) have greater precision. However, three rounds of $^{40}Ar/^{39}Ar$ dating (over 20 years) resulted in significantly different dates (>1%) reported for the same bentonites. Variation was due mostly to adjustments of monitor mineral ages and ongoing improvements in laboratory techniques and equipment. In this context, more recently derived $^{40}Ar/^{39}Ar$ dates were usually reported as superseding previously published results. Furthermore, before meaningful comparisons or combinations (e.g., averages) of newer and older results can be completed, older data must be recalibrated. Recently completed laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) analyses of zircons from these same bentonites (2013) have resulted in a suite of $^{206}Pb/^{238}U$ dates with relatively modest errors (0.51–0.75 Ma, 2) that encompass almost all of the previously calculated $^{40}Ar/^{39}Ar$ dates (differing from them by as much as 0.8%). Thermal ionization mass spectrometry (TIMS) analyses of zircons is underway in the hopes of reducing error. The most recent $^{40}Ar/^{39}Ar$ data indicate that the DPP datable section spans 1.44 Ma (dates presented at symposium). Alternatively, the LA-ICP-MS data indicate that this section may be slightly younger and shorter, spanning 1.26 Ma (dates presented at symposium). Lastly, $^{40}Ar/^{39}Ar$ and LA-ICP-MS results are consilient in suggesting a decrease in rates of sediment accumulation from the lower, fossil-rich 30 m of the DPFm, to the uppermost 40 m of the DPFm. If confirmed, this will have implications for assessing rates of faunal turnover for the Park's dinosaurs.

Technical Session XIV (Saturday, November 2, 2013, 10:30 AM)

SYNCHROTRON-BASED IMAGING REVEALS CHEMOTAPHONOMY OF TWO BIRDS FROM THE GREEN RIVER FORMATION (EOCENE)

EGERTON, Victoria, University of Manchester, Manchester, United Kingdom; BERGMANN, Uwe, SLAC National Accelerator Laboratory, Menlo Park, CA, United States; WOGELIUS, Roy, University of Manchester, Manchester, United Kingdom; NORELL, Mark, American Museum of Natural History, New York, NY, United States; MANNING, Phillip L., University of Manchester, Manchester, United Kingdom

The Green River Formation is well-known for the exceptional preservation of vertebrates such as fish, amphibians, reptiles, birds, and mammals. It has not been fully understood whether structures such as feathers and skin were merely preserved as impressions, chemically replaced organic structures (either through bacterially mediated films or inorganic replacement), or the original organic residue (or their breakdown products) from the organism. Two semi-articulated birds (American Museum of Natural History specimens AMNH 30805 and AMNH 30806) from the Green River Formation (Eocene) of Wyoming were imaged using Synchrotron Rapid Scanning X-ray Fluorescence (SRS-XRF). SRS-XRF is a powerful method for mapping dilute concentrations of elements from which a fossil is composed. This method also rapidly scans (up to 3000 times faster than conventional element mapping techniques) to high sensitivity (parts per million) large fossils without risk of damage. The SRS-XRF maps of the bone chemistry (calcium, phosphorus and zinc) are comparable to those seen in extant birds and are distinct from the encasing matrix. The elemental inventory of the preserved feathers shows the distribution of organic sulfur that corresponds with trace metals (copper, zinc and nickel) that map discretely within biological structures. The trace-metal inventory in the fossil feathers most likely represents organometallic products consistent with melanin pigments. These results add to the growing number of studies that verify the presence of melanin pigment in exceptionally preserved tissues of extinct organisms. The preservation of endogenous trace metal patterns suggests that within specific environments, there is not a complete replacement of the original chemistry during fossilization. Furthermore, the preservation of soft-tissue structures is aided by the endogenous trace metal inventory. The trace-metals function as bacterial inhibitors that provide a taphonomic filter which prevents the breakdown and replacement of these structures.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NIMRAVIDS AND STENOPLESICTIDS (MAMMALIA, CARNIVORA) FROM THE UPPER EOCENE OF MONGOLIA AND THEIR PALEOBIOGEOGRAPHIC SIGNIFICANCE

EGI, Naoko, Kyoto University, Inuyama, Japan; TSUBAMOTO, Takehisa, Hayashibara Museum of Natural Science/Okayama University of Science, Setouchi, Japan; WATABE, Mahito, Hayashibara Museum of Natural Science, Setouchi, Japan; SANEYOSHI, Mototaka, Hayashibara Museum of Natural Science/Okayama University of Science, Setouchi, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

This study reports occurrences of nimravid and stenoplesictid carnivorans from the upper Eocene Ergilin Dzo Formation of southeastern Mongolia, and discusses their significance on dispersal hypotheses of these carnivoran taxa. Presence of *Nimravus* and *Stenoplesictis* in the Ergilin Dzo Formation was reported in the previous studies, and we obtained additional specimens of *Nimravus* and two new taxa, *Eofelis* and *Stenoplesictidae* gen. et sp. indet., during our recent expeditions at the Khoer Dzan locality of the formation. *Nimravus* (Nimravidae) is the most abundant carnivoran at the

formation, known also from the Ergilin Dzo locality. Dentognathic size and shape of these Mongolian specimens fall within the variation of those of *N. intermedius* from the Oligocene of Europe. Thus, we agree with the previous suggestion that the Mongolian *Nimravus*, *N. mongoliensis*, should be included in *N. intermedius*. Earlier records of *Nimravus* have been reported from the middle Eocene of southern China. *Nimravus* presumably originated in the southern part of East Asia during the middle Eocene, migrated into the northern part of East Asia during the late Eocene, and dispersed into MP22 of Europe and the Whitneyan of North America. The other nimravid, *Eofelis*, was previously known only from the Oligocene of Quercy, France. The finding of the genus from the Ergilin Dzo Formation reveals the wide geographic distribution of the genus for the first time, and moves the appearance time of the genus from the Oligocene (MP23) to the late Eocene. The smallest carnivorans from the Khoer Dzan locality were identified as stenoplesictids. Two stenoplesictids have been previously known from the late Eocene of Mongolia: *Stenoplesictis simplex* from the Ergilin Dzo locality, and *S. indigenus* from the Alag Tsav locality, which is lower than the Ergilin Dzo Formation. Size of the Khoer Dzan specimens is between these two species, and its m2 morphology indicates that the materials also belong to the Mongolian *Stenoplesictis* lineage. However, it has been suggested that these stenoplesictids from the Eocene of Mongolia should be excluded from the genus *Stenoplesictis*, of which type species occur in the Oligocene of Quercy, because some morphologies of the Mongolian forms are too derived for an ancestor of the European species. In contrast to the nimravid genera, which migrated between East Asia and Europe, stenoplesictids seem to have migrated into these two areas independently from another area in Eurasia.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

AN EOCENE OCCURRENCE OF A DYROSAURID (CROCODYLOMORPHA, MESOEUCROCODYLIA) FROM ALABAMA, USA

EHRET, Dana, Alabama Museum of Natural History, Tuscaloosa, AL, United States, 35487-0340; HASTINGS, Alexander, Georgia Southern University, Statesboro, GA, United States

Dyrosaurids represent a group of mostly marine, mesoeucrocodylian crocodyliforms that are known from the Maastrichtian through the late Eocene of Africa, Asia, Europe and North and South America. In the Western Hemisphere, the latest reported occurrences of the Dyrosauridae are constrained to the Paleocene. In North America, the genus *Hyposaurus* has been recovered from the Maastrichtian and Danian of New Jersey, Alabama, South Carolina, and possibly Maryland and Virginia. In Africa and Asia, the family extends into the late Eocene before going extinct prior to the early Oligocene. Here we report on a new specimen recovered from Clarke County, Alabama that is assigned to the Priabonian (late Eocene) Yazoo Clay. The Yazoo Clay has exposures in Mississippi and Alabama and is constrained to Biozones E14-E16. The lithology of the Yazoo Clay is characterized as glauconitic sands and sandy limestones that represent marine shelf margin deposits. Fossils typically found in this formation include sharks, archaeocete whales, and marine turtles, which corroborate a marine shelf margin paleoenvironment. The recovered specimen is a distal caudal vertebral centrum that exhibits the typical amphicoelous condition of the Dyrosauridae, as well as characteristic semi-rectangular shape and articular facets for the haemal arch. The centrum is complete but missing the neural arch at the sutural contacts, which indicates that the individual was likely immature. The presence of a dyrosaurid in the Gulf Coastal Plain during the late Eocene greatly extends the temporal range of the family in the Western Hemisphere. Reasons for the family's extinction are currently unknown, but this discovery indicates that dyrosaurids were present in the New World as well as the Old World until their ultimate and apparently synchronous extinction. The new dyrosaurid from Alabama will need to be included in explanations for the extinction of the family. While the dyrosaurids undergo an apparent range constriction in North America across the Cenozoic, it appears that a relict population was able to persist in the Gulf Coastal Plain until the end of the Eocene.

Technical Session XV (Saturday, November 2, 2013, 10:30 AM)

INNER EAR STRUCTURE OF EARLY MYSTICETES (CETACEA) FROM THE LATE OLIGOCENE OF SOUTH CAROLINA: IMPLICATIONS FOR THE EVOLUTION OF HEARING IN BALEEN WHALES

EKDALE, Eric G., San Diego State University, San Diego, CA, United States, 92182

Late Oligocene deposits of the Ashley and Chandler Bridge Formations near Charleston, SC have yielded baleen whale fossils that play a critical role in the interpretation of mysticete evolution. In particular are the earliest edentulous mysticetes and mysticetes that retained teeth from an earlier ancestor. Cochlear anatomy of those taxa provides information regarding evolution of low frequency sensitivity in mysticetes – a major physiological difference between extant toothed (odontocete) and baleen whales. The link between frequency sensitivity and cochlear morphology is complex, especially given the uncertainty of extant mysticete hearing ranges, but knowledge of early mysticete anatomy elucidates the evolution of sensory physiology in whales. Taxa with sensitivity to relatively lower frequencies tend to have cochleae with a greater number of turns, less extensive secondary bony laminae (support for the basilar membrane), and thinner walls between the basal and apical turns. Using CT data, those features thought to relate to hearing are explored in important Oligocene mysticetes, including the edentulous taxa *Eomysticetus whitmorei* and *Micromysticetus rothauseni*, as well as an earlier diverging toothed mysticete. In general, the morphology of the Oligocene taxa is consistent with that described for stratigraphically younger mysticetes rather than for odontocetes. The cochleae of *Eomysticetus* and *Micromysticetus* complete over 2.5 turns, similar to extant *Balaenoptera*, but the cochlea of the toothed mysticete completes only a little over 2 turns, which is similar to extant *Balaena* but more than the extant dolphin *Tursiops*. Although the secondary bony lamina is restricted to the basal turn in *Eomysticetus* and the toothed taxon (similar to extant mysticetes), the lamina extends well into the second turn in *Micromysticetus*, but to a lesser extent than observed in extant odontocetes. The wall separating the basal and apical turns in all of the mysticetes examined for this study is half as thick as that in odontocetes. Together, these results suggest that extant baleen whale physiology (low frequency sensitivity) is the ancestral condition for Mysticeti. In addition, the cochlea of the Eocene archaeocete *Zygorhiza kochii* (2.5 turns, secondary lamina restricted to basal turn, thin wall separating basal and apical turns) implies further that low frequency hearing may be ancestral for crown Cetacea and was retained across the mysticete lineage with a shift towards high frequency sensitivity in odontocetes.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

LAST YEARS OF LIFE AND SEASON OF DEATH OF A COLUMBIAN MAMMOTH FROM RANCHO LA BREA

EL ADLI, Joseph, University of Michigan, Ann Arbor, MI, United States, 48103; CHERNEY, Michael, University of Michigan, Ann Arbor, MI, United States; FISHER, Daniel, University of Michigan, Ann Arbor, MI, United States; HARRIS, John, George C Page Museum, Los Angeles, CA, United States; FARRELL, Aisling, George C. Page Museum, Los Angeles, CA, United States

Excavation for a parking structure for the Los Angeles County Museum of Art in 2006 revealed Pleistocene-age fluvial deposits containing the disarticulated and variably dispersed skeleton of an adult Columbian mammoth (*Mammuthus columbi*). The skeleton is approximately 80% complete, and the stage of molar replacement and wear suggests a Laws' Age Class of ca. XXV, representing a probable age in the mid-forties. The length and maximum diameter of the left tusk (318 cm and 24 cm, respectively), the width of the molars, the sizes of postcranial elements, and the shape of the ischial region of the pelvis all indicate that this individual is male. A sample was excised from near the proximal end of the left tusk to evaluate the last years of life and assess season of death. This sample was located along the outer curve of the tusk base, about 23 cm from the (broken) proximal margin, proximal to the gingival margin and within a sequence of periradicular topographic features that represent approximately annual intervals of tusk growth. The sample extended through cementum and dentin, from the outer surface of the tusk to the pulp cavity. This sample was scanned by microCT and then thin-sectioned. In transverse sections derived from microCT data, the dentin shows somewhat regularly spaced zones of low x-ray attenuation, suggesting more rapid dentin apposition that we interpret as early spring growth, as documented more thoroughly in specimens from the Great Lakes region. Analysis of approximately weekly incremental features in a transverse thin section shows little systematic seasonal variation in rates of dentin apposition - not surprising for southern California - but does help to confirm some of our identifications of year boundaries. Daily dentin increments are visible in some parts of the sequence, but not consistently. One of the years included in this sample achieves a length, on the external surface of the tusk, of 7.9 cm - relatively long for a male at this stage of life - and a thickness (normal to the appositional surface) of 6.6 mm. Subsequent years preceding death are shorter (ca. 4.6 cm/yr) and thinner (ca. 3.9–4.6 mm). Judging from rates of tusk growth in the last years of life, death appears to have come in early summer, the season identified as normal for musth, the period of heightened aggression and sexual activity in which mating and male-male conflict would be expected to occur. It thus seems plausible that this male died as a result of soft-tissue injuries sustained in a musth conflict.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

PREDATION OF EARLY VERTEBRATES BY EURYPTERIDS

ELLIOTT, David, Northern Arizona Univ, Flagstaff, AZ, United States, 86011-4099; LASSITER, Linda, Northern Arizona University, Flagstaff, AZ, United States

Eurypterids were marine arthropods that existed from the Ordovician through the Permian. The fact that they often occur in the same horizons as early vertebrates (agnathans) has led to speculation that eurypterids were predators on agnathans, and that vertebrate armor developed as a defense against eurypterids.

Direct fossil evidence is rare because successful predation generally results in the destruction of hard parts. However, an Early Devonian heterostracan, *Lechriaspis patula*, exhibits three aligned punctures in the dorsal shield, presumably from predation. It was deduced that the most likely predator was the pterygotid eurypterid *Jaekelopterus howelli*, as the main denticles on a recently described coeval chela closely match the *L. patula* puncture pattern. In addition, agnathan fragments have been reported in masses identified as eurypterid coprolites from the Silurian of Scotland. There is still a question as to whether eurypterid chelae could have generated enough force to pierce agnathan armor. A recent investigation of the mechanical strength of eurypterid chelae determined their ability to cut or tear rigidly armored prey. This investigation focused on the pterygotid genus *Acutiramus*, and reported that it could not have penetrated the armor of an agnathan without failure due to the unique denticle configuration on the chelae. However, the experimental data suggests that a different configuration of the chela could enable penetration of bony armor. Analysis of modern crab chelae shows that they can be generalized as cutters or crushers and that the raptorial pterygotid eurypterids had chelae designed for cutting, but certainly capable of gripping and penetrating bony armor. Thus, direct evidence of predation, design of the chelae, and mechanical analysis suggest that pterygotid eurypterids were capable of predating armored vertebrates. Study of the frequency of co-occurrence of eurypterids and agnathans shows a strong correlation between pterygotid eurypterids and early vertebrates, indicating that they also had the opportunity to carry out such predation.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A NEW PHYLOGENETICALLY-INFORMED LIFE RECONSTRUCTION OF THE GIANT EOCENE CARNIVOROUS ARTIODACTYL *ANDREWSARCHUS MONGOLIENSIS* (MAMMALIA, ARTIODACTYLAMORPHA, CETANCODONTOMORPHA)

ELLISON, Mick, American Museum of Natural History, New York, NY, United States, 10024; FLYNN, John, American Museum of Natural History, New York, NY, United States

Arguably the largest terrestrial mammal carnivore ever, the relationships and full-body anatomy of *Andrewsarchus* have been debated since its discovery in 1923. Known only from a single, massive, 85.7 cm-long skull, and originally considered to be a mesonychian, its affinities have remained enigmatic. Recent phylogenetic analyses combined molecular and morphological data, and extant and fossil taxa, to compellingly document that it is not allied with mesonychians, but instead is most closely related to entelodonts and achaenodonts in a polytomy forming the nearest outgroup to hippos and whales.

Many prior reconstructions of *Andrewsarchus* as a wolf-like predator, with an unusually large head, short limbs, and stocky body, were influenced by its classification as a mesonychian. Revised understanding of its relationships permits a new and markedly different life-reconstruction of *Andrewsarchus*, using phylogenetic bracketing to infer unknown traits. We discuss the reconstruction process, a collaboration between artist and paleontologist, reflecting both direct observation and reanalysis of the holotype and detailed consideration of the anatomy of its closest extinct and extant relatives. Study of the skull corrects observational and dimensional errors in some prior reconstructions, including orbit location, snout length, position and shape of teeth (particularly the canine, based on alveolus dimensions and phylogenetic bracketing), and zygomatic breadth. The craniodental anatomy, together with comparison to close relatives, permit reconstruction of *Andrewsarchus* as a giant, powerful carnivore with relatively long and robust limbs, short torso and broad girth, instead of a short limbed, elongate bodied and more slender wolf-like form. The prominent sagittal crest indicates large temporalis muscles, implying a pronounced angular process and deep lower jaw (as in *Achaenodon*), facilitating the powerful bite indicated by large, apically flattened cheek teeth. By comparison with large entelodonts, *Achaenodon*, and hippos, *Andrewsarchus* is inferred to have possessed a short and muscular neck, and large, high shoulders, with the head held low rather than high as in many reconstructions. We conservatively infer four hoofed toes on each foot, and sparse hair, consistent with facilitating heat loss because of its large size and dry paleoenvironment. The new reconstruction is displayed within an exhibit that will receive hundreds of thousands of visitors, to illustrate the role of fossils and phylogeny in paleobiological inference.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DIVERSITY AND BODY SIZE EVOLUTION OF ANGUID LIZARDS THROUGH CLIMATIC TRANSITIONS OF THE NORTH AMERICAN CENOZOIC

ELSHAFIE, Sara, Univ of Nebraska-Lincoln, Lincoln, NE, United States, 68588-0340; HEAD, Jason, Univ of Nebraska, Lincoln, NE, United States

Lizards are diverse components of modern tropical and subtropical ecosystems, and their distributions are strongly correlated with climate. Relationships of lizard diversity and body size to environmental transitions over long time scales are generally unknown, however. To test the effects of climate change on lizard evolutionary histories, we examined diversity and body size changes through time in fossil anguid lizards from the Paleogene and Neogene of North America. We collected species diversity data at NALMA temporal resolution from museum collections, literature, and the Paleobiology Database. To account for sampling bias, we compared metrics for anguids against the same metrics for coeval North American mammals. We collected skull length data as a proxy for overall body size from museum collections, focusing on glyptosaurines, the largest and most diverse fossil anguid clade. Diversity patterns in anguids are similar to those for mammals, with peak diversity during the Wasatchian and Bridgerian followed by decline during the late Paleogene and a second, smaller increase during the Barstovian. These trends partially reflect changes in sampling intensity between the Western Interior basins and the Great Plains, but also coarsely correspond to changes in global temperature patterns. Maximum body size trends in anguids do not correspond to either mammalian histories or climate proxies. Maximum body size remains approximately constant among the largest glyptosaurines from the early Eocene (*Glyptosaurus sylvestris*) to early Oligocene (*Helodermoides tuberculatus*), despite global cooling represented by >6ºC decreases in average Sea Surface Temperatures. Constancy of body sizes across climate transitions suggests that overall temperature decreases remained above critical minimum temperatures for efficient metabolism in large lizards prior to the Neogene, whereas decreasing diversity may represent a reduction in habitat availability with increasing aridity during the late Paleogene and early Neogene.

Technical Session I (Wednesday, October 30, 2013, 9:15 AM)

A NEW SPECIMEN OF THE TEMNOSPONDYL *AUSTRALERPETON COSGRIFFI* FROM THE LATE PERMIAN OF BRAZIL (RIO DO RASTO FORMATION, PARANÁ BASIN): NEW ANATOMICAL INFORMATION AND PHYLOGENETIC RELATIONSHIPS.

ELTINK, Estevan, USP, Ribeirão Preto, Brazil; LANGER, Max, USP, Ribeirão Preto, Brazil

A new temnospondyl specimen, assigned to *Australerpeton cosgriffi*, from the Rio do Rasto Formation (Late Permian, Paraná Basin) of south Brazil is composed of a left mandible, right pelvis, femur, tibia, and fibula. Characters shared with other mandibles referred to *A. cosgriffi* (two skulls have preserved jaws) include the anteriorly extended prearticular, the 'zig-zag' contact between splenial and postsplenial, the lack of denticles or teeth in the coronoids, the posterior coronoid entering the adductor fossa anteriorly, and the extended symphysis that bears a conspicuous anterior foramen posteriorly extended as a deep furrow. New information about the pelvis and hindlimb includes: a deep pubic notch anteriorly merged by the pubic crest, a laminar intertrochanteric fossa, a conspicuous tuberosity on the posterior face of the cnemial crest of the tibia, and an extra tuberosity on the anterior rim of the tibial shaft. This long-snouted temnospondyl has been regarded as either a stereospondyl (Rhinesuchidae) or a non-stereospondyl stereospondylomorph (Platyoposaurinae). The reassessment of the phylogentic placement of *A. cosgriffi*, with information drawn from the new specimen, was based on a data matrix of 133 characters and 25 taxa, and recovered 2 most parsimonious trees of 351 steps. *A. cosgriffi* was positioned as a basal member of Stereospondyli, more derived than *Peltobatrachus pustulatus* and basal to Rhinesuchidae. The synapomorphies shared with other stereospondyls include: tabular and exoccipital contacting in the paroccipital process, parasphenoid articulated with the pterygoid corpus forming a broad contact along the lateral margins of the parasphenoid plate, internal carotid and the palatine and intracranial artery branches passing through the dorsal surface of the parasphenoid plate, and enlarged field of denticles forming a transverse 'belt' along the pterygoid-parasphenoid articulation. Indeed, the occipital and posterior palatal regions of *A. cosgriffi* are more similar to those of rhinesuchids, than to those of platyoposaurs, as exemplified by the presence of an oblique ridge on the ascending ramus of the pterygoid. Accordingly, *A. cosgriffi* represents one of the first stereospondyls, and the oldest known long-snouted member of the group. Therefore, the dispersion and diversification of this clade appears to have happened before Permo–Triassic boundary.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

CHARACTER VARIATION IN MODERN CAMELS AND SHEEP HIGHLIGHTS PROBLEMS IN THE GENUS-LEVEL TAXONOMY OF AGRIOCHOERID OREODONTS

EMERY, Meaghan, University of Oregon, Eugene, OR, United States, 97405; DAVIS, Edward, Univ of California Berkeley, Eugene, OR, United States; HOPKINS, Samantha, Univ of Oregon, Eugene, OR, United States

Quantification of variability in modern animals clarifies taxonomically informative differences among fossil specimens. The three currently valid genera of agriochoeres (*Agriochoerus*, *Diplobunops* and *Protoreodon*), diagnosed largely by dental characteristics, overlap in biostratigraphic ranges and in overall size. Camelids are a potential sister group to oreodonts, while sheep occupy a similar ecological niche and body form. Both possess characters homologous to those previously considered diagnostic in agriochoeres; these were examined as a proxy for variation. Several genus-level agriochoere characters showed considerable variation between individuals of modern species, including presence/absence of paraconules and external molar ribs. Similarly, individuals within species of camelids and sheep display variation in the prominence of the para-, meso-, and metastyles of their molars akin to that ascribed to different genera of agriochoeres. As a case study of these taxonomic problems we considered the agriochoere from the Hancock Mammal Quarry (HMQ) of the Eocene Clarno Formation. Individuals from the HMQ display characters considered diagnostic to each Agriochoerid genus including an expanded rostrum and absence of a P4 hypocone characteristic of *Diplobunops*, prominent molar styles and split P4 parametacone of *Agriochoerus*, and the connection between the P3 parametacone and protocone of *Protoreodon*. The HMQ specimens have variable expression in the P3 connection of the parametacone and protocone, and the internal and external molar ribs. We also found that though previous workers have compared size using the P1-M3 toothrow, these differences were highly affected by both taphonomic distortion and individual variation. The coefficient of variation for the P1-P4 and M1-M3 toothrows of the HMQ agriochoerid was an order of magnitude higher than that of the M1 or M2; we advocate using individual molar dimensions for future size comparisons. It is clear that the current defining characteristics of these genera do not represent biologically discrete units. As an alternative, we suggest using the shape of the auditory bullae, postglenoid processes, and the structure of the basiospehnoid and basioccipital regions of the skull, which show lower levels of variation in modern and fossil specimens. Using characters tested for variation in modern as well as fossil organisms can clarify genus-level diversity that is otherwise obscured by overlapping taxonomy.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

MICROVERTEBRATES FROM THE SAINTS AND SINNERS QUARRY (NUGGET SANDSTONE: ?LATE TRIASSIC–EARLY JURASSIC): A REMARKABLE WINDOW ONTO THE DIVERSITY AND PALEOECOLOGY OF SMALL VERTEBRATES IN AN ANCIENT EOLIAN ENVIRONMENT

ENGELMANN, George, University of Nebraska- Omaha, Omaha, NE, United States, 68182; BRITT, Brooks, Brigham Young Univ, Provo, UT, United States; CHURE, Daniel, Dinosaur National Monument, Jensen, UT, United States; ANDRUS, Austin, Brigham Young University, Provo, UT, United States; SCHEETZ, Rodney, Brigham Young Univ, Provo, UT, United States

The Nugget Sandstone in northeastern Utah is dominated by a thick sequence of eolian sandstone. This formation and the Navajo and Aztec sandstones to the south define a vast erg that spanned the Triassic-Jurassic boundary over a large area of western North America. These eolianites have yielded a very sparse record of large vertebrate body fossils. Small vertebrates are virtually unknown from this environment.

The Saints and Sinners Quarry (SSQ) has produced abundant vertebrate fossils from a bonebed within the Nugget. The fossiliferous horizon occurs within interdunal sands of limited lateral extent between thick sequences of dune sands and about 55 meters above the base of the dominantly eolian sequence. Taphonomic and sedimentologic evidence suggests the interdunal facies represent a small lake. The environmental setting could be

similar to that fond in the modern Badain Jaran Desert in parts of Chinese Mongolia where small interdunal lakes are surrounded by large and active sand dunes.

The fossils of the SSQ consist overwhelmingly of thousands of disarticulated bones of a coelophysoid dinosaur from at least 20 individuals. The microvertebrate fauna, however, is relatively diverse. So far we have found a cluster of 3 articulated skeletons and disarticulated elements of drepanosaurids, jaw, armor, girdle and limb elements of multiple protosuchians, scutes of a larger crocodylomorph, dentaries of two sphenodont taxa and abundant problematica. All the articulated and closely associated small vertebrates come from the basal 15 cm of the 50 cm-thick bonebed

The diversity of the small vertebrates indicates a stable, favorable environment as a function of proximity to an oasis. Because small vertebrates are not likely to have been sufficiently vagile to replenish an ephemeral habitat, they must have occupied the area continuously for an interval of many generations, during which the lake was a persistent feature. Small vertebrates are known from the dune facies by the ichnofossil *Brasilichnium*, but no skeletal material likely to represent the *Brasilichnium* track-maker (thought to be a synapsid) have been found in the SSQ, suggesting environmental segregation within the Nugget microvertebrate fauna.

The presence of small vertebrates in the SSQ in sand instead of mudstone encourages us to think that other such samples may be found within the eolian sequences of the Nugget/Navajo sandstones by searching all interdunal facies, including horizontally bedded red sandstones.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE MESSEL ADAPIDS - 3D RECONSTRUCTION, REPOSITIONING, AND FUNCTIONAL ANALYSIS OF THE DENTITIONS

ENGELS, Sandra, Senckenberg Research Institute and Natural History Museum, Frankfurt/Main, Germany; HABERSETZER, Joerg, Senckenberg Research Institute and Natural History Museum, Frankfurt/Main, Germany; KULLMER, Ottmar, Senckenberg Research Institute and Natural History Museum, Frankfurt/Main, Germany; HURUM, Joern, Naturhistorisk Museum Universitetet i Oslo, Oslo, Norway

In early and middle Eocene, the Adapoidea were one of the two dominant primate groups. Their fossil record is particularly rich in Europe and North America, nonetheless they are also known from Asia. One of the most important European localities is the Messel Pit in Germany (middle Eocene). Three well-preserved adapid species are known from this locality (*Darwinius masillae, Europolemur kelleri, E. koenigswaldi*). Of each species a skull with three-dimensionally preserved teeth is known, bearing valuable information about the dietary spectrum, mode of life and phylogenetic position. Until now the dentitions of the Messel primates were not completely accessible in 3D, since in most cases they are largely obscured by the resin plate or other parts of the fossil, such as bones or antagonistic teeth. Moreover, because of the properties of the fossil itself, high resolution micro-CT scanning is technically problematic. Therefore, to make the complete dentitions, including their functionally and phylogenetically significant occlusal surfaces, comprehensible for the first time, they were scanned using a special micro-CT technique and reconstructed virtually. A new method was used to generate highly resolving 3D surfaces of all teeth. All preserved teeth were subsequently repositioned on a morphofunctional basis into functioning dental arches, such that biologically meaningful masticatory movement can be calculated and simulated as well. For the first time the dentitions are repositioned as a functional whole again, whose configuration in turn provides phylogenetic signal. The simulation of the masticatory movement revealed how apparent morphological differences are reflected in the process of comminution by quantifying the different cusp morphologies of both genera. Thereby conclusions can be drawn on paleodiets, which probably varied in their mechanical properties. Moreover, the virtual separation of the different tooth materials allowed insight into the development of the molar cusps, insofar as the enamel-dentine junction reveals the ontogenetic and phylogenetic origin of the cusps. This enhances our understanding of the dietary spectrum, mode of life, and phylogenetic position of the Messel adapoids. In the process, the long overdue comparison of all three species to other adapids is finally enabled.

Technical Session XVIII (Saturday, November 2, 2013, 3:30 PM)

PREDICTING THE SHAPE OF UNDISCOVERED FOSSILS

EVANS, Alistair, Monash University, Melbourne, Australia; CHIEU, Thai Lap, Monash University, Melbourne, Australia; SIU, Karen, Australian Synchrotron, Melbourne, Australia; RICH, Thomas, Museum Victoria, Melbourne, Australia

The fragmentary nature of most fossils causes great problems in interpreting and classifying them. However, correlations among parts of an organism should make it possible to reconstruct missing components using modern statistical shape analysis. The shapes of opposing mammal molars are highly correlated due to their interaction during occlusion, making them a good candidate for this approach. A substantial number of fossil mammals are known solely from their teeth, and for many of these only a few teeth have been identified. A major problem exists in determining whether isolated upper and lower teeth are from the same taxon, as well as matching new specimens with existing taxa. A prime example of this is the ausktribosphenids of the Australian Mesozoic. Since the first lower jaw of *Ausktribosphenos nyktos* was discovered in 1997, 23 specimens with lower molars have been recovered but none with upper teeth. Knowledge of the shape of the upper teeth may help taxonomic assignment of the ausktribosphenids and the identification of any new fossils found in the future. We aimed at quantitatively predicting the shape of the undiscovered upper molars of ausktribosphenids.

We reconstructed the lower molar shape of *Ausktribosphenos* and *Bishops* using high-resolution SPring-8 synchrotron X-ray microtomography (SXmCT) scans. To make quantitative predictions of the shape of opposing teeth, we developed a database of 3D shapes of opposing tribosphenic teeth. The database includes microCT scans of comparative taxa with tribosphenic tooth form in orders Chiroptera, Dasyuromorphia, Didelphimorphia, Erinaceomorpha, and Soricomorpha. It also included tribosphenic fossil taxa for which associated upper and lower molar teeth are known or suspected, including *Cimolestes*, *Prokennalestes*, *Deltatheridium*, and *Holoclemensia*.

We examined the variation in 3D shape for upper and lower molars using landmark-based 3D geometric morphometric analyses. The lower molars of *Ausktribosphenos* and *Bishops* fall close to marsupials in the first two principle components of shape, demonstrating that the upper molars are tribosphenic with a lingually-displaced mesostyle rather than dilambdodont with a buccal mesostyle. 2-block partial least squares analysis was used to investigate the covariation in shape between upper and lower teeth. We generated 3D models of the predicted upper molar shapes based on the first five principle components of shape. This approach has great potential to examine other mammal taxa with referred tooth associations or with unknown opposing molars.

Symposium 1 (Wednesday, October 30, 2013, 9:00 AM)

WASTED YOUTH: THE IMPORTANCE OF ONTOGENETICALLY EQUIVALENT SEMAPHORONTS IN DINOSAUR PHYLOGENETIC SYSTEMATICS

EVANS, David, Royal Ontario Museum, Toronto, ON, Canada, M5S2C6; CAMPIONE, Nicolas, Royal Ontario Museum, Toronto, ON, Canada; BRINK, Kirstin, , Mississauga, ON, Canada; SCHOTT, Ryan, University of Toronto, Toronto, ON, Canada; BROWN, Caleb, University of Toronto, Toronto, ON, Canada

Phenotypic traits of organisms can change greatly through their life history. Hennig recognized this, and defined the term semaphoront to refer to an individual at a given life stage. A basic tenet of phylogenetic systematics is that comparisons should involve comparable semaphoronts, or individual representative specimens that approximate the same life stage, so that ontogenetic differences do not influence the phylogenetic signal. This issue is particularly relevant for analyses of dinosaurs, where the identification of adults and juveniles is difficult and often overlooked. Dinosaurs can undergo substantial morphological change during their ontogeny, particularly in 'bizarre' structures associated with intraspecific display, and juvenile specimens often display unique combinations of characters that do not occur in adults. Despite this, many dinosaur systematists continue to combine different semaphoronts in cladistic analyses and these are frequently used to justify the erection of new taxa, even when the proposed holotype is recognized as a juvenile.

In order to explore the effects of mixing juvenile and more mature semaphoronts, we conducted five cases studies in which multiple, histologically demonstrated juvenile specimens are included as operational taxonomic units (OTUs) in a phylogenetic analysis with their adult form. We used recent phylogenetic datasets and known ontogimorphs in the three ornithischian clades: Hadrosauridae (*Prosaurolophus, Hypacrosaurus*), Ceratopsidae (*Centrosaurus*), and Pachycephalosauridae (*Stegoceras, Pachycephalosaurus*). Analyses were run with and without juvenile specimens, and results were compared.

In general, the tree topologies with and without juveniles were comparable. Juveniles exhibited more plesiomorphic characters relative to adults, and typically formed sister taxa to more inclusive groups within the clade. However, some juveniles exhibit derived morphologies not found in more mature individuals, such as squamosal spikes in immature *Pachycephalosaurus*, emphasizing the need to carefully consider ontogeny in the construction of characters and in the interpretation of specimens and cladograms. Due to the potential for juveniles to possess apomorphic traits or unique combinations of traits, their effects on tree topology cannot be easily predicted in any given case. Therefore, juvenile specimens should not be included in phylogenetic analyses based on adult semaphoront morphologies.

Technical Session I (Wednesday, October 30, 2013, 10:30 AM)

BIG, BAD, AND BIZARRE: NEW MATERIAL OF *BEELZEBUFO*, A HYPEROSSIFIED ANURAN FROM THE LATE CRETACEOUS OF MADAGASCAR, YIELDS FURTHER SURPRISES.

EVANS, Susan, University College London, London, United Kingdom; GROENKE, Joseph, Stony Brook University, New York, NY, United States; JONES, Marc, Univ College London, London, United Kingdom; TURNER, Alan, Stony Brook University, Stony Brook, NY, United States; KRAUSE, David, Stony Brook Univ, Stony Brook, NY, United States

The extant anuran fauna of Madagascar is extraordinarily speciose and almost exclusively endemic. In recent years, our understanding of the history and relationships of this fauna has been greatly advanced by molecular studies, but very little is known of the fossil history of frogs on the island. *Beelzebufo ampinga*, the first named pre-Holocene frog from Madagascar, was originally described on the basis of numerous disarticulated cranial and postcranial elements from the Upper Cretaceous (Maastrichtian) Maevarano Formation. These specimens documented the presence of a hyperossified anuran that differed strikingly from living Malagasy taxa in its large size and well-developed cranial exostosis. The 2010 field season yielded the first articulated cranial material of *Beelzebufo*. This discovery, in conjunction with additional isolated specimens of the skull, vertebral column, and hind limb, greatly adds to our understanding of this unusual frog. New reconstructions, based on microCT data, demonstrate that *Beelzebufo* was even more bizarre than originally interpreted, with large posterolateral skull flanges and wide, sculptured vertebral spine tables. The head was disproportionately large, supporting the original interpretation of *Beelzebufo* as a wide-mouthed ambush predator of other vertebrates. There is sedimentological, taphonomic, and other paleontological evidence that the Maevarano Formation was seasonally arid, a challenging environment for a large amphibian. The apparent absence of an external ear, the strong exostosis, and aspects of vertebral morphology suggest that *Beelzebufo* may have burrowed during adverse conditions. New phylogenetic analyses, incorporating both morphological and molecular data, confirm the placement of *Beelzebufo* with hyloid rather than ranoid frogs. Within Hyloidea, *Beelzebufo* still groups with the South

American Ceratophryidae, thus continuing to pose difficulties with both biogeographic reconstruction and prior molecular divergence dates.

Romer Prize Session (Thursday, October 31, 2013, 9:15 AM)

EMPIRICAL AUTHENTICATION OF OUR UNDERSTANDING OF FLUVIAL TAPHONOMIC PROCESSES

EVANS, Thomas, Montana State University, Bozeman, MT, United States, 59717-3480

For decades analytical techniques like Voorhies Groups, bone orientation, and equivalent spherical quartz diameters have been used to interpret paleontological and archaeological skeletal assemblages. However, these methods incorporate untested assumptions concerning how bones behave in fluvial systems. A validation study was performed to determine if bones in rivers behave as predicted and determine if any of these techniques accurately predict skeletal assemblages moved and deposited by rivers. Over 7000 modern bones and 3686 bone casts were seeded in three rivers over four years, and bone movement and burial were tracked over time and space. Bone long axis orientations did not correlate with flow direction, though 75% of concave bones did orient concave down, and bones did not display Voorhies Group like transport behavior. Bones deposited in rivers were not found on sediment with equivalent grain sizes, and no consistent relative transportabilities (R) of bones were observable. Bone shape and density showed no consistent relationship to transport. Individual bone bulk density varied wildly as they became waterlogged, causing bones to float, hydrate, sink, and move stochastically. In addition, 56% of bones were deposited with woody debris, and many more were found in conjunction with bed obstructions. Field data suggests bone transport is governed by bone density (floating and hydration) while deposition is governed by bed interactions, demonstrating that existing analytical techniques are inadequate to describe fluvial bone transport behavior. Consequently, our existing understanding of fluvial taphonomic processes is incomplete suggesting that present fluvial taphonomic analytical techniques should be updated before use.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TRAUMATIC PATHOLOGIES IN THE POSTCRANIUM OF AN ADULT *ALLOSAURUS* SPECIMEN FROM THE MORRISON FORMATION OF THE HOWE QUARRY, WYOMING, U.S.A.

EVERS, Serjoscha, Ludwig-Maximilians-University Munich, Munich, Germany; FOTH, Christian, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; PABST, Ben, Sauriermuseum Aathal, Aathal, Switzerland; MATEUS, Octavio, Universidade Nova de Lisboa, Faculdades de Ciências e Tecnologia-CICEGe & Museo da Lourinhã, Lourinhã, Portugal

Adult large-bodied theropods are often found with numerous pathologies. A large, almost complete, adult *Allosaurus* specimen (Sauriermuseum Aathal [SMA] 0005) from the Howe Quarry, Morrison Formation (Late Kimmeridgian–Early Tithonian), Wyoming, shows a number of pathologies. Pathologic bones include the left scapula, several left dorsal ribs, the right ischium, and a left pedal phalanx.

A complete, transverse fracture occurs in the proximal part of the left scapula. The distal fragment is displaced and distorted in relation to the proximal fragment. The fracture does not show a callus structure as expected for a healed injury, but some secondary osseous connection to the distal fragment is apparent at the rupture point of the proximal fragment, resulting in a weak attachment. This is consistent with the formation of a pseudoarthrosis, which occurs as a delayed healing response in fractures that lack adequate stabilizing and are subject to frequent movement.

The distal part of the left scapula is fractured incompletely and transversely. The bone around the fracture is slightly thickened and roughened. The fracture is at approximately the same level as a series of transversely fractured left dorsal ribs. The presence of calli around the rib fractures and the alignment of the scapula and rib pathologies suggest that all may have been caused by a single traumatic event.

The right ischium suffered a complete, oblique fracture. Rough bone tissue covers the fracture on one side completely, while the other shows no sign of reactive growth.

A pedal phalanx has a hyperostosis at the dorsal and lateral sides of its proximal end, forming an ovoid callus, unlike the large irregular exostoses in phalanges of other *Allosaurus* specimens, including Museum of the Rockies specimen MOR 693 from the same quarry. The bone surface is roughened, but not rugose, and lacks lesions indicative for infections. This indicates bone resorption in an advanced healing stage of the injury.

All the pathologies show signs of healing, suggesting that none of them directly caused the death of the individual. This again underlines that large-bodied theropods experienced frequent traumatic injuries during life, an indication of an active lifestyle as a predator.

Technical Session I (Wednesday, October 30, 2013, 11:45 AM)

THE PERMIAN ARCHOSAUROMORPH RECORD REVISITED: A NEW SPECIES FROM TANZANIA AND THE POTENTIALLY OLDEST ARCHOSAURIFORM

EZCURRA, Martin D., School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, United Kingdom; BUTLER, Richard, School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, United Kingdom; SCHEYER, Torsten M., Paläontologisches Institut und Museum, Universität Zürich, Zurich, Switzerland

Archosauromorphs include all diapsids closer to crocodiles and birds than to lepidosaurs. The group has a very rich Mesozoic and Cenozoic fossil record, but the Paleozoic record is restricted to a handful of Late Permian specimens. The most informative Permian archosauromorph so far discovered is *Protorosaurus speneri* from the middle Late Permian of Western Europe. In addition, there are several less well-known putative archosauromorphs from Russia and Africa. We review these records here and include several of them in a quantitative phylogenetic analysis for the first time. This phylogenetic analysis included a broad taxonomic sampling of basal synapsids, basal diapsids and saurians. We could not find archosauromorph apomorphies in a supposed Late Permian proterosuchid cervical vertebra from South Africa (Bernard Price Institute for Palaeontological Research specimen BP/1/4220), and consider this specimen to belong to an indeterminate amniote. BP/1/4220 possesses striking features that are not present in other amniotes of which we are aware, such as posteriorly extended, wide and almost horizontally oriented accessory processes between the postzygapophyses. A problematic reptile (University Museum of Zoology, Cambridge specimen UMZC T836) from the Late Permian of Tanzania, first described in the 1950s, was recovered in the phylogenetic analysis as a protorosaur at the base of Archosauromorpha and is probably diagnosable as a new species. The position of UMZC T836 within Archosauromorpha is supported by the presence of three well-developed laminae in the cervico-dorsal neural arches and the absence of a humeral entepicondylar foramen. The supposed protorosaur *Eorasaurus olsoni* from the middle Late Permian of Russia was recovered within Archosauriformes, being more closely related to crown archosaurs than to proterosuchids, implying that this species may be the oldest known archosauriform. However, the fragmentary nature of the known material of this taxon and the low character support for this position means that this identification is currently tentative. *Archosaurus rossicus* from the latest Permian of Russia was found to be more closely related to *Proterosuchus fergusi* than to other archosauromorphs and represents a valid species. The revision conducted here suggests a minimum fossil calibration date for the crocodile-lizard split of 254.7 Ma. The occurrences of *Protorosaurus speneri* close to the paleo-Equator and UMZC T836 in high paleolatitudes of southern Pangea imply a wider paleobiogeographic distribution for archosauromorphs during the Late Permian than previously appreciated.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ONE FITS ALL: USING PHOTOGRAMMETRY TO SOLVE DIVERSE PROBLEMS WITH LARGE-SIZED PALEONTOLOGICAL OBJECTS

FAHLKE, Julia, Museum für Naturkunde, Berlin, Germany; MALLISON, Heinrich, Museum für Naturkunde, Berlin, Germany; WINGS, Oliver, Niedersächsisches Landesmuseum Hannover, Hannover, Germany; SCHWARZ-WINGS, Daniela, Museum für Naturkunde, Berlin, Germany

Photogrammetry is a method for creating three-dimensional (3D) surface models by aligning photographs of an object, originally used in architecture and mapping. With increasing computing power it has become a versatile method with a wide array of applications in paleontology. Several freeware or low-cost programs are available. Vertebrate paleontologists at the Museum für Naturkunde Berlin use Agisoft PhotoScan Professional and collaborate to enhance efficiency in using photogrammetry. Research examples presented here reflect typical paleontological problems and provide solutions for accurate 3D model production that can easily be adapted by colleagues facing similar problems. (1) Specimens that must remain in the field: dinosaur tracks from Münchehagen (Germany) show that rapid photo acquisition in consistent light conditions is required when covering large specimens outdoors. Sufficient surrounding surface should be covered to avoid model warping for long tracks. For precise mapping of large excavation sites (i.e., Dana Quarry) and documentation over several field seasons it is important to define and retain field markers over the entire documentation time. To limit file size, model creation can be split into chunks. (2) Specimens that are too large for manual measurements, immobile, and cannot be scanned using other equipment: photogrammetry of mounted skeletons for whole-body modeling illustrates the importance of post-processing. Thin bones require higher resolution than thicker ones, thus model creation settings need to be adapted individually. With elongate large objects like baleen whale skulls, depth of field can be problematic. One should avoid head-on photographs and pay particular attention to focusing. Creating partial surfaces and aligning them during post-processing can help. Surface smoothing is not recommended as it blurs morphological features used, e.g., in landmark-based analyses. (3) Specimens that are physically inaccessible: photogrammetry of a forelimb of *Janenschia* (Sauropoda) on exhibit behind glass allowed generation of 3D models for character analysis. Application of polarizing filters and directional light helped to minimize reflections. Bones of *Steneosaurus* (Crocodyliformes) from Holzmaden (Germany) that had to be protected from contact contamination could also be measured using a 3D model. Generally, one should avoid changes in lighting or white balance and use accuracy settings that match photograph resolution. Sufficient computing power is required to keep calculation times tolerable.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EARLY SAUROPODOMORPH JAW APPARATUS ANATOMY: A COMPARATIVE STUDY WITH IGUANIAN LIZARDS

FAIRMAN, Jennifer, Johns Hopkins University School of Medicine, Baltimore, MD, United States, 21205; NABAVIZADEH, Ali, Johns Hopkins University School of Medicine, Baltimore, MD, United States; WEISHAMPEL, David, Johns Hopkins University School of Medicine, Baltimore, MD, United States

Various genera of early sauropodomorph dinosaur, or "prosauropod", are argued to have ranged from omnivorous to herbivorous based on a ventrally offset jaw joint articulation, neck length, skull size, and a gastric mill, among other characters. One key analogy that has been used to infer omnivory and herbivory in early sauropodomorphs, however, is the shape and orientation of their dentition and their similarity to that of iguanian lizards, which are also known to range from omnivorous to herbivorous. To test the validity of the comparison, this study examines the temporal fenestrae and jaw musculature in herbivorous, omnivorous, and insectivorous iguanian models to predict jaw musculature for the plateosaurid *Plateosaurus engelhardti* and the anchisaurid *Anchisaurus polyzelus* with respect to diet. Dissections and skeletonization of the

omnivorous *Sceloporus magister* and the herbivorous *Iguana iguana* provided the basis for the extant comparative sample. The insectivorous *Ctenosaura hemilopha* and *C. pectinata* were also dissected for further comparison. A suite of skull structures and muscle locations were identified that appear to relate to differences in feeding styles in these extant iguanians. In the omnivorous and insectivorous forms, similarities include the oblique shift of the temporal fenestrae in relation to each other and the long axis of the skull, the dorsal shift of the supratemporal fenestra, and the overall lengthening of the jaw muscles. Alternatively, in the herbivorous *Iguana*, features include the relationship of the temporal fenestrae at right angles to each other and the long axis of the skull, the larger surface area of the parietal bone in the supratemporal fenestra, and the laterally located jaw muscles. These features are also found in the early sauropodomorphs under study. The skull of *P. engelhardti* exhibits temporal fenestrae that are located at a right angle with respect to each other and the long axis of the skull, like that of *I. iguana*, whereas *A. polyzelus* has temporal fenestrae that are of an oblique relationship, similar to that of *S. magister*. Therefore, it is suggested that *Anchisaurus* had a facultative omnivorous feeding style whereas *Plateosaurus* was predominately herbivorous. This study presents the likelihood of a dual origin of herbivory in Sauropodomorpha, as anchisaurids are thought to be phylogenetically more derived than plateosaurids, therefore further elucidating the evolution of herbivory in the derived sauropod dinosaurs.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE PLUMAGE OF *CONFUCIUSORNIS*: PRIMITIVE OR MODERN?

FALK, Amanda, University of Kansas, Lawrence, KS, United States, 66049

The Lower Cretaceous Jehol Group of northeastern China has yielded fantastic fossils of primitive birds. *Confuciusornis*, the most basal beaked bird, is the most numerous fossil bird in the Jehol Group. The osteology of *Confuciusornis* has been extensively defined; however, the structure, positioning, and nature of the feathers remains largely unstudied. *Confuciusornis* does not have a tail fan as do modern birds; many specimens preserve two very long tail feathers. These tail feathers have a unique morphology and have been interpreted as (1) featureless ribbon-like structures with barbs on the distal end, (2) a large rachis with distal barbs, (3) undivided modified pennaceous feathers, and (4) feathers encased in an elongate, persistent feather sheath. These types of feathers have not been found in modern bird lineages, and are dissimilar from modified feathers in the mot-mots (Momotidae), birds of paradise (Paradisaeidae), and nightjars (Caprimulgiformes). Mot-mots and nightjars have modified flight and tail feathers that consist of barbs with weakened bases that are preened away, whereas Birds of Paradise have featureless, ribbonlike feathers. There is no evidence of these modified barbs in the tail feathers of *Confuciusornis*, nor is the proximal part featureless and ribbonlike. *Confuciusornis* has exceptionally long primary feathers, and there is evidence for a fully modern arrangement of these flight feathers. There are 10 primary feathers on the hand. The 10th (outermost) primary is significantly shorter than the 9th primary, however, in the specimens examined there is no evidence of an alula. The rachis in the primary feathers is large and robust (~1–1.5 mm wide), contrary to what has been reported previously for confuciusornithids. The secondary feathers contact the ulna, but in the specimens examined they are folded and cannot be counted. The primaries and secondaries are partially covered by greater primary and secondary coverts. The primary feathers appear to overlap flattened portions of the proximal phalanx and carpometacarpus, as in modern birds. Primary feathers 5–10 appear to abut the proximal phalanx, whereas 1–4 likely abut the carpometacarpus; however, in most specimens the carpometacarpus and the proximal rachises are not visible. Barbules are preserved on some of the primary feathers. There is also significant evidence of a crest based on the feathers of the head.

Technical Session XIV (Saturday, November 2, 2013, 8:00 AM)

USING AVIAN SUBSURFACE 3D FOOT MOTION TO SIMULATE FOSSIL TRACK DIVERSITY

FALKINGHAM, Peter, Royal Veterinary College London, London, United Kingdom; GATESY, Stephen, Brown University, Providence, RI, United States

The fossil track record is our primary window on the locomotor capabilities and behaviors of extinct animals, yet the variation seen among footprints is daunting, both at the assemblage level, and even within trackways made by a single individual. In order to make solid inferences about the trackmaker, locomotion, or behavior, we must understand how pedal anatomy, distal limb kinematics, and substrate interact to generate track morphology.

Our aim was to begin to decouple this complex system by simulating tracks of different depth while holding foot structure and motion constant. We first analyzed a chicken-like bird, the helmeted guineafowl, traversing a bed of poppy seeds using X-ray Reconstruction of Moving Morphology (XROMM) to reconstruct the 3D kinematics of the distal limb both above and below the surface of the compliant substrate. We then imported these 3D kinematics into computer simulations of granular material, carried out using the Discrete Element Method (DEM).

Changes in depth alone produce a wide diversity of resultant tracks, both at the exposed surface and at intermediate levels. The shallow angle of the metatarsus and digits at entry and exit cause elongation of the surface morphology as the foot sinks deeper. Backwards motion of the distal phalanges at toe-off results in parallel scratch marks at the base of the track.

The variation seen in these simulated tracks bears striking resemblance to many of the tracks in the Hitchcock collection, held at the Beneski Museum of Natural History, Amherst. Our kinematic data and simulations suggest much of this variation stems from the depth to which the foot sank and to the level subsequently exposed, rather than from a diversity of foot morphologies or locomotor kinematics. We also show that the subsurface foot motion associated with traversing a compliant substrate can produce tracks (or portions of tracks) which may, if interpreted without complete context, be attributed to unusual behaviors such as swimming.

Technical Session II (Wednesday, October 30, 2013, 9:45 AM)

FRACTAL DIMENSIONALITY AS A MEASURE OF OCCLUSAL ENAMEL COMPLEXITY IN EQUIDAE (MAMMALIA: PERISSODACTYLA)

FAMOSO, Nicholas, University of Oregon, Eugene, OR, United States, 97401; DAVIS, Edward, University of Oregon, Eugene, OR, United States

Enamel patterns on the occlusal surfaces of equid teeth are asserted to have tribal-level differences. The most notable example compares the Equini and Hipparionini, where Equini have higher crowned teeth with less enamel-band complexity and less total occlusal enamel than Hipparionini. While previous work has successfully quantified differences in enamel band shape by dividing the length of enamel band by the square root of the tooth surface area (Occlusal Enamel Index, OEI), we have discovered that OEI only partially removes the effect of body size. Because enamel band length scales allometrically, body size still has an influence on OEI, with larger individuals having relatively longer enamel bands than smaller individuals. Fractal dimensionality (D) can be scaled to any level, so we have used it to quantify occlusal enamel complexity while completely eliminating the effects of scaling from body size. With the effects of body size removed, we can now directly investigate complexity. To test the hypothesis of tribal-level complexity differences between Equini and Hipparionini, we digitally traced a sample of 20 teeth, ten from each tribe. We restricted our sampling to the P3 to eliminate the effect of tooth position. After calculating the D of these teeth with the fractal box method, we performed a nested two-way analysis of co-variance (ANCOVA) with taxonomy (tribe, genus, and species) as a nested independent factor, true occlusal area (a proxy for body size) as a continuous independent factor, and D as the dependent factor. The ANCOVA indicates that genus nested within tribe (p=0.0428), and species nested within genus and tribe (p=0.0148) are significant. True occlusal surface area (p=0.4116) and tribe (p=0.0666) are not significant. Our preliminary results suggest that, as expected, fractal complexity is independent of body size. The tribal level was not significantly different for complexity and the significance of the lower taxonomic levels suggests that complexity is the product of speciation and behavior rather than taxonomy.

Technical Session III (Wednesday, October 30, 2013, 3:00 PM)

BIOGEOGRAPHY OF BASAL NEOCERATOPSIAN DINOSAURS ILLUMINATED BY A SKULL FROM THE CLOVERLY FORMATION (LOWER CRETACEOUS) OF MONTANA

FARKE, Andrew, Raymond M. Alf Museum of Paleontology, Claremont, CA, United States, 91711; MAXWELL, Desmond, University of the Pacific, Stockton, CA, United States; CIFELLI, Richard, Oklahoma Museum of Natural History, Norman, OK, United States; WEDEL, Mathew, Western University of Health Sciences, Pomona, CA, United States

Basal neoceratopsians have been previously reported from the Early Cretaceous of North America based on postcrania and isolated teeth, but the incompleteness of these fossils has hampered meaningful broader interpretation. The skull of a small basal neoceratopsian from the Cloverly Formation of Carbon County, Montana, provides clarification of the phylogenetic and biogeographic relationships of Asian and North American neoceratopsians. The specimen was collected from the basal portion of Unit VII of the formation; we provisionally regard it as Albian in age. The skull measures 84 mm from the tip of the rostral to the tip of the jugal, representing a small (possibly immature) animal. Definitive ceratopsian synapomorphies include a rostral bone, among others. The three premaxillary teeth lack denticles, and only the labial surfaces of the 10 maxillary teeth possess enamel. Each tooth crown shows a distally-placed primary ridge with at least one accessory ridge on each side, as in *Archaeoceratops*. Similar to *Archaeoceratops* and coronosaurs, the predentary tapers to a sharp point. The jugal is prominent but lacks an epijugal, as in *Liaoceratops* and non-neoceratopsians. Phylogenetic analysis places the Cloverly ceratopsian within Neoceratopsia, close to *Liaoceratops* and the origin of the clade. Somewhat surprisingly, the Cloverly taxon is not closely related to later North American ceratopsians. Dispersal Vicariance Analysis and the Dispersal-Extinction-Cladogenesis model were used to reconstruct ancestral ranges within Ceratopsia. In agreement with previous hypotheses, the earliest ceratopsians are reconstructed as Asian; dispersal into North America during the Early Cretaceous is required to account for the Cloverly taxon. As many as two subsequent and separate dispersals are required to account for later North American ceratopsoids and leptoceratopsids. The Cloverly ceratopsian provides additional evidence for a faunal connection between North America and Asia by the mid-Albian or perhaps even earlier.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A PHOTOGRAMMETRIC RECREATION OF ROLAND T. BIRD'S PALUXY RIVER THEROPOD-SAUROPOD "CHASE SEQUENCE" TRACKSITE QUARRY (GLEN ROSE FORMATION, LOWER CRETACEOUS, DINOSAUR VALLEY STATE PARK, SOMERVELL COUNTY, TEXAS)

FARLOW, James, Indiana Purdue Univ Fort Wayne, Fort Wayne, IN, United States, 46805; FALKINGHAM, Peter L., Brown University, Providence, RI, United States; BATES, Karl, University of Liverpool, Liverpool, United Kingdom

In 1940 R.T. Bird of the American Museum of Natural History (AMNH) exposed a sequence of footprints of a sauropod and an associated theropod dinosaur in the dolomitic mudstone bed of the Paluxy River. Portions of the two trackways were cut into pieces from the river bed, and later reassembled at the AMNH and the Texas Memorial Museum (TMM) in Austin. Bird took an extensive series of overlapping photographs along the length of the two trackways. We digitized these images, and used photogrammetric software to combine them into a model that can be viewed from any perspective, digitally

recreating a set of footprints that has not existed in its complete form for more than 70 years.

The quality of reconstruction of the two trackways in situ along their lengths varies, depending on the amount of overlap between successive fields of view in Bird's original photographs. The reconstruction is best toward the down-trail end of the two trackways. This corresponds to the portion of the quarry beginning with the final right sauropod pes print in the TMM slab, and ending by a sandbag dam seen in Bird's photographs. The photogrammetric reconstruction is less satisfactory in its up-trail portion (including the prints in the AMNH slab and most of the TMM slab).

We made comparisons among the photogrammetric reconstruction, the reassembled AMNH-TMM slabs, and Bird's Rye Chart of the trackways. Examination of the AMNH-TMM slabs reveals several theropod prints not depicted in the Rye Chart. There is reasonably good agreement about the positions of sauropod and theropod footprints between the Rye Chart and the photogrammetric reconstruction for the above-described final interval of the reconstruction over which the reconstruction is good, but the match is poor for more up-trail portions of the two trackways. The arrangement of the sauropod footprints in the Rye Chart and the reconstructed AMNH-TMM slabs can be made to match fairly well, but this results in footprints of the theropod being somewhat offset in the chart as opposed to the slabs.

The Rye Chart, the reassembled AMNH-TMM slabs, and our photogrammetric reconstruction all agree, however, in the overall pattern of the trackways of the two dinosaurs. The theropod crossed the tracksite after the sauropod did, repeatedly stepping in the latter's footprints. Over most of the length of the two trackways, the theropod's prints hugged the left margin of the sauropod trackway, the trackways of both animals bending to the left, with the theropod crossing the sauropod's trackway only at the end of the latter (as exposed in Bird's quarry).

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE EARLY PLEISTOCENE MAMMALIAN FAUNA OF 'MARSABIT ROAD', CHALBI BASIN, NORTHERN KENYA

FERRARO, Joseph, Baylor University, Waco, TX, United States, 76798; BINETTI, Katie, Baylor University, Waco, TX, United States; RICHMOND, Brian, George Washington University, Washington, DC, United States; MANTHI, Fredrick, National Museums of Kenya, Nairobi, Kenya

The Chalbi Basin of northern Kenya preserves a long succession of laterally-extensive but little-explored fossiliferous sediments dating to the early and middle Pleistocene. Located to the immediate southeast of Lake Turkana, the Chalbi Basin offers paleobiologists a relatively rare opportunity in East Africa to assess ancient faunas and paleoenvironments outside of the Great Rift Valley. In the summers of 2009-2012, our team conducted a series of expeditions to the southernmost margin of the Basin. Our primary goal was to investigate the early Pleistocene fossil locality of 'Marsabit Road', a site originally noted by surveyors in the 1940s. Through a combination of prospecting, sweeping, sieving, and excavation, we recovered an abundant and speciose collection of ~1500 accessionable fossil mammal specimens. Finds include an intact hominin third metacarpal, as well as the remains of 30+ species of primates, carnivores, bovids, equids, suids, elephants, deinotheres, camels, and hippos, amongst others. A biostratigraphic analysis of the fauna provides a date of 1.9-2.1 Ma – an age consistent with an 40Ar/39Ar date of 1.9 Ma for a basalt layer at the top of the local stratigraphic sequence. The fauna is thus roughly comparable in age to the important regional fossil records of the Turkana Basin, Kenya and Ethiopia, and Kanjera South, Kenya. With regard to paleoenvironmental setting, the fauna indicates the presence of an edaphic grassland directly abutting a large river or lake, with secondary grasslands and lightly wooded settings present at slightly higher elevations. With the assemblage dominated by grazing ungulates (both in terms of gross numbers of individuals and species), coupled with a date of ~2.0 Ma, the Marsabit fauna samples one of the earliest grassland ecosystems yet known from sub-Saharan Africa. The fauna is also relevant to discussions of regional faunal endemism. We explore faunal similarities and differences relative to penecontemporaneous assemblages from across East Africa, noting some striking patterns in species distributions.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

WHY HIGHER SPECIES DIVERSITY DOES NOT ALWAYS EQUAL HIGHER MORPHOLOGICAL DISPARITY: AN EXAMPLE FROM VARANID LIZARDS

FERRER, Elizabeth, University of California, Berkeley, Berkeley, CA, United States, 94720

Although fairly conservative in morphology, varanids encompass a wide range of habitats and ecologies everywhere they are found. Extant *Varanus* are widespread in the Old World, and the geographic origin of the group is in question. *Varanus* is known from the early Miocene of Africa, although fragmentary remains suggest an earlier origin. However, present species diversity is highest in Indo-Asia and Indo-Australia, and recent molecular evidence shows some support for an Asian origin. A better understanding of phylogenetic and morphological disparity may help resolve issues of timing and diversification in this group. I tested how the occupation of cranial morphospace in varanids relates to regional species diversity by using geometric morphometrics to quantify variation in the skulls of 25 species from the African, Indo-Asian, and Indo-Australian regions including some fossil varanoids for comparison. I photographed and landmarked 127 skull images in several orientations, conducted a Procrustes superimposition, and then ran general principal component (PCA), phylogenetic PCA, canonical variate (CVA), and partial disparity analyses of species and regional groups. I also measured phylogenetic diversity (as opposed to taxonomic) of each region to compare with disparity. There is substantial skull variation within *Varanus*, with species like *V. komodoensis* and *V. exanthematicus* greatly expanding the range of morphospace. Indo-Australian varanids are situated in the middle of varanid morphospace (along with the few fossil varanoids), but *V. komodoensis* separates on various shape axes. The species poor African group covers almost the whole expanse of morphospace, and is distinct with CVA and Discriminant analyses. The partial disparity of the Indo-Asian group is the largest, but the African group makes a considerable contribution to shape space. The phylogenetic diversity (based on a recent molecular phylogeny) for Africa is low, but is highest in Indo-Australia followed by Indo-Asia. Indo-Australia may be low in total morphological disparity due to few samples in this study and considerable size (but not shape) variation in Indo-Australia. More information on the history and current distribution of varanids is needed to gain a better understanding of the dynamics of this group. This demonstrates the importance of incorporating past diversity patterns, disparity at various levels, and phylogenetic history in these studies.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE MIOCENE MAMMAL FAUNA OF SOUTHEASTERN MEXICO: AN UPDATING OVERVIEW

FERRUSQUIA-VILLAFRANCA, Ismael, UNAM, Mexico City, Mexico; RUIZ-GONZALEZ, Jose, UNAM, Mexico City, Mexico

Understanding of the Late Cenozoic evolution of the American continental fauna requires an appropriate knowledge of Middle America's late Tertiary faunas, which are known from a handful of sites in Central America and Mexico south of the Trans-Mexican Volcanic Belt. Although important advances in the paleontology of Central America and southeastern Mexico have occurred in the last decades, much work remains to be done not only at the known localities, but also in making a systematic effort to discover new localities and study their faunas. The information on the Miocene fauna of southeastern Mexico, is presented below to contribute to this effort. The fauna comes from four locality-areas in the States of Oaxaca (three) and Chiapas (one). The bearing strata form part of fluvio-lacustrine sequences preserved as graben fills, whose deposition was partly contemporaneouswith silicic explosive eruptions that emplaced tuff mantle sheets that either interbeded the sedimentary sequences, or formed thick volcanic successions associated with them. The fauna consists of five orders, 17 families and 35 genera [mainly represented by a single species each]; last decade's findings allow us to record or supplement material referred to eight genera; this fauna includes two chronofaunas, Hemingfordian and Barstovian, the former comes from the Suchilquitongo Area [northern arm of the Valle de Oaxaca Graben], the latter proceeds from the Matatlán Area [southeastern arm of the Valle de Oaxaca Graben], Nejapa Area [Nejapa Graben, eastern Oaxaca], and Ixtapa Area [Ixtapa Graben, northwestern Chiapas]. The Hemingfordian diversity is about one third that of the Barstovian; the Oaxacan Barstovian chronofauna is by far the largest. Both chronofaunas mainly consists of herbivores with very few carnivores [one order, three families, and four genera]; the former includes: Artiodactyla [nine families and 21 genera], Perissodactyla [two families and nine genera], Rodentia [two families and genera], and Proboscidea [one family and genus]. Camelidae and Equidae are more diverse, both include survivors and newcomers, which seem to have been contemporaneous; the latter comprise an ancestral merychippine coexisting with hipparionines and pliohippines. All taxa show strict North American affinities. Seven families and fifteen genera have their southernmost occurrence in Mexico. However, the presence in Peru of North American Clarendonian or older mammals may supersede this, thus leading to changes in the timing of the Great American Biotic Interchange.

Technical Session XIV (Saturday, November 2, 2013, 9:00 AM)

PRECISE INFERENCE OF AVIALAN FLIGHT ABILITY FROM SHOULDER JOINT DIMENSIONS

FIELD, Daniel, Yale University, New Haven, CT, United States, 06511; LYNNER, Colton, Yale University, New Haven, CT, United States

The evolution of powered flight, defined as the capacity to sustain level aerial locomotion by flapping wings as in crown-clade birds, was a pivotal event in dinosaur evolution, and played a major role in the ascendancy of avians to their current position as the most diverse and widely distributed tetrapods. Understanding the pattern of powered flight acquisition has become a key goal in dinosaur paleobiology, with the flying potential of basal avialans, such as *Archaeopteryx*, inspiring debate since the 19th Century. Understanding of powered flight capacity on the avian stem has, however, been limited by the difficulty of obtaining precise, quantitative estimates of flying potential from fossils. Here, an analysis of shoulder joint dimensions and body mass in 1142 extant birds and 11 stem-birds precisely delimits functional flying and flightless zones, enabling explicit tests of flying potential in stem-birds. This analysis demonstrates that basal avialans such as *Archaeopteryx* – despite possessing aerodynamically modified 'protowings' - were nevertheless incapable of the wing-powered, flapping flight seen in living birds. Instead, we infer that the basalmost-known stem-bird capable of powered flight was the Early Cretaceous species *Sapeornis chaoyangensis*. This discovery suggests that avian-style wing-powered flight evolved later than previously believed, shedding light on the importance of the stepwise sequence by which flight-related modifications accrued on the avian stem (e.g., the evolution of asymmetrical pennaceous feathers predates the evolution of powered flight, whereas a robust sternal keel evolved later). These data also confirm that flightlessness evolved multiple times within stem-birds, and, for the first time, provide a clear picture of the phylogenetic pattern of avian powered flight acquisition in Mesozoic feathered dinosaurs. Furthermore, this study reveals that dimensions of the glenoid facet of the avian coracoid provide the most robust skeletal correlate of body mass for volant birds, rendering these measurements the best option for estimating body mass in volant crown-bird fossils, as well as for crownward stem taxa. Given the relatively high preservation potential of avialan coracoids from the Late Cretaceous through the Cenozoic, this method facilitates robust mass estimates for volant avialans, even when only fragmentary remains are preserved.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

TWO THREE DIMENSIONALLY PRESERVED TELEOST NEUROCRANIA FROM THE CORSICANA FORMATION (UPPER CRETACEOUS, MAASTRICHTIAN), BEXAR COUNTY, TEXAS, U.S.A.

FIELITZ, Christopher, Emory & Henry College, Emory, VA, United States, 24327; COWAN, Tiffany, Emory & Henry College, Emory, VA, United States

Fossil fish are commonly laterally compressed when preserved. As a result, the bones and features of the lateral neurocranium are poorly preserved, if not lost all together. Two teleost fish specimens were collected from the Corsicana Formation of Bexar County, Texas. The Corsicana Formation is Upper Cretaceous (Maastrichtian, 72–65 Ma) and consists of fine claystone. Numerous macro-invertebrates have been found in the formation, but vertebrate fossils are scarce and have consisted of mainly chondrichthyan teeth. The teleost specimens consist of small braincases. One was 1.2 cm long, the other 0.9 cm long. They lack jaws, opercular bones, and the post-cranial skeleton. What makes them unusual is that they are preserved three dimensionally. The anatomy of the skulls were described and compared to known teleost fish groups. The smaller specimen could only be classified as a teleost, but the other is assigned to the order Albuliformes (subdivision Elopomorpha), possibly related to the fossil *Osmeroides* based on features of the exoccipital in posterior view. We propose that as gases from the decomposition of the brain escaped, the lower pressure created allowed fine clay to fill in the fish braincases, preventing the skulls from being crushed. We base this evidence on the numerous crustaceans found that have also been preserved in three dimensions.

Technical Session XV (Saturday, November 2, 2013, 8:00 AM)

ON THE EVOLUTION OF THE PREDATORY BEHAVIOR OF NORTH AMERICAN CANIDS AND ITS RELATIONSHIP WITH ENVIRONMENTAL TRANSFORMATION AND CLIMATIC CHANGE

FIGUEIRIDO, Borja , University of Málaga, Malaga, Spain; MARTÍN-SERRA, Alberto, University of Málaga, Malaga, Spain; PÉREZ-CLAROS, Juan A., University of Malaga, Malaga, Spain; PALMQVIST, Paul, University of Malaga, Málaga, Spain; JANIS, Christine, Brown Univ, Providence, RI, United States

The evolution of running-adapted (cursorial) carnivores is thought to have evolved for pursuing prey in open habitats. Evidence from paleosols and phytoliths indicate that open grassy habitats in North America were prevalent by the latest Oligocene, but there is little evidence of long-legged pursuit predators before the Pliocene. Here we use the impressive and recently documented fossil record of North American canids (family Canidae) to test if changes in elbow-joint shape, an established correlate of predatory behavior in extant carnivores, can be correlated with climatic change: did the specialized hunting techniques of fast-running pounce and pursuit predators evolve in concert with the spread of open habitats in the late Cenozoic, which in turn resulted from increasingly cold and arid environmental conditions? We examined elbow-joint shape (i.e., the anterior surface of humerus distal epiphysis) patterns in North American Canidae (subfamilies Hesperocyoninae, Borophaginae, and Caninae) from the Oligocene (~37 Ma) to the end of the Pleistocene (~0.01 Ma). We used a canonical variates analysis performed on a wide sample of living terrestrial predators classified within the three present-day predation modes (pursuit, pounce-pursuit and ambush predators), which was then used to assign the extinct taxa to predatory mode. The discrimination of these three hunting groups was significant using the Mahalanobis distances among groups ($P<0.0001$). Fossil data indicates a directional shift in elbow-joint shape indicative of increasing locomotor specialization from the basal hesperocyonines through the borophagines to the more recently-appearing canines. The chronological arrangement of elbow-joint shape data for canids shows that: (1) during the first ~10 Ma of the evolutionary history of this family, only ambush predators were present; and (2) present-day specialized hunting techniques first appeared in association with major environmental and biotic changes in the late Cenozoic of North America, including the expansion of open habitats and the diversification of grazing equids.

Symposium 4 (Saturday, November 2, 2013, 10:45 AM)

DISTRIBUTION AND POLAR PALEOENVIRONMENTS OF LARGE THEROPOD SKELETAL REMAINS FROM THE PRINCE CREEK FORMATION (EARLY-LATE MAASTRICHTIAN) OF NORTHERN ALASKA

FIORILLO, Anthony, Perot Museum of Nature and Science, Dallas, TX, United States, 75201; TYKOSKI, Ronald, Perot Museum of Nature & Science, Dallas, TX, United States

The Prince Creek Formation of northern Alaska contains the richest record of polar dinosaur skeletal remains known. While previous work has focused on various ornithischian taxa, small theropods, and theropod teeth, additional field work has yielded new cranial, axial and appendicular remains attributable to large theropods. Large theropods are now known from non-dental remains from four different sites, the Kikak-Tegoseak Quarry, the Liscomb Bonebed, the Byers Bonebed, and the Magical Mystery Bar. Cranial elements are from the Kikak-Tegoseak Quarry and are unambiguously referable to Tyrannosauridae. These four fossil sites are tightly constrained in time and space. Though the Prince Creek Formation spans a significant length of geologic time (Campanian-Paleocene), chronostratigraphic markers within the study area have placed all of these sites within the latest early or earliest late Maastrichtian (70-69 Ma). The fossil sites are all part of a sedimentary sequence that records an ancient high-latitude alluvial succession deposited on an ancient coastal plain. More specifically, the depositional setting of the sites ranges from upper delta facies to more proximal coastal plain settings. Mean annual temperature was warmer than that experienced today, creating an unusual ecosystem model as there is no modern analog for an ecosystem that experienced relatively warm temperatures under a polar-light regime. These new theropod fossils demonstrate two things. First, large theropod remains are more common in the Prince Creek Formation than previously recognized. Second, the tyrannosaurid cranial elements from the Kikak-Tegoseak Quarry may not be referrable to the contemporaneous *Albertosaurus sarcophagus* in the Horseshoe Canyon Formation of southern Alberta.

Romer Prize Session (Thursday, October 31, 2013, 9:30 AM)

THE EXTINCTION OF ICHTHYOSAURS IS A FACET OF A MAJOR CENOMANIAN TURNOVER IN MARINE ECOSYSTEMS

FISCHER, Valentin, Royal Belgian Institute of Natural Science, Brussels, Belgium

Untangling geosphere-biosphere interactions is crucial to understand biodiversity and how it might evolve in a changing environment. But little is known about the possible impact of environmental changes on animals occupying the highest levels of the marine trophic chains. The Cretaceous period offers a fantastic opportunity to investigate such relationship, being characterized by a globally warm but changing climate and a diverse assemblage of aquatic reptiles that underwent profound modifications during this period, ultimately permitting the diversification of the animals dominating modern marine ecosystems. The origin, magnitude and nature of these turnovers are poorly understood and have rarely been investigated in a global canvas. Especially, how and why ichthyosaurs, the 'fish-shaped' marine reptiles, went extinct at the beginning of the Late Cretaceous has been a mystery for decades. Previous assessments of their diversity suggested ichthyosaurs were already on the decline since the end of the Jurassic; their final extinction was therefore regarded as anecdotal. Several theories have proposed unique biological drivers to this event, including a break in the food chain or competition with other marine vertebrates.

The reassessment of the taxonomy, phylogeny and paleoecology Cretaceous ichthyosaurs from Eurasia tells a much different story. Ichthyosaurs were ecologically and taxonomically diverse in several Eurasian ecosystems up to the latest Early Cretaceous. This revision also reveals that their extinction is diachronic, being staggered over four phases that span the entire Cenomanian stage. Detailed comparison with other groups suggests the multiphased extinction of ichthyosaurs is not an isolated event, as was previously assumed, but correlates with profound, multiphased turnovers among other marine animals, such as microplankton, rudists, ammonoids, and pythonomorphs. The diversity and contemporaneity of the biotic responses suggest worldwide physicochemical drivers for this profound reorganization of the marine ecosystems. The extinction of ichthyosaurs therefore appears as one of the facets of a much wider event that affected most of the marine ecosystems during the Cenomanian.

Technical Session X (Friday, November 1, 2013, 8:00 AM)

3D OSTEOLOGY OF THE AMERICAN MASTODON

FISHER, Daniel, University of Michigan, Ann Arbor, MI, United States, 48109-1079; EL ADLI, Joseph, University of Michigan, Ann Arbor, MI, United States; CALAMARI, Zachary, University of Michigan, Ann Arbor, MI, United States

Digital technology is quickly changing the ways in which information can be shared globally. Advances in the speed and precision of 3D digitization will increasingly allow for rapid dissemination of detailed information on fossil material. Moreover, 3D representations allow for more illuminating portrayals of anatomical relationships and perimortem features that serve as evidence in taphonomic analyses. As a step toward the goal of wider use of 3D data in studies of proboscidean evolution and paleoecology, we present a complete, articulated, 3D model of an adult male American mastodon (*Mammut americanum*) skeleton, based principally on a single individual from a late Pleistocene site in northeast Indiana. This model forms the basis for an online resource on proboscidean osteology. Skeletal and dental elements of this individual, plus others that have already begun to supplement it, were digitized using several techniques (a point digitizer, a laser scanning digitizer, x-ray computed tomography, and photogrammetry) to capture data on form. For many purposes, surface models suffice, but taking best advantage of the 3D format is sometimes facilitated by creating photorealistic models through texture-mapping. We do this by using specialized software to map images of individual skeletal elements onto corresponding surface models. Bone models, texture-mapped or not, have been articulated to portray anatomical relationships and plotted in a 3D reference frame to build an interactive digital replica of site structure. Our articulated model skeleton serves as an interface for selecting individual bones for detailed viewing, supporting both comparative studies and precise identifications of material recovered at additional sites. Implementation of an online repository for proboscidean osteology is also the first step in development of tools for mapping sites as they are being excavated. Future expansion of this project is expected to incorporate scans of additional specimens and taxa, leading to a range of educational applications within both academic and museum settings.

Technical Session XV (Saturday, November 2, 2013, 8:30 AM)

EARLIEST SEALS FROM AUSTRALASIA REVEAL COLONIZATION OF THE SOUTHERN OCEAN BY ARCHAIC MONACHINAE (PHOCIDAE)

FITZGERALD, Erich, Museum Victoria, Melbourne, Australia; HASTIE, Darren, Deakin University, Melbourne, Australia; BUCKERIDGE, John, RMIT University, Melbourne, Australia; SCOFIELD, Paul, Canterbury Museum, Christchurch, New Zealand

Despite being the center of present day monachine seal (Phocidae) diversity and abundance, the Southern Ocean and its fringes remain a critical geographic gap in our knowledge of phocid evolution. Middle Miocene to early Pliocene fossils from South America and South Africa imply a long history in austral seas, yet Australasian records have so far been silent. Two key specimens from Australia and New Zealand shed light on the history of austral phocids. NMV (Museum Victoria) P160399, is an isolated

temporal bone of latest Miocene to earliest Pliocene age (5.0–6.2 Ma; Black Rock Sandstone, Beaumaris, Victoria, Australia). NMV P160399 has been referred to in print as a monachine, which is confirmed here by phylogenetic analysis, resolving it as an early monachine stemward of *Mirounga* (elephant seals) + Lobodontini (Recent Antarctic phocids plus extinct *Acrophoca* and *Homiphoca*). The second specimen is a cranium, CM (Canterbury Museum) Zfa333, of uncertain middle Miocene to Pliocene age (3.0–?12.0 Ma; Greta Siltstone, Motunau, South Island, New Zealand). CM Zfa333 is also a monachine, possesses more derived morphology than *Monachus* and NMV P160399, but lacks apomorphies of Lobodontini. Neither of the Australasian phocids appears to have close relationships with (1) approximately coeval fossil monachines described from Peru and South Africa; or (2) living Lobodontini of the Southern Ocean. Australasian fossil phocids were surprisingly disparate from those occurring elsewhere on the margins of the Southern Ocean during the Mio-Pliocene. These archaic phocids may represent a hitherto unrecognized austral dispersal and diversification of early monachine seals that preceded the pagophilic Lobodontini of present day Antarctica.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW LIZARDS FROM THE EARLY EOCENE VASTAN LIGNITE MINE OF INDIA

FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; RANA, Rajendra S., H.N.B. Garhwal University, Srinagar, India; AUGÉ, Marc, Muséum National d'Histoire Naturelle, Paris, France; KUMAR, Kishor, Wadia Institute of Himalayan Geology, Dehradun, India; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The lower Eocene (Ypresian) Cambay Formation at Vastan Lignite Mine in Gujarat, western India, has yielded a rich vertebrate assemblage including the earliest modern mammals and oldest birds of the Indian subcontinent. Among the herpetological faunas, snakes, lizards and amphibians are abundant, but, strangely, lizards are only represented by agamids. Here we describe the agamid assemblage based on numerous, diverse and well-preserved dentaries, premaxillaries, and maxillaries. At least four taxa are present at Vastan. *Vastanagama susanae* is characterized by dentaries with a large symphyseal facet, three anterior pleurodont teeth followed by acrodont teeth presenting a main cusp bordered by two lateral crests; the teeth increase in size posteriorly toward the coronoid process. *Tinosaurus indicus* exhibits a subdental ridge between the tooth row and the Meckelian canal, pleurodont symphyseal teeth including one that can be caniniform, and acrodont and tricuspid posterior teeth with poorly differentiated lateral cusps. Two other taxa represent two new genera and species. The first taxon presents multicuspid acrodont teeth with the main cusp surrounded by two or three progressively smaller lateral cusps. The second taxon presents pleurodont anterior teeth followed by a few acrodont teeth and ending with three or four subacrodont teeth near the coronoid process.

Our results confirm that Agamidae (assigned to the Acrodonta) is the only lizard group present at Vastan, whereas many other groups are already present in the Early Eocene on the other continents. Agamidae is considered to have had a Gondwanan origin, with 52 genera and 420 species of extant agamids known from Asia, Australia, Africa and a few from Southern Europe. The oldest occurrence of formally recognized Acrodonta is found in the Jurassic of India. Other fossil agamids are known in the Upper Paleocene of Kazakhstan, Paleocene and Eocene of China, Early Eocene of Europe, Eocene of North America, and Middle Eocene of Pakistan. The diversity of the agamids in India and the absence of other lizard groups at Vastan tentatively support the Out-of-India hypothesis for agamids.

Technical Session XV (Saturday, November 2, 2013, 11:15 AM)

LATE OLIGOCENE TUSKED DOLPHIN FROM THE WAITAKI REGION, NEW ZEALAND

FORDYCE, Robert, University of Otago, Dunedin, New Zealand; AGUIRRE-FERNÁNDEZ, Gabriel, University of Otago, Dunedin, New Zealand; LOCH, Carolina, University of Otago, Dunedin, New Zealand

The Oligocene early radiation of the Neoceti involved major increases in taxonomic, structural, and ecological diversity amongst Odontoceti and Mysticeti. Some fossils are putative stem members of living families, but others defy easy phylogenetic placement, and many have presented unexpected or unusual morphologies. One such fossil is an unnamed late Oligocene dolphin from Tokarahi, Waitaki district of New Zealand. The source horizon is transitional Kokoamu Greensand-Otekaike Limestone, about 26 Ma (Sr/Sr and foraminiferal dates), representing a mid-shelf setting. OU 22397 (Geology Museum, University of Otago) includes a skull (condylobasal length 584 mm), tympanoperiotics, and a mandible. The elongate (386 mm) narrow rostrum is markedly flattened, with elongate distal premaxillae (~82 mm) and an open shallow mesorostral groove. The rostrum carries gracile, horizontally-projecting, tusk-like incisors to 65 mm long, which grade back to less procumbent and increasingly vertical maxillary teeth. The latter are polydont (n = 13) and emergent, with prominent diastemata. Posteriorly, the tooth crowns become high, bucco-lingually flattened, and triangular, with vestigial posterior denticles. The cranium is low, with a prominent flat vertex and shallow facial fossae, and is roughly symmetrical. The intertemporal constriction is marked. Pterygoid sinuses are restricted to the basicranium. Because of its associated skull, mandible and earbones, OU 22397 is the key to identifying three other less-complete late Oligocene New Zealand dolphins as related closely (OU 22126 and other specimens, representing 3 species, from the Kokoamu Greensand and Otekaike Limestone).

A cladistic analysis (67 taxa, 311 characters, run with TNT) gave a single tree of 2231 steps, with OU 22397 and OU 22126 in a clade along with un-named tusked species from the northeast Pacific including USNM 205491 (US National Museum; Oligocene, Oregon). In turn, the tusked dolphins form the sister taxon to *Simocetus* in a clade that includes, as progressively basal members, *Agorophius*, *Patriocetus*, and *Waipatia*. The New Zealand tusked dolphins have been identified tentatively as Dalpiazinidae, but whether they are truly close to the fragmentary, longirostral, Miocene Italian *Dalpiazina ombonii* is uncertain. The scattered phylogenetic occurrences of gracile procumbent tusks amongst stem and crown odontocetes (e.g. dalpiazinids, *Waipatia*, Squalodelphinidae, and *Kentriodon*) suggest that the tusks are homoplastic structures.

Technical Session XI (Friday, November 1, 2013, 1:45 PM)

PROCESSED-BASED ESTIMATES OF STRATIGRAPHIC COMPLETENESS: IMPLICATIONS FOR THE ALLUVIAL VERTEBRATE FOSSIL RECORD

FOREMAN, Brady, University of Minnesota, Minneapolis, MN, United States, 55414; HAJEK, Elizabeth, Penn State University, University Park, PA, United States; STRAUB, Kyle, Tulane University, New Orleans, LA, United States

Sedimentation within alluvial stratigraphic sequences exerts a first order control on the completeness of the terrestrial fossil record. Discontinuous sedimentation results in discontinuous preservation of fossil material and, in turn, a discontinuous record of the history of life. Yet, recent field and experimental stratigraphic studies suggest there is a characteristic timescale over which deposition may be considered continuous. In fluvially dominated basins this timescale is controlled by the long-term aggradation rate and the topographic 'roughness' and kinematics of the paleo-landscape. Under constant climate, tectonic, and eustatic conditions internally generated (i.e., autogenic) landscape dynamics set the timescale at which spatially non-uniform sedimentation patterns are compensated and the basin filled evenly. We propose this timescale provides 1) an estimate on the finest temporal resolution that the fossil record may be considered 'complete', 2) a greater understanding of spatiotemporal variability in time-averaging within fossil sites, 3) a means to assess secular shifts in sampling density, and 4) a natural bin size to examine rates of taxonomic turnover, diversity, and evolutionary changes. We illustrate this approach using the early Paleogene mammalian record in the Bighorn Basin of northwest Wyoming (U.S.A.). Here, alluvial strata of the Fort Union and Willwood formations display repetitive packages of amalgamated channel belt deposits and overbank sequences of avulsion deposits with variably developed paleosols. Based on subsidence histories and reconstructed paleo-topography, a best case scenario estimate suggests sedimentation may be considered continuous at ~10 kyr and longer. Binning fossil sites with this new measure reveals that ~16% of the mammal record is represented by at least one fossil locality on the 10 kyr timescale and ~73% on the 100 kyr timescale. Bins near the Paleocene-Eocene boundary represent a near 'continual' sampling of taxa and highest density of localities per bin. We also assess how secular changes in tectonic subsidence and transient climate change events may have affected basin-scale fossil preservation patterns. Overall this process-based approach enhances chronostratigraphic frameworks, and allows for more detailed evaluation of evolutionary, ecological, and taphonomic uncertainty.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A SMALL SAUROPOD DINOSAUR (*HAPLOCANTHOSAURUS*?) FROM THE LOWER MORRISON FORMATION (UPPER JURASSIC) OF CENTRAL COLORADO

FOSTER, John, Museum of Western Colorado, Grand Junction, CO, United States, 81502

Remains of a dinosaur collected from the Rocky Mountains of central Colorado (north of the Elk Range, Pitkin County) are likely those of the small, rare sauropod *Haplocanthosaurus*. The remains (Museum of Western Colorado specimen MWC 8028) are from the lower third of the Upper Jurassic Morrison Formation, at a level similar to the Cleveland Museum Delfs Quarry at Garden Park, Colorado. The new specimen consists of four dorsal centra, five partial ribs, the sacrum, five caudal vertebrae, three chevrons, and five partial neural spines. The dorsal centra possess pleurocoels and fossae and are not strongly camerate, sacral neural spines are characterized strong posterior inclination, the anterior caudal vertebrae are moderately amphicoelous to slightly procoelous (the differences between vertebrae likely being preservational), are antero-posteriorly short for their diameters, and have squarish ventral surfaces, straight sides, and pneumatic(?) excavations of the dorsal surfaces of the centra, apparently from the ventral surfaces of the neural canals, the chevron facets are large, the five isolated, non-bifurcate neural spines appear to belong to dorsal vertebrae. The neurocentral sutures and caudal ribs are fused, indicating an adult animal, but the sacral and anterior caudal vertebrae are small, only 17–20 cm in diameter. Various morphological aspects prevent definitive identification of the material as any of the common Morrison diplodocid sauropods (*Diplodocus*, *Barosaurus*, or *Apatosaurus*); *Camarasaurus* and *Brachiosaurus* are less readily eliminated as possibilities but in their adult dorsal size and morphology do not match MWC 8028. The specimen appears generally similar in size and vertebral morphology to *Haplocanthosaurus priscus* (Carnegie Museum specimen CM 572), and the stratigraphic level of the quarry is consistent with the likelihood that the material belongs to this species. MWC 8028 is similar in morphology but slightly smaller than Utah Field House of Natural History specimen FHPR 1106 (*Haplocanthosaurus* sp.), and the sacral and caudal vertebrae are ~50% smaller than Cleveland Museum of Natural History specimen CMNH 10380 (*H. delfsi*). If confirmed as *Haplocanthosaurus* by a more complete dorsal vertebra, MWC 8028 will represent just the tenth specimen and the seventh locality for this sauropod in the Morrison Formation.

Technical Session XIV (Saturday, November 2, 2013, 9:30 AM)

A NEW LOOK FOR AN OLD BIRD: A NEW SPECIMEN OF *ARCHAEOPTERYX* WITH EXCEPTIONAL FEATHER PRESERVATION PROVIDES NEW INSIGHTS INTO THE EVOLUTION OF FEATHER PLUMAGES WITHIN MANIRAPTORA

FOTH, Christian, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

Since its first discovery over 150 years ago, the Late Jurassic *Archaeopteryx* has played a central role in our understanding of the early evolution of birds and the origin of flight. Recent discoveries of numerous closely related species from China have challenged the phylogenetic position of *Archaeopteryx* as most basal bird and provided new insights into the evolution of feathers and the origin of flight. Here, we present a new specimen of *Archaeopteryx* from the Solnhofen Limestones with exceptional feather preservation. The plumage is preserved as imprints in ventral view and consists of symmetrical, narrow-vaned contour feathers, which seem to have extended all the way to the head. Only the right wing is preserved, consisting of twelve asymmetric primary feathers. The raches of the primaries are relatively thick proximally, but thin down to the distal end abruptly. No evidence of dorsal covert impressions is present. Hind limb feathers are well-preserved, and were only present along the femur and the tibia. They closely resemble the morphology of the body contour feathers, being symmetrical rather than asymmetrical as it is the case in *Microraptor*. These feathers thus correspond to the leg feathers seen in many basal as well as recent birds and argue against a 'four-winged' state in *Archaeopteryx*. For the first time the tail plumage is completely preserved. The distal rectrices are considerably longer than previously reconstructed and form a slightly bifurcated end as present in *Caudipteryx* or *Microraptor*. In contrast, the lateral rectrices are approximately half as long as the distal rectrices and possess an asymmetric shape. This observation sheds new light on the original holotypic feather of *Archaeopteryx*, which probably represents a lateral tail feather instead a primary feather. Furthermore, the presence of asymmetric rectrices in *Archaeopteryx* indicates an aerodynamic function of the tail.

Symposium 1 (Wednesday, October 30, 2013, 12:00 PM)

THE INFLUENCE OF MULTI-NICHE ONTOGENY ON DIFFERENTIAL SURVIVORSHIP ACROSS THE K-PG BOUNDARY

FOWLER, Denver, Montana State University, Museum of the Rockies, Bozeman, MT, United States, 59717; FREEDMAN FOWLER, Liz, Montana State University, Museum of the Rockies, Bozeman, MT, United States; SCANNELLA, John, Montana State University, Museum of the Rockies, Bozeman, MT, United States; HORNER, John, Montana State University, Museum of the Rockies, Bozeman, MT, United States

The Cretaceous-Paleogene (K-Pg) extinction is one of the major events in the history of life on Earth, with the loss of up to 75% of species. Extinction rates were not uniform, however; although all clades suffer lineage extinctions, some are wiped out entirely. Such differential survivorship is suggestive of 'species selection' acting on attributes shared by every member of a clade (e.g., residence in detritus-based or aquatic ecosystems, burrowing ability, or small size). Variation in life history has been offered as an explanation for differential survivorship of ammonites and nautilus across the K-Pg boundary, but only recently has research begun to investigate this for vertebrates. Many Mesozoic vertebrates (including non-avian dinosaurs, and many basal birds, but excluding mammals and derived birds) occupy a chain of niches through ontogeny, due to small neonate size compared to large adults, and/or multi-year maturation. This contrasts with most mammals and derived birds where each species effectively occupies a single niche, dominated by adults. Here, any potential niche distance between neonates and adults is closed by parental care until the offspring reach maturity, which, due to rapid growth rates, is typically achieved in one year or significantly less. To investigate the implications of multi-niche ontogeny for extinction, we used a simple mathematical model in which vertebrate species in a Late Cretaceous terrestrial ecosystem occupy one to five niches dependent on body size and life history. We then randomly removed niches to simulate the effects of environmental perturbation, with extinction implied if a species' niche, or any part of its niche chain was lost. Removing 50% of niches resulted in extinction of 63% of taxa, including 78% of non-avian dinosaurs, and 40% of mammals. Dinosaur extinction rates become asymptotic at niche removal rates >~70%, largely as a result of the simplicity of the model, but at high rates of niche removal other previously recognized factors probably enhance extinction (e.g., food web collapse, effects of body size). Multi-niche ontogeny may be beneficial during periods of relative environmental stability (e.g., the late Mesozoic) as it reduces intraspecific competition between cohorts, and allows larger populations. However, it becomes a liability during periods of environmental instability or stress, where one or more niches may become inviable. Post-K-Pg faunas are dominated by clades composed of single-niche species, which may be better exapted to the more dynamic environments of the Cenozoic.

Technical Session II (Wednesday, October 30, 2013, 10:30 AM)

DIETARY RECONSTRUCTION OF PLIO-PLEISTOCENE RODENTS FROM SOUTHWEST KANSAS USING STABLE CARBON ISOTOPES AND THREE DIMENSIONAL TOOTH SHAPE METRICS

FOX, David, University of Minnesota, Minneapolis, MN, United States, 55455; KELLER, Jonathan, University of Minnesota, St. Paul, MN, United States; HAVELES, Andrew, University of Minnesota, Minneapolis, MN, United States; BAGLEY, Brian, University of Minnesota, Minneapolis, MN, United States

Plio-Pleistocene deposits around Meade, Kansas preserve a sequence of fossil assemblages that document the origin of the modern rodent community in the region over the last 5 My in the context of the progressive development of the modern, C_4-dominated grassland of the southern Great Plains over the same interval. To examine how changing habitats impacted the ecology of successive rodent communities, we reconstruct diets of individual species using both laser ablation isotope ratio mass spectrometry of fossil tooth enamel and three dimensional tooth shape metrics based on µCT scans of isolated teeth and jaws (volumetric hypsodonty index; Relief Index, a ratio of total tooth surface area to cross-sectional area; Orientation Patch Count, a measure of surface complexity; and Dirichlet normal surface energy, a measure of surface curvature). The carbon isotope composition ($\delta^{13}C$) of tooth enamel is sensitive to the dietary proportions of isotopically distinct C_3 (trees, shrubs, cool season grasses) and C_4 (warm season grasses, sedges) plants. Based on a current calibration set of 25 modern species with known diets, volumetric hypsodonty index and relief index are lower for granivorous (seed eating) relative to folivorous (leaf eating) species, which previous studies have treated collectively as herbivores; no metrics currently distinguish insectivores or omnivores statistically but sample sizes are small for these. We have focused initially on the Rexroad 3A locality (ca. 3 Ma), for which we currently have $\delta^{13}C$ values for 55 specimens of 10 species of geomyids, sciurids, heteromyids, and cricetids, and all shape metrics for six of those species. $\delta^{13}C$ values for all species span the entire C_3-C_4 range, indicating a locally heterogeneous habitat in terms of C_4 grass abundance. Species with high and low $\delta^{13}C$ values generally have low ranges among individuals (2–4‰), which is less than the C_3-C_4 range and indicates some degree of specialization, whereas most species with intermediate $\delta^{13}C$ values also have a wide range. Although sample size is small, species mean $\delta^{13}C$ values are strongly negatively correlated with volumetric hypsodonty index for each molar, suggesting that species with high $\delta^{13}C$ values specialize on C_4 grass seeds, those with low $\delta^{13}C$ values specialize on leaves of C_3 grasses and/or shrubs and trees, and those with intermediate values are potentially generalized herbivores. These results suggest that the combination of stable isotope and tooth shape analysis can provide more detailed paleodietary information than either in isolation.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

PARTITIONING OF *MUSTELA NIGRIPES* AND *MUSTELA VISON* DENTARIES FROM SNAKE CREEK BURIAL CAVE, NV.

FOX, Nathaniel, East Tennessee State University, Johnson City, TN, United States, 37614; WALLACE, Steven, East Tennessee State University, Johnson City, TN, United States; MEAD, Jim, East Tennessee State University, Johnson City, TN, United States

A karstic natural trap, Snake Creek Burial Cave (SCBC) provides a rare window into the marginally understood late Pleistocene valley-bottom paleofaunas of the Great Basin. Radiocarbon and uranium isotope series analyses yield ages ranging from the terminal Pleistocene (Rancholabrean land mammal age) into the early Holocene. Among the taxa identified from preliminary examinations, SCBC has produced an unprecedented diversity of eight tentatively allocated mustelid species. Occurrence of *Mustela nigripes* (black-footed ferret) among these taxa expands the historic distribution of this now exclusively captive taxon further westward. Moreover, *Cynomys* spp., critical prey resource of contemporary black-footed ferrets, are markedly absent from this and other nearby Great Basin localities. In the preliminary description of SCBC mustelids, it was noted that specimens identified as *M. nigripes* and *M. vison* (American mink) would benefit from re-examination due to osteologic similarity and size overlap.

Eleven dentaries tentatively labeled *Mustela nigripes/vison* were evaluated in an effort to classify these materials at the specific level. Linear measurements included: total dentary length, depth of dentary at p3, dentary depth at m1, height of p4, width of p4, length of m1, width of m1 talonid, diameter of m2, width of m2, and length of the mandibular toothrow (p2 - m2). Values were initially obtained from modern specimens of *Mustela vison* (n = 21) and *M. nigripes* (n = 38) housed within East Tennessee State University Vertebrate Paleontology collections. Preliminary stepwise discriminant analyses and principal component analyses substantiated distinction of these taxa utilizing the ten mandibular variables. With effective separation established, analyses were re-run integrating fossil specimens. Results demonstrated 100% predicted group membership with SCBC materials plotting exclusively among *Mustela nigripes*. These data strongly support occurrence of black-footed ferrets among the SCBC paleofauna.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PRELIMINARY INVESTIGATIONS OF CHONDRICHTHYAN AND ACTINOPTERYGIAN FISHES FROM THE FISH SCALE SANDSTONE (ALBIAN TO CENOMANIAN), BIRCH MOUNTAINS, ALBERTA, CANADA

FRAMPTON, Emily, Stantec Consulting, Calgary, AB, Canada, T3C 0K1; COOK, Todd, Univ of Alberta, Edmonton, AB, Canada; NEWBREY, Michael, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Very little is known about marine fish from the northern region of the Western Interior Seaway (WIS) during the late Albian to Cenomanian. Here we report three genera of chondrichthyans and five genera of actinopterygians from the Fish Scale Sandstone (FSS), or Fish Scale Marker Bed, in the Birch Mountains of northeastern Alberta, Canada. The FSS occurs within the Shaftesbury Formation, a marine unit of Albian to Cenomanian age. The base of the FSS is recognized as latest Albian to earliest Cenomanian. In the Birch Mountains (57°N), the FSS is poorly developed and is made up of multiple horizons of siltstone and sandstone that contain variable concentrations of fossil debris including actinopterygian teeth, bones, and scales and rare chondrichthyan teeth, vertebrae and denticles. Chondrichthyan fauna from the FSS includes the genera *Carcharias* (Family Odontaspididae), *Archaeolamna* (Family Archaeolamnidae), and *Squalicorax* (Family Anacoracidae). This is the first report of these genera from this region of Alberta. Actinopterygian fauna include the genera *Ichthyodectes* (Family Ichthyodectidae), *Osmeroides* (Family Osmeroididae), *Enchodus* (Family Enchodontidae) and *Xenyllion* (Family Sphenocephalidae). *Pachyrhizodus* (Family Pachyrhizodontidae) is also reported for the first time in Alberta. The Birch Mountains fauna represents the northernmost record of five genera from the WIS: *Carcharias*, *Archaeolamna*, *Squalicorax*, *Xenyllion*, and *Pachyrhizodus*. Many of the genera are also

reported from other late middle Cenomanian to Turonian assemblages from southern regions of North America. Previously, only four genera were reported from the Fish Scale Sandstone with only *Xenyllion zonensis* figured and described. Furthermore, the Birch Mountains actinopterygian and chondrichthyan fauna helps to fill a gap in the marine stratigraphic record of the WIS in Canada.

Technical Session XI (Friday, November 1, 2013, 2:15 PM)

GLOBAL CLIMATE DRIVES TEMPORAL PATTERNS OF NORTH AMERICAN MAMMAL BETA DIVERSITY

Fraser, Danielle, Carleton University, Ottawa, ON, Canada, K1S 5B6; HASSALL, Christopher, University of Leeds, Leeds, United Kingdom; GORELICK, Root, Carleton University, Ottawa, ON, Canada; RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada

Climatic variables (e.g., rainfall, temperature, evapotranspiration) are thought to drive patterns of both modern mammal richness and community composition. Of these two dimensions of diversity, spatiotemporal patterns of species richness (alpha diversity) have received the greatest attention. Yet, changes in organismal communities are not always associated with changes in richness. Spatiotemporal patterns of community composition or beta diversity may therefore be better indicators of climate change response but remain relatively unstudied. We measured total beta diversity for eight periods of Cenozoic climate change using similarity distance decay (as measure of taxonomic change across the landscape). Generalized linear models show that North American Cenozoic mammal beta diversity is associated with global climate over the last 56 Ma ($p < 0.05$) but not with taphonomy or various sample size metrics, providing further empirical support for climate-based diversity models. Interestingly, temporal changes in generic-level beta diversity resemble modern latitudinal richness gradients, showing a unimodal relationship with global climate ($\delta^{18}O$ values from benthic foraminifera), peaking during the early Oligocene and late Miocene. At the species level, North American mammal beta diversity shows a dramatic peak during the Paleocene-Eocene thermal maximum, declining dramatically into the early Eocene. Based on our results, we predicted that beta diversity should decline under modern anthropogenic global warming. We therefore constructed climate space models (CSMs) for modern North American mammals under similar magnitudes of global warming and found no change in mammalian beta diversity. CSMs are therefore unlikely to accurately predict the outcomes of modern global warming for North American mammals because they do not account for evolutionary processes. We suggest that studying the community composition of fossil animals represents a new frontier in paleontological research that has the potential to inform modern conservation and is a robust metric for measuring climate change response because it can be easily applied in the past and present. We propose that integrating the study of fossil, modern, and projected patterns of mammal community composition may i) allow ecological principles to be tested in the temporal dimension, ii) provide the most complete picture of climate change response, and iii) enable the efficacy of predictive ecological models to be independently tested.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW VERTEBRATE FAUNAS FROM THE EARLIEST CARBONIFEROUS OF SCOTLAND

FRASER, Nicholas, National Museums Scotland, Edinburgh, United Kingdom; CLACK, Jennifer, Univ Museum of Zoology Cambridge, Cambridge, United Kingdom; MILLWARD, David, British Geological Survey, Edinburgh, United Kingdom; DAVIES, Sarah, University of Leicester, Leicester, United Kingdom; MARSHALL, John, University of Southampton, Southampton, United Kingdom

*Romer's Gap is a period of approximately 20 million years at the base of the Carboniferous characterized by a world-wide break in the fossil record of early tetrapods as well as a paucity of terrestrial invertebrates. Here we report on a major initiative in the Tweed Basin of southern Scotland that is providing completely new insights into this pivotal period for the evolution of life on land. A number of localities in this region are yielding significant new tetrapod material that is helping to populate the gap. Importantly these contain not only tetrapods but broader remains of complete ecosystems including fish, invertebrates and plants. In addition to the tetrapods, vertebrates include fishes such as gyracanthids, lungfish, rhizodonts and actinopterygians, both as associated and partially articulated remains. The invertebrate faunas are also quite diverse and include malacostracans, eurypterids, ostracods, scorpions and myriapods. The fossils are all from the Ballagan Formation, a distinctive rock unit that crops out widely across the Midland Valley of Scotland and the Borders into northern England. The Ballagan Formation is a cyclic succession of mudstone with interbedded sandstone and thin beds and nodules of "cementstone". The sediments were deposited on an extensive low relief, muddy, vegetated floodplain that was traversed by numerous river systems. Periodically the river-derived floods submerged the floodplains generating extensive shallow freshwater lakes. The widespread presence of gypsum, anhydrite and pseudomorphs after halite suggest that these were marginal coastal floodplains that were subject to occasional marine transgressions, periods of intense evaporation and fluctuating salinity. A critical component of the study is a core drilling program in the Tweed Basin which will help to generate a tight stratigraphic framework for the tetrapod localities and provide high resolution datasets that will underpin interpretation of the depositional and climate systems during this time.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

BIOMECHANICAL SIGNIFICANCE OF TRABECULAR ARCHITECTURE IN PTEROSAURS

FRIGOT, Rachel, Johns Hopkins University, Baltimore, MD, United States, 21202; PALMER, Colin, University of Bristol, Bristol, United Kingdom

Pterosaurs have a substantially reduced trabecular network, consisting of fewer well-defined and enlarged struts, rather than the spongy network of fine, numerous trabeculae found in the cancellous bone of most other vertebrates.

This reduction has been considered highly functional, associated with reduction in skeletal mass to produce a framework capable of stiffening and strengthening the bone at minimum mass.

To test the functionality of pterosaur trabeculae, we created simplified finite element models consisting of a uniform tube taken from a CT scan of a first wing phalanx, representing the cortex of the bone, with uniform trabeculae placed at regular intervals and a single trabecular orientation. The orientation and spacing were then changed to create a series of models, each varying in a single parameter, which were then loaded to correspond to steady state flight. Tension in the membrane was loaded as horizontal and vertical components and a torque was applied corresponding to the proximal translation of forces acting on more distal elements of the wing.

Comparison of stress and strain distributions in these models allowed isolation of how trabeculae in different orientations were loaded and investigation of the functional link between trabecular spacing and thickness.

The results indicate that trabeculae do not appear to have been subject to substantial loads, at least not under steady state flight. This suggests that the cortex is the primary means of resisting the loads generated during flight. Take-off, landing and changing direction would all generate higher loads, but these loads become more tenuous to estimate. In at least the case of pterosaurs, the historical view that trabeculae are highly functional appears not to be the case. The possibility that they would serve a functional purpose under extreme loads is not here ruled out. However, alternative explanations for their retention should be explored further.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE QUALITY OF THE FOSSIL RECORD OF ANOMODONTS (SYNAPSIDA, THERAPSIDA)

FRÖBISCH, Jörg, Museum für Naturkunde, Berlin, Germany; WALTHER, Marcus, Museum für Naturkunde, Berlin, Germany

This study presents an up-to-date assessment of the quality of the fossil record of anomodont synapsids, one of the major clades of Permian-Triassic terrestrial tetrapods. A Character Completeness Metric (CCM2) is calculated for each taxon and consecutive time intervals at the global scale and in the South African Karoo Basin. At the global stage scale the mean completeness score for Anomodontia is 66.80%, and if the anomodont-devoid time bin of Olenekian age is excluded, the mean score increases to 73.50%. Anomodont completeness per stage ranges from 60.12% to 86.63%. At the regional scale of the South African Karoo Basin, the mean completeness of anomodonts calculated over the entire time interval is with 77.37% even higher than at the global stage and completeness per assemblage zone ranges between 62.71% and 91.33%. We further performed up-to-date taxic and phylogenetic diversity estimates, confirming the general biodiversity trends recovered by recent analyses. Therein, anomodont diversity increases throughout the Permian with varying support for a minor mid-Permian (end-Guadalupian) extinction, collapses in the earliest Triassic and reaches a second peak in the Middle Triassic before their final decline in the Late Triassic. Finally, we tested potential correlations of completeness scores with anomodont biodiversity trends and various sampling proxies (geologic and anthropogenic) at the regional scale of the South African Karoo Basin. Our analysis suggests that all these variables are independent of one another, as they generally lack a significant correlation. The consistently high completeness scores throughout their evolutionary history together with a lack of correlation with biodiversity patterns and sampling proxies document a high quality of the anomodont fossil record. In fact, when compared to other vertebrate groups, the completeness of anomodonts is exceptionally high. Yet, whether this pattern results from the unrivalled fossil record of the Karoo Basin or whether it is clade-specific and unique to anomodonts remains to be tested.

Technical Session I (Wednesday, October 30, 2013, 9:30 AM)

LIMB ABNORMALITIES IN THE DISSOROPHOID AMPHIBIAN *MICROMELERPETON CREDNERI* - PRIMARY PATHOLOGY OR FAILED REGENERATION?

FROEBISCH, Nadia, Museum fur Naturkunde Berlin, Berlin, Germany; WITZMANN, Florian, Museum fur Naturkunde Berlin, Berlin, Germany; BICKELMANN, Constanze, Museum fur Naturkunde Berlin, Berlin, Germany

Micromelerpeton credneri is a basal dissorophoid and well known from hundreds of specimens from Lower Permian lake deposits in central Europe. It is represented by a wide range of ontogenetic stages and frequently preserved as complete skeletons with skin shadows, scalation, and stomach contents. Recent reinvestigations of collections material revealed an astonishing frequency and variety of limb pathologies in *Micromelerpeton*. These include uni- and bilateral polydactyly in the fore- and hind limb, whereas supernumerary digits are added preaxially, postaxially or centrally. Furthermore, the additional rays are either represented by single, seemingly functional digits or show pathological morphologies such as being very thin or branching distal to the metapodium at different phalangeal levels. Different types of pathologies can occur in single specimens and may vary between fore- and hind limb. Some individuals show a combination of abnormalities that are reminiscent of pathologies known from extant tetrapods (including humans) such as congenital fibular deficiency. Yet the great

diversity and variability of pathological patterns is striking and cannot easily be explained by a single genetic defect. Moreover, although all specimens derive from spatially and stratigraphically restricted sites, the assemblage is time averaged, making it very unlikely that the pathologies are caused by one or more genetic defects manifested in a small population. In extant amphibians two major factors are responsible for a high percentage of limb abnormalities: 1. Infection with the parasitic trematode *Ribeiroia* produces limb and digit duplications as well as development of ectopic limbs in salamanders and frogs. While *Ribeiroia* infections have been reported for Mesozoic salamanders, it does not resemble the patterns seen in *Micromelerpeton* and can be excluded. 2. Salamanders are the only tetrapods known to be capable of fully regenerating their limbs throughout life history. While regeneration is often genuine, various pathological patterns caused by failed regeneration have been demonstrated. The variety and combination of pathologies observed in *Micromelerpeton* are very similar to the abnormalities caused by failed regeneration in extant salamanders and could indicate that the striking regenerative capacity of modern salamanders is not derived, but may be an ancient feature either of dissorophoids or even more broadly of tetrapods.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

FUNCTION AND POLARITY OF CONCAVO-CONVEX ARTICULATIONS IN THE VERTEBRAL CENTRA OF SAUROPOD DINOSAURS WITH IMPLICATIONS FOR OTHER VERTEBRATES

FRONIMOS, John, University of Michigan, Ann Arbor, MI, United States, 48109-1079; WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, United States

Sauropod dinosaurs are unique among terrestrial vertebrates in the extremes of body size and neck elongation they attained. Their long neck and tail were held aloft, as seen from anatomical and ichnological evidence, loaded as cantilevers or beams supported at only one end. Flexibility under this loading was facilitated by the presence of concavo-convex articulations between vertebral centra. In the necks of all but perhaps the earliest sauropods, postaxial cervical centra are anteriorly convex and posteriorly concave (i.e., opisthocoelous), a feature that was not reversed throughout the 135 Ma history of the clade. Opisthocoelous contacts often continue into the dorsal series, sometimes all the way to the sacrum. Substantial variation is present in the caudal vertebrae of sauropods. Anteriorly concave, posteriorly convex (i.e., procoelous) caudal centra evolved independently at least three times. They are limited to the anterior caudal region in mamenchisaurs and flagellicaudatan diplodocoids and extend almost to the tip of the tail in some derived titanosaurs.

Concavo-convex articulations provide a greater range of motion than the ancestral biconcave (i.e., amphicoelous) condition by permitting rotation without losing contact between articular faces. The large contact area between centra and the nesting of one centrum within another provides a greater resistance to forces that would translate one centrum relative to another. The consistent presence of this feature in the cervical vertebrae of sauropods indicates a greater functional constraint on the neck than the tail. This may result from the structure of the neck, which consists of fewer, more elongate vertebrae than the tail. In almost all sauropods with concavo-convex articulations in the tail, caudal vertebrae have polarities opposite those of cervical vertebrae, resulting in symmetry about the body. Although opisthocoelous and procoelous vertebrae are anatomically opposite, they are mechanically equivalent. In both cases, the concave articulation faces the fixed end of the cantilever, the body, and the convex articulation faces the free end. Experiments demonstrate that this consistent polarity provides only a slight advantage in range of motion over the opposite polarity but may confer greater resistance to proximally-directed stress generated by the muscles and ligaments that support and move the neck and tail. The factors controlling articulation polarity in vertebrae should be the same as for concavo-convex joints in the appendicular skeleton.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

OPTIMUM SCAPULAR POSITION TO SUPPORT AND STABILIZE THE BODY ON A FORELIMB IN QUADRUPEDAL TETRAPODS

FUJIWARA, Shin-ichi, Nagoya University, Nagoya, Japan

Deducing a spatial scapular position relative to the trunk is essential for estimating postures and functional performances of forelimbs in extinct tetrapods. However, due to the absence of direct skeletal articulations between the scapula and the rib cage, it remains difficult to reconstruct the scapular position in 3D from the skeletal morphology. I approached this problem in quadrupedal tetrapods by focusing on moment arms of antigravity muscles (i.e., serratus and rhomboideus muscles) which connect the dorsal portion of the scapula and the thoracic bones. Assuming stance phase on a single forelimb in addition to support on the hindlimb(s), these muscles function to roll, yaw, and pitch the presacral portion of the body about the acetabular or lumbosacral joints. The muscle moment arms for the roll and yaw are expected to be minimized to stabilize the body, whereas those for the pitch are expected to be maximized to suspend the presacral portion of the body efficiently against the gravity. Software for three-dimensional musculoskeletal modeling was used to determine the optimum scapular position that meets the abovementioned conditions. Musculoskeletal models were built for rib cages of some small therian mammals based on the computed tomography image sequences. According to the moment arm analyses on these models, the optimum position of the dorsal portion of the scapula was (1) at above or at the level of the dorsal margin of the trunk, (2) at anterior-most portion of the rib cage, (3) near the ribs where the mediolateral width of the rib cage is narrow, and (4) at close to the median plane. Although there is relatively high mobility between the scapula and the trunk, the optimum scapular position estimated by the moment arm analysis was consistent with scapular positions *in vivo* during the stance phase which were observed in extant therian mammals. Estimation of muscle paths of the antigravity muscles and the moment arm analyses on these muscles will provide quantitative criteria for determining reliable scapular positions in extinct quadrupedal tetrapods.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

RADIOCARBON DATING AND ISOTOPIC ANALYSIS OF PLEISTOCENE FAUNA FROM PROJECT 23 AT RANCHO LA BREA: A NOVEL METHOD FOR TAR REMOVAL FROM BONE COLLAGEN BY ULTRAFILTRATION

FULLER, Benjamin, UC Irvine, Irvine, CA, United States, 92697-3100; FAHRNI, Simon, UC Irvine, Irvine, CA, United States; HARRIS, John, George C Page Museum, Los Angeles, CA, United States; FARRELL, Aisling, George C Page Museum, Los Angeles, CA, United States; SOUTHON, John, UC Irvine, Irvine, CA, United States

The Rancho La Brea tar pits located in Los Angeles, California contain one of the largest concentrations of flora and fauna remains from the late Pleistocene and provide one of the most detailed and complete pictures of North America at the end of the most recent glacial period. Most of the vertebral skeletal remains are exceptionally well preserved and contain close to modern amounts of collagen as they were immersed and impregnated with asphalt shortly after death. However, the removal of this asphalt from the bone collagen for radiocarbon dating and stable isotope ratio analysis has proven difficult and time consuming and often produced results with atomic C:N ratios that fall outside the accepted range of 2.9-3.6 for stable isotope ratio analysis. Previous methods have relied on hydrocarbon removal using a Soxhlet apparatus and then either bulk collagen isolation or hydrolysis and column purification of amino acids. If these deposits are to be accurately radiocarbon dated and analyzed for stable isotope ratios on a large scale, then a rapid and more cost-effective method for the removal of the asphalt is required.

Here we describe a novel protocol for collagen purification from asphalt impregnated skeletal remains recovered from a new area of excavation known as Project 23 (new fossil deposits discovered in 2006 during construction of a nearby underground parking structure for the Los Angeles County Museum of Art; n = 11) and from previously dated pits (n = 5) at Rancho La Brea. This method requires the use of a simple solvent soak and sonication treatment and a higher gelatinizing temperature to break down collagen strands to the point that they can be separated by ultrafiltration. The traditional method of ultrafiltration for bone collagen is reversed here and the high molecular weight fraction (>30 kDa) contains mainly the asphalt (too big to pass through the filter), while the lower molecular weight fraction (<30 kDa) contains the collagen. A further ultrafiltration (>3kDa) step is then preformed on the <30 kDa fraction to remove the lower molecular weight contaminants such as humic acids. The middle fraction (3-30 kDa) is freeze dried to produced fluffy white collagen with excellent atomic C:N of 3.2-3.4. The processes involved in the design of protocol will be discussed in detail and the first radiocarbon dates from the Project 23 site will be presented, including the first radiocarbon date for a Rancho La Brea mammoth (*Mammuthus columbi*).

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

EXAMINING THE DIET OF A TOOTHLESS DINOSAUR: EVIDENCE SUPPORTING A HERBIVOROUS DIET IN *CAENAGNATHUS* (DINOSAURIA: OVIRAPTOROSAURIA)

FUNSTON, Gregory, University of Alberta, Edmonton, AB, Canada, T6G2E9; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada; MURRAY, Alison, Univ of Alberta, Edmonton, AB, Canada

*The Oviraptorosauria are an enigmatic group of dinosaurs, known from well-preserved specimens from China, Mongolia, and North America. Surprisingly, caenagnathids, a family of oviraptorosaurs, remain poorly understood. This study focuses on a previously undescribed mandible of *Caenagnathus* sp. (Royal Tyrrell Museum of Palaeontology specimen TMP2001.12.12), which reveals a morphology distinct from *Caenagnathus collinsi*. The mandible is fused, toothless, and shows adaptations for shearing. A well-fused dentary symphysis and post-dentary akinesis are incongruent with large-prey carnivory, as is the toothlessness. The occlusal margin is upturned, and would have been covered in life by a rhamphotheca (keratinous beak). Lateral occlusal grooves likely supported similar structures in the rhamphotheca, akin to the tomium in anatid birds (ducks). The articular region shows dorsally convex condyles, which would have allowed propalineal movement of the mandible. Extensive pneumatization of the dentary symphysis and lightly built post-dentary bones make crushing behavior unlikely. A finite element analysis supports these conclusions, and demonstrates that crushing puts more strain on the lightly-built post-dentary bones than shearing. Comparisons are drawn with turtles, dicynodonts (therapsid reptiles) and parrots, which have known diets, and show similar adaptations. *Caenagnathus* sp. has a cropping beak similar to those of turtles and parrots, but possesses a midline sulcus lacking a tubercle, which eliminates the crushing platform. The articular region is remarkably similar to dicynodonts, which used propalineal movement for food processing. Thus, *Caenagnathus* sp. shows adaptations for a non-crushing herbivorous or omnivorous life habit, which potentially may have included fruits, leaves, eggs and/or small prey.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

REDESIGNING THE DINOSAURS COURSE: AN INQUIRY-BASED APPROACH TO TEACHING PALEONTOLOGY

GALLAGHER, William, Rider University, Lawrenceville, NJ, United States, 08648; BROWNE, Kathleen, Rider University, Lawrenceville, NJ, United States

As part of the Discovery Program at Rider University, an inquiry-based interdisciplinary science course was added for undecided freshmen entering college. A major theme of the class was the nature of science; specific topics included evolution and extinction of dinosaurs, energy resources, geologic time, and environmental change. In addition, we attempted to establish links to other subjects, including history, political science, and composition and reading. The program started with a kayaking trip to a New

Jersey barrier beach island where we looked at the changeable geology of the islands and bays from a multidisciplinary perspective. Other field trips involved visits to Late Cretaceous fossil sites to see stratigraphy and collect marine fossils from the K/T section in New Jersey; this initiated a discussion of sea level and climate change over time. Classroom activities started with a simple experiment designed to introduce students to the laws of thermodynamics and scientific thinking involving the sources of energy. This led to a consideration of fossil fuel resources, and a role-playing debate about hydrofracturing. An evolution module began with students constructing their own family tree, and then learning about cladistics by using MacClade to manipulate a tree of vertebrate animals, emphasizing that each cladogram is a hypothesis of evolutionary relationships. This set up a visit to the dinosaur halls of the American Museum of Natural History; the students were now prepared to answer questions on evolution of the Dinosauria based on their own observations of the exhibits. The extinction module started with a session on the three evolutionary faunas and the Big Five mass extinctions involving hands-on study of fossil specimens, including fossils collected by the students. We then looked at the gradual and catastrophic hypotheses for dinosaur extinction at the K/T boundary. A computer simulation exercise involved modeling impact effects of smaller and larger fireball and asteroid impacts. Students engaged in a formal debate over proposed extinction mechanisms, considering strengths and weaknesses of gradualist and catastrophic hypotheses and the nature of scientific evidence. This initiated a unit on the Pleistocene megafauna extinction, modern climate change and endangered species. Exit surveys identified field trips and class debates as favorite learning experiences. Preliminary statistics indicate that the Discovery cohorts had higher retention rates and higher GPAs than the entire Rider student body.

Technical Session X (Friday, November 1, 2013, 10:30 AM)

STABLE ISOTOPIC PALEOENVIRONMENTAL RECONSTRUCTION OF THE LATE PLEISTOCENE SITES ON RUSINGA AND MFANGANO ISLANDS, LAKE VICTORIA, KENYA

GARRETT, Nicole, University of Minnesota, Minneapolis, MN, United States, 55455; FOX, David, University of Minnesota, Minneapolis, MN, United States; TRYON, Christian, New York University, New York, NY, United States; FAITH, J. Tyler, The University of Queensland, Brisbane, Australia; PEPPE, Daniel, Baylor University, Waco, TX, United States

Environmental pressures are generally presumed to play a key role in the evolution of mammals, including humans. Anatomically and behaviorally modern *Homo sapiens* evolved during the late Pleistocene, but the lack of detailed paleoenvironmental reconstructions from East African hominin sites during this interval limits our understanding of the evolutionary pressures shaping early modern humans and their dispersals within and out of Africa. Here we present a paleoenvironmental reconstruction for the Late Pleistocene deposits on Rusinga and Mfangano Islands in Lake Victoria, Kenya. These sites date to 33–100 Ka and preserve a taxonomically diverse fossil fauna and associated Middle Stone Age (MSA) and perhaps Later Stone Age (LSA) artifacts. The unique faunal assemblage from Rusinga and Mfangano Islands is characterized by the presence of extinct specialized grazers and arid adapted species outside their modern-day range. Stable carbon and oxygen isotope analyses include paleosol carbonate and organic matter (n=75), and fossil tooth enamel (n=62), including the first isotopic analyses for the extinct bovids *Rusingoryx atopocranion*, *Damaliscus hypsodon*, and an exceptionally hypsodont gazelle (*Gazella* aff. *granti*). Providing a regional proxy, the mammalian dental isotopic analysis documents the presence of increased aridity and that most large-bodied mammals consumed a predominantly C_4 diet. These data support other studies indicating a significant reduction in the size of Lake Victoria at this time. Conversely, the paleosol carbonate and organic matter analyses suggest that the local habitat associated with human activities was a riverine woodland ecosystem with on average ca. 60% woody cover. Together, these results suggest the significant expansion of C_4 grasslands relative to today during the late Pleistocene, with hominins persisting in the Lake Victoria region perhaps by exploiting locally wooded and well watered habitats.

Technical Session IX (Friday, November 1, 2013, 8:15 AM)

OSSIFIED CRANIAL ORNAMENTATION CORRELATES WITH MID- TO LARGE-BODY MASS IN THEROPOD DINOSAURS

GATES, Terry, North Carolina State University, Raleigh, NC, United States, 27695; ZANNO, Lindsay, North Carolina Museum of Natural Sciences Nature Research Center/North Carolina State University, Raleigh, NC, United States

Studies on the pattern, prevalence, and implications of ossified cranial ornamentation in dinosaurs have largely focused on the elaborate structures characterizing megaherbivorous clades (e.g., ceratopsians, hadrosaurs). However, a variety of theropod taxa also display prominent cranial ornamentation in the form of crests, horns, or conspicuous rugosities (e.g., *Cryolophosaurus*, *Dilophosaurus*, *Carnotaurus*, *Tyrannosaurus*, and *Oviraptor*) and yet systematic study of theropod cranial ornamentation and associated evolutionary constraints has not been undertaken. Cranial ornamentation in extant vertebrate clades correlates with complex biological and ecological parameters such as body mass, habitat, and social structure. Moreover, prominent signaling structures have been shown to impart significant costs, specifically in predation risk. We tested for a correlation between size and ossified cranial ornamentation in 78 theropod dinosaurs ranging from basal taxa to paravians and spanning over four orders of magnitude in estimated body mass (0.08-6280 kg). We preliminarily excluded nearly all avialans because we predict that extraneous osteological growth on volitant species is subject to distinctive functional constraints relative to non-volitant theropods. Ornamentation and body mass were binned into binary states and tested using a sliding window approach in the Discrete Module of the software package BayesTraits. We find osteological cranial ornamentation to be significantly correlated with medium to large body size in theropods (>100 kg) when using both maximum likelihood and Markov chain Monte Carlo (MCMC) Reversible Jump approaches. More restricted body mass bins (e.g., all theropods >500 and >1000 kg) also obtained significance, but at lower p-values. Our data support studies documenting a complementary role for large body size in the evolution of cranial ornamentation in extant megafauna. The low frequency of osteological ornamentation on the smallest non-avian theropods is consistent with a selective preference for feathers in cranial display as observed in a variety of small-bodied extant bird species, and may result from similar evolutionary constraints.

Technical Session XIV (Saturday, November 2, 2013, 10:15 AM)

MELANIN CONCENTRATION GRADIENTS IN MODERN AND FOSSIL FEATHERS

GEARTY, William, Yale University, New Haven, CT, United States, 06511; D'ALBA, Liliana, University of Akron, Akron, OH, United States; VINTHER, Jakob, Bristol University, Bristol, United Kingdom; SHAWKEY, Matthew, University of Akron, Akron, OH, United States; FIELD, Daniel, Yale University, New Haven, CT, United States

In birds and feathered non-avian dinosaurs, within-feather pigmentation patterns range from discrete spots and stripes to more subtle patterns, but the latter remain largely unstudied. Here, we establish a method of quantifying melanosome concentration in fossil and modern feathers, and demonstrate that the darkness of melanin-based feather colors is directly related to the concentration of melanosomes within feathers. By quantitatively demonstrating a link between feather melanosome concentration and feather color, we help substantiate the common assumption that darker plumage can be caused by the deposition of larger amounts of melanin. These data are needed to validate discussion of, for example, the potential physiological costs of producing darker plumage, and the inference of color gradients from darkness gradients in fossil feathers. Our data show that melanosome density predicts brightness of some melanin-based colors, suggesting that it can be used to help determine if feathers were originally dark or pale. These data may help improve the resolution of fossil color reconstructions, enabling more precise functional inferences, and the quantification of intraspecific variation. Because sexual dimorphism and age may influence melanin-based colors of some species, this latter ability may potentially enable detection of sexual dichromatism and individual maturation in the fossil record. Although experimental taphonomic studies have indicated that melanosome size may be diagenetically altered, our inference of relative pigmentation within individual feathers should be robust in most taphonomic settings.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

USING PARTNERSHIPS AND VOLUNTEERS TO MANAGE MIOCENE-AGED (HEMINGFORDIAN-BARSTOVIAN NALMA) PALEONTOLOGICAL RESOURCES ON BLM LANDS IN THE ESPANOLA BASIN OF NEW MEXICO

GENSLER, Philip, Bureau of Land Management, Santa Fe, NM, United States, 87502; MORGAN, Gary, New Mexico Museum of Natural History, Albuquerque, NM, United States; MOORE, Jim, New Mexico Friends of Paleontology/ New Mexico Museum of Natural History, Albuquerque, NM, United States; ABY, Scott, Muddy Spring Geology, Dixon, NM, United States; FOSS, Scott, Bureau of Land Management, Salt Lake City, UT, United States

The New Mexico Bureau of Land Management (BLM) and the New Mexico Museum of Natural History and Science (NMMNHS) have entered into a formal partnership to manage paleontological resources on public lands in New Mexico. Working through the NMMNHS, volunteer members of the New Mexico Friends of Paleontology have played a key role in paleontological site monitoring on these public lands. This partnership has been most successful through work within the Miocene-aged Tesuque Formation of the Santa Fe Group within the Espanola Basin of northern New Mexico.

BLM lands in this area, the El Palacio Special Recreation Management Area (SRMA) and the El Sombrillo Area of Critical Environmental Concern (ACEC), contain approximately 40 square miles of badlands that were originally recognized for their fossiliferous importance by E.D. Cope. About 50 years later this area was intensively prospected by collectors from the Frick Laboratory of the American Museum of Natural History. The Frick collectors visited this area continuously from 1924 to 1964 and have amassed a large collection of Hemingfordian and Barstovian NALMA vertebrate fossils.

Due to the highly erodible badlands that make up the Santa Fe Group in the Espanola basin paleontological resources are continually eroding away and being destroyed. Through the BLM/NMMNH partnership, new fossil specimens are now being collected on a yearly basis. The collections are permanently housed in the collections at the NMMNH which is the paleontological repository for BLM New Mexico. In the past five years over 150 localities have been identified and collected.

Ongoing scientific studies in the Española basin includes the mammalian biostratigraphy of the Pojoaque and Skull Ridge members of the Tesuque Formation with geologists from the New Mexico Bureau of Geology and Mineral Resources who have been conducting geologic mapping and lithostratigraphic studies of Miocene rocks in this same area. We also have discovered several new microvertebrate sites in the Pojoaque Member that have produced a diverse late Barstovian small mammalian fauna.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

GIS ANALYSIS OF THE FAUNMAP II DATABASE TO RECOGNIZE GEOGRAPHIC BIAS IN THE IDENTIFICATION OF FOSSILS

GEORGE, Christian, Univ of Texas at Austin, Baltimore, MD, United States, 21202

There is tremendous potential for asking many paleontological questions from large datasets, such as FAUNMAP II. However, the results of any inquiry using them are

dependent on the quality of the data in the database. There is always the potential that published identifications of species of fossils were not solely based on morphology, but rather were made by using geography the restrict the number of species that were considered when the identifications were made. If geography was used to aid in the identification of species, then any studies using those identifications to examine range shifts during the Quaternary will be biased. It is therefore necessary to determine which identifications may be biased in this way. In a novel use of GIS (geographic information systems), I analyzed the FAUNMAP II database for potential geographic bias in the identification of Quaternary fossils. I queried the FAUNMAP II database for shrews, (Soricidae) deer (*Odocoileus* spp.), pocket mice and kangaroo rats (Heteromyidae), and spotted skunks (*Spilogale* spp.). These taxa were selected because they are difficult to identify to species from isolated skeletal material, and there are significant differences in the geographic ranges of the species within a genus. To capture the shape of the geographic distribution of the species from the FAUNMAP II database, I generated a standard deviational ellipse for each species. A standard deviational ellipse encloses one standard deviation, or 68% of the features. The ellipses were then compared between species of the same genus and to the modern ranges of the taxa. My analysis found that there was a significant geographic influence in the identification of species of Soricidae, Heteromyidae, *Odocoileus*, and *Spilogale*. The strength of this technique is that it rapidly recognizes those taxa where the identification potentially was based on geographic assumptions. In those cases, a re-examination of the identification is warranted to determine what role geography may have played. Of special concern are taxa like *Notiosorex* and *Blarina*, for which there was only a single species recognized for all or most of the twentieth century. Due to the historical bias towards the first named species, the identification of those fossils should be treated as generic identifications until they are reevaluated against the full diversity of species from the broadest geographic sample possible.

Preparators' Session (Thursday, October 31, 2013, 11:15 AM)

MOVING COLLECTIONS INTO THE NEW NATURAL HISTORY MUSEUM OF UTAH

GETTY, Mike, Natural History Museum of Utah, Salt Lake City, UT, United States, 84112

In November 2011, the new Natural History Museum of Utah opened to the public in our new facility at the Rio Tinto Center. For those of us in the paleontology collections, however, the job of moving into the building had just begun. From October 2011 through April 2012, we transferred all of the NHMU paleontology collections, including approximately 26,000 vertebrate, 6,000 invertebrate, and 4000 paleobotanical specimens into our new collections facility. This proved to be a very intense process which required repairing, rehousing and stabilizing a large diversity of specimens, including significant Mesozoic and Cenozoic faunas from Utah and the surrounding area. Most vertebrate specimens were rehoused into new drawers and fully stabilized with ethafoam prior to being moved into the new building, where they were sorted into cabinets mounted on compactable carriages. Oversized specimens were palletized and stabilized prior to moving. All of the large broken material was repaired and many of the largest and most delicate specimens were rehoused into large open faced or clam-shell styled support jackets, constructed of fiberglass and gypsum cement and lined with felt or ethafoam. Throughout the move specimens were organized into hierarchical order based on a combination of stratigraphic , systematic and anatomical properties. A small crew of three full time staff, three part time interns and 10–15 volunteers worked six days a week for six months to complete the move. Four days per week were spent rehousing and stabilizing specimens in the old building, which were moved into the new facility on two move days per week with the assistance of professional movers. The movers also provided assistance and expertise on moving large specimens out from difficult places in the old collections as well as moving select furniture and cabinets which were transferred from the old building into the new museum. While the move was complete by April 2012, reorganization and inventory of the collections in the new facility will continue for at least another year.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

TESTING CLIMATE CHANGE AND OVERKILL EXTINCTION HYPOTHESES FOR PLEISTOCENE EQUIDS WITH DENTAL MESOWEAR

GHANI, Ishrat, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States, 11568; CAMPBELL, Daniel, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States; BARRON-ORTIZ, Christian, Univ of Calgary, Calgary, AB, Canada; MIHLBACHLER, Matthew, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States

The late Pleistocene equid (*Equus ferus*) underwent rapid body size decline in Alaska preceding its extinction c.a. 12.5 radiocarbon KYBP. This size shift, thought to be caused by a climate/vegetational shift, has been used to argue against human overkill. The disarticulated condition of fossils from this region renders it difficult to examine paleoecological trends because the skulls, jaws, and dentitions are disassociated from the ^{14C} dated metacarpals. Nevertheless, if changes in paleodiet are associated with body size decline, then correlations between body size and paleodiet should exist. We examined trends in paleodiet using a recently developed semilandmark-based mesowear technique with 245 fossil equid molars (174 lower m2s and 71 upper M2s). We also analyzed several species of extant wild equids to establish a relationship between the mesowear of upper and lower molars. Using photographs taken at a standardized angle, 70 evenly spread semilandmarks were distributed on the paracones of the uppers and in the corresponding occlusal valleys between the paraconid and metaconid on the lowers.

Among modern equids, the first principal component scores of the upper and lower landmark data are significantly correlated, suggesting that both uppers and lowers provide similar paleodietary information.

For the Alaskan equid, tooth shape, defined by the Procrustes coordinates, was compared to a body size proxy (molar length + width) using multivariate regression. Lower dental mesowear is significantly related to size, with smaller (and presumably younger) specimens having a shallower lingual occlusal valley, suggesting a shift towards more highly abrasive diets as body size declined. We found no relationship of mesowear and size among upper molars, although the smaller sample size of upper molars may explain the insignificant result. Thus far, the results are most consistent with ecological change towards the end of the Pleistocene, although intraspecific variation in body size renders it difficult to establish a true relationship with time. Directly dating the cranio-dental material would enable a more direct analysis of ecological change through time.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

FIRST REPORT OF JURASSIC PTEROSAUR TRACKS FROM AFRICA

GIERLINSKI, Gerard, JuraPark, Ostrowiec Sw, Poland; ADACH, Lidia, Polish Geological Institute, Warsaw, Poland; LOCKLEY, Martin, Univ of Colorado Denver, Denver, CO, United States

Although pterosaur tracks are now quite well known from North America, Western Europe and Asia, they are still almost unknown from Africa and South America, and are completely unknown from Australia and Antarctica. Here we report a Jurassic assemblage found by Piotr Menducki from Mibladen, Morocco in 2009, which is likely the oldest known occurrence of pterosaur tracks and possibly the first from Africa. The specimen consists of a slab with more than a dozen *Pteraichnus* tracks and trackway segments from a known stratigraphic horizon of red sandstones, which also yield theropod and sauropod tracks. The pterosaur tracks are very well-preserved and medium sized (manus and pes length about 10 cm). Moreover, replicas of the tracks are preserved in the JuraPark and University of Colorado collections (J389 and UCM 185.17 respectively). Although the tracks occur in the Mibladen region which is very famous for mineral mines, tracks in this area have not previously been reported or dated accurately. According to the published geological maps the strata are Lower Jurassic in age. The dinosaur tracks confirm a Jurassic age, but are suggestive of a Middle to Upper Jurassic assemblage (with *Parabrontopdus, Therangospodus*, and cf. *Jialingpus*). Given that no pterosaur track assemblages have yet been dated as earlier than Late Jurassic, the Mibladen pterosaur tracks are at least as old if not older than any previously reported.

Enigmatic tracks of possible reptilian (lacertilian) affinity were reported from the Upper Cretaceous (Maastrichtian) of the Agadir region of Morocco in 1954 and named *Agadirichnus*. These were later re-interpreted as "possible" pterosaur tracks, although this conjecture is not proven, as the type material is not available for study. Thus, the Mibladen assemblage is the only pterosaur tracksite from Africa for which actual specimens (and GPS coordinates) are available.

Technical Sesssion XII (Friday, November 1, 2013, 3:15 PM)

INFERENCES ON THE FEEDING BIOMECHANICS OF THE BIZARRE PUG-NOSED CROCODYLIFORM *SIMOSUCHUS CLARKI*

GIGNAC, Paul, Stony Brook University, Stony Brook, NY, United States, 11794-8081; KLEY, Nathan, Stony Brook University, Stony Brook, NY, United States

Living crocodylians and their ancestors are commonly thought of as predators that manage, simultaneously, to be large and stealthy, and these seem to be consistent factors in their evolutionary success. Several recently discovered crocodylian ancestors (i.e., notosuchians), however, have demonstrated that the evolutionary narrative of crocodile-line archosaurs is far more diverse than previously realized. Among these divergent fossil forms is *Simosuchus clarki* from the Late Cretaceous of Madagascar, a relatively small, heavily armored, and blunt-snouted relative of modern alligators and crocodiles. Multiple analyses of tooth and jaw morphology indicate that this taxon represents an herbivorous radiation within Notosuchia. Here we examine the diet and feeding biomechanics of *Simosuchus* to address how this fossil mesoeucrocodylian evolved into its highly divergent feeding niche. Relying largely on gross dissections and iodine-enhanced X-ray μCT scanning, we use modern crocodylian cranial soft-tissue anatomy, along with the exquisitely preserved hard-tissue anatomy of *Simosuchus*, as foundations for reconstructing a functional anatomical model of the jaw adductor system in this taxon. We integrate investigations of gross cranial morphology, estimates of bite-force capacity, and inferences of transverse jaw motion with examinations of dental form and tooth pressures to address the anatomical and functional characteristics of *Simosuchus* herbivory. These findings are compared to the feeding biomechanics of the closest living relatives of *Simosuchus*, modern crocodylians, as well as to a sample of herbivorous reptiles. Our results indicate numerous specializations for processing plant matter in several cranial systems (e.g., skull structure, dentition, adductor musculature) that are convergent with those of other living and fossil reptilian herbivores. In sum, these findings provide an example of how the crocodylian cranial bauplan can be co-opted to facilitate a major transformation in feeding ecology that seems to have influenced even the post-cranial anatomy of this taxon (resulting in expansion of body armor and semi-erect posture, among other features).

Technical Session X (Friday, November 1, 2013, 10:45 AM)

EARLY OLD WORLD MONKEYS FROM AFRICA AND ARABIA: IMPLICATIONS FOR THE ORIGINS AND BIOGEOGRAPHY OF MAJOR CERCOPITHECID CLADES

GILBERT, Christopher, Hunter College of the City University of New York, New York, NY, United States, 10065; BIBI, Faysal, American Museum of Natural History, New York, NY, United States; HILL, Andrew, Yale University, New Haven, CT, United States; BEECH, Mark, Abu Dhabi Authority for Tourism and Culture, Abu Dhabi, United Arab Emirates; ROSSIE, James, Stony Brook University, Stony Brook, NY, United States

Recently, we described ~12.5 million year old fossil colobine teeth from the Tugen Hills, Kenya. These specimens represent the earliest colobine and the earliest cercopithecid specimens in the fossil record by ~3 million years. In addition, recent expeditions to the Baynunah Formation, Emirate of Abu Dhabi, UAE, have resulted in the recovery of a fossil tooth representing the earliest known member of the tribe Cercopithecini (guenons), and the only guenon known outside of Africa. This new specimen is presented here, and it is currently the earliest cercopithecine monkey yet known outside of the African continent. The late Miocene fauna of Abu Dhabi is a unique blend that includes both African and Eurasian elements at this time, suggesting that the Arabian Peninsula was an important dispersal and exchange route for various mammalian lineages. The presence of early cercopithecines, and cercopithecins, in particular, on the Arabian Peninsula during the late Miocene provides important insight into primate biogeography and evolution over the past seven million years. Specifically, the newly discovered fossils support late Miocene dispersal hypotheses into Eurasia through Southwest Asia in addition to and perhaps instead of dispersal routes over the Straits of Gibraltar. The discovery of these Arabian fossils demonstrates that identifiable cercopithecin fossils extend back into the Miocene epoch, thereby refuting hypotheses that crown cercopithecin monkeys are a very recent radiation first appearing in the Pliocene or Pleistocene. Finally, the fact that these discoveries in Africa and Arabia extend the first appearance dates (FAD) for cercopithecids, colobines, and cercopithecins by 3-5 Ma demonstrates, rather disturbingly, the rarity of some taxa in the Afro-Arabian fossil record and the corresponding imprecision of their existing FADs. This should be taken into consideration when evaluating hypotheses and molecular clock estimates that rely too heavily on such data.

Technical Session XIV (Saturday, November 2, 2013, 12:00 PM)

ILLUMINATING HOLOCENE DIET SHIFTS IN PENGUINS WITH COMPOUND SPECIFIC ISOTOPE ANALYSIS

GILBERT, Kwasi, University of California Santa Cruz, Santa Cruz, CA, United States, 95060; KOCH, Paul, Univ of California Santa Cruz, Santa Cruz, CA, United States; MCCARTHY, Matthew, University of California Santa Cruz, Santa Cruz, CA, United States; BARONI, Carlo, Università di Pisa, Pisa, Italy; LORENZINI, Sandra, Università di Pisa, Pisa, Italy

Holocene-aged Adélie penguin (*Pygoscelis adeliae*) remains from the Ross Sea, Antarctica, offer a picture of changes in the ecology of this species and in ecosystem dynamics in response to natural and anthropogenic perturbations. Time series of stable carbon and nitrogen isotope values constructed from radiocarbon-dated guano and eggshell fragments show increasing variation to lower values beginning 4000 years BP. These records culminate with low carbon and nitrogen isotope values in penguin remains from the last 200 years. The increase in variation and shift toward lower values has been interpreted as reflecting an increase in the abundance of krill in penguin diets, from diets that formerly included more fish. A diet dominated by krill matches observations made on penguins that forage and provision chicks at land-based rookeries along the coast of the Ross Sea today. The timing and magnitude of this expansion and shift in dietary breath remains unclear, however. The guano and eggshell isotopic records are complex and are at times conflicting. In addition, each only reflects the diets of penguins on rookery sites, not diets for the majority of the year when they are foraging away from the coast. Isotopic records from bone, which offer a long term perspective on animal diets, have not been included in the past because of the potential for post-depositional alteration and because abundant sub-fossil bone was lacking.

Here we analyze bulk carbon and nitrogen isotope values in Adélie penguin bone collagen from Holocene Ross Sea sites. We introduce new preparation steps to clean the bones of contaminant, and compare the bone collagen isotope data with existing records. In addition we use compound specific isotope analysis of bone collagen amino acids to disentangle the contributions of shifts in trophic level (i.e., diet) from those caused by biogeochemical changes in isotopic baseline values. We find that the bone collagen carbon and nitrogen isotope values show a similar pattern of stability over much of the Holocene and a marked decline in the latest Holocene. Amino acid isotope values indicate that these trends are consistent with an expansion in penguin trophic breadth. No significant changes in the biogeochemical baseline were detected. The incorporation of krill into Adélie diet at current levels appears to be a relatively recent phenomenon that may relate to both commercial whaling and changes in ice conditions in the Ross Sea in the latest Holocene.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ONTOGENY AND SEXUAL DIMORPHISM IN THE NORTH AMERICAN GLYPTODONT, *GLYPTOTHERIUM* (XENARTHRA, CINGULATA)

GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ, United States, 86001; CARRANZA-CASTAÑEDA, Oscar, Centro de Geociencias, Universidad Nacional Autonoma de Mexico, Campus Juriquilla, Juriquilla, Queretaro, Mexico

Newly discovered infant, juvenile, and adult members of the Plio-Pleistocene glyptodont, *Glyptotherium texanum* Osborn 1903 from the San Miguel de Allende Basin in Guanajuato, Mexico and the 111 Ranch fauna, southeastern Arizona, permit an expanded understanding of growth and development, including sexual dimorphism. Osteoderms that formed the carapace in infants were in full edge-to-edge contact from an early age. Growth of the osteoderms was allometric, but preserved osteoderm-to-osteoderm contacts. Osteoderms individually grew more rapidly on the edges than in the center, changing the relative proportions of the external sculpturing formed by surficial sulci. Central figures of dorsal osteoderms were relative large in infants, and became relatively smaller with growth as peripheral figures expanded more rapidly. In *G. texanum* as presently understood, growth of osteoderms ceased before central figures became smaller than half the side-to-side diameter. In addition, relative thickness of the osteoderms was greatest in infants, and became reduced with growth. Osteoderms of the caudal opening of juveniles and adults are either flat or markedly conical, which we define as female and male, respectively. Growth of the cranium, jaws, and dentition was also allometric. The lower jaw of an infant indicates that individual teeth were tapered and widely spaced along the occlusal plane, and became prismatic with parallel sides in juvenile stage of growth, with closely spaced occlusal surfaces beginning with young juveniles. Anterior teeth were semilunar with only faint division into three lobes in infants, and the trilobate anatomy became more pronounced posteriorly but all possessed rounded outlines formed by the osteodentine rim on the occlusal surface. In juveniles and adults the teeth were increasingly trilobate and the osteodentine rims on the occlusal surfaces became markedly angular. In addition, the orientation and position of the ascending ramus of the mandible changed with growth, and development of pronounced muscle scars on the cranium continued well into fully adult stage of development. Large muscle scars and bosses on the anterior face of the descending process of the zygomatic arches were subtle or indistinguishable in juveniles, but prominent in adults. Recognition of allometric growth and sexual dimorphism allows broader understanding of the taxonomy and evolution of this genus.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THREE NEW PROCYONIDS FROM THE BLANCAN OF FLORIDA

GILMORE, Laura, East Tennessee State University, Johnson City, TN, United States, 37604

Procyonids are well known biologically but knowledge of their fossil record is comparatively sparse. This study describes a sample of late Blancan fossils representing a population of unusually large procyonids. These fossils have been classified previously as "*Procyon* sp.," "*P. lotor*," "*P. rexroadensis*" and "*Procyon* cf. *P. rexroadensis*", but an in-depth investigation of the material, and the assignments thereof, was lacking. Fossils are compared with the Blancan species, *P. rexroadensis*, as well as a large sample (n=250) of modern specimens from a wide geographic area to understand the range of intraspecific variation. This variation is then quantified through the use of linear and 2D geometric morphometrics. Results indicate the presence of two new species of *Procyon* and one new species of *Nasua* in Florida during the Blancan, and that the Blancan species *P. rexroadensis* is actually a junior synonym of *P. lotor* because the distinguishing dental feature for which the species is named is within the range of variation of *P. lotor*. One species is described as a new taxon based on unique morphology of the postcrania and lower dentition (upper dentition is preserved, but indistinguishable from *P. lotor* in morphology). Differences between *P. lotor* and this new taxon include enlarged medial epicondyles of the humeri, enlarged tibial tuberosities, elongated attachments for the brachioradialis, and an elongated coracoid process of the scapulae. A second *Procyon* species is described based on characters in the upper dentition, namely a distinct reduction of the metaconule of the M1, lack of a crista between the paracone and hypocone and lack of a lingual basin between the protocone and hypocone. A dentary and some postcrania may be referable to this second *Procyon* species. A new species of coati (*Nasua*) is identified and described based on a right dentary with m1 and p4, as well as a complete humerus. Dentition is defined by a conspicuous accessory cusp of the m1, anteroposterior compression of the trigonid of the m1, inflated entoconid of the m1, and a p4 with the hypoconid separated from the protoconid by a shallow valley. A sacrum and the dentary of a male *Nasua* are also referred to this species. Results also include a considerable temporal range extension for *P. lotor* due to the synonymizing of *P. rexroadensis* with *P. lotor*, as well as the first record of *Nasua* from the Blancan of Florida, and the largest *Procyon* species yet found.

Technical Session XV (Saturday, November 2, 2013, 10:15 AM)

FAUNAS OF WHALES AND SEA COWS (CETACEA AND SIRENIA) FROM MIDDLE AND UPPER EOCENE STRATA IN WESTERN FAYUM PROVINCE, EGYPT

GINGERICH, Philip D., University of Michigan, Ann Arbor, MI, United States, 48109-1079; ANTAR, Mohammed Sameh, Egyptian Environmental Affairs Agency, Cairo, Egypt; ZALMOUT, Iyad S., King Saud University, Riyadh, Saudi Arabia

Eocene whales and sea cows were first found in northern Fayum, Egypt in 1879 and 1886, respectively, by explorer Georg Schweinfurth. Additional specimens were collected in the early 20th century by geologists and paleontologists Hugh Beadnell, Charles Andrews, Ernst Stromer, and Eberhard Fraas. Layman Richard Markgraf was trained to collect by Fraas and Stromer, and later developed a business collecting for museums and dealers. Markgraf's specimens are found in museums around the world, but he paid little attention to stratigraphy and his collections continue to cause confusion. We have worked in western Fayum in recent years to document the succession of middle and late Eocene formations and marine mammal faunas in Wadi Al Hitan and Wadi El Rayan, covering 1200 km^2 of desert and spanning some 12 million years of geological time. Specimens are mapped, measured, and identified in the field when possible, or excavated, collected, and identified in the laboratory.

Six of the following intervals have yielded cetaceans and/or sirenians: (1) Muweilih and lower Midawara Fms., early Lutetian: not yet explored; (2) middle Midawara Fm.,

middle Lutetian: Protocetidae, Remingtonocetidae, and Protosirenidae; (3) upper Midawara Fm., late Lutetian: Protocetidae and Protosirenidae; (4) Sath el-Hadid Fm., early Bartonian: Protocetidae; (5) El-Gharaq Fm., late Bartonian: not yet explored; (6) Gehannam Fm., early Priabonian: Protocetidae, Basilosauridae, and Protosirenidae; (7) Birket Qarun Fm. and lower Qasr el Sagha Fm., early Priabonian: Basilosauridae, Dugongidae, and Protosirenidae; (8) middle Qasr el-Sagha Fm., middle Priabonian: Basilosauridae and Dugongidae; (9) upper Qasr el-Sagha Fm., late Priabonian: not yet explored. Markgraf collected primarily from intervals 7 and 8, which have quite different faunas (*Basilosaurus*, *Dorudon*, *Masracetus*, *Eotheroides*, and *Protosiren* in the former; *Saghacetus*, *Stromerius*, and *Eosiren* in the latter). Markgraf mixed collections, sometimes creating chimerae represented as single individuals. The sequence of faunas in Egypt overlaps that documented in Pakistan, with the Muweilih and Midawara formations in Egypt being correlatives of the Habib Rahi and Domanda formations in Pakistan, the Sath el-Hadid being equivalent to Pir Koh, and the El-Gharaq and possibly higher formations being equivalent to Drazinda. Together, the two areas provide a coherent stratigraphic base for understanding change in Eocene cetacean and sirenian faunas through time.

Symposium 4 (Saturday, November 2, 2013, 9:30 AM)

FEATHER-LIKE STRUCTURES AND SCALES IN A JURASSIC NEORNITHISCHIAN DINOSAUR FROM SIBERIA

GODEFROIT, Pascal, Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium; SINITSA, Sofia, Institute of Natural Resources, Ecology and Cryology, SB RAS, Chita, Russia; DHOUAILLY, Danielle, Université Joseph Fournier, La Tronche, France; BOLOTSKY, Yuri, Institute of Geology and Nature Management, FEB RAS, Blagoveschensk, Russia; SIZOV, Alexander, Institute of the Earth's Crust, SB RAS, Irkutsk, Russia

Recent discoveries in Middle–Late Jurassic and Early Cretaceous deposits from northeastern China have revealed that numerous theropod dinosaurs were covered by feathers. Furthermore, filamentous integumentary structures were also recently described in rare Early Cretaceous ornithischian dinosaurs from Liaoning Province in China. Whether these filaments can be regarded as epidermal and therefore part of the evolutionary lineage towards feathers remains controversial. Here we describe a new basal neornithischian dinosaur, based on isolated bones and partial skeletons collected in two monospecific bonebeds from the Middle–Late Jurassic Kulinda locality in the Transbaikal region (Russia). Varied integumentary structures were found directly associated with skeletal elements, supporting the hypothesis that simple filamentous feathers, as well as compound feather-like structures comparable to those in theropods, were widespread amongst the whole dinosaur clade. Moreover, scales along the distal tibia and on the foot closely resemble the secondarily-appearing pedal scales in extant birds. More surprisingly, dorso-ventral movements of the tail were prevented by large imbricated scales on its dorsal surface. It is hypothesized that, at the same time early feathers evolved within the whole dinosaur clade, genetic mechanisms limiting the growth of long epidermal structures on the distal portion of the hind limb and on the tail were selected as they facilitate bipedal terrestrial locomotion.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FIRST RECORD OF ABDOMINAL CONTENTS IN FOSSIL CROCODYLIFORMES

GODOY, Pedro, University of Sao Paulo (USP), Ribeirao Preto, Brazil; MONTEFELTRO, Felipe, University of Sao Paulo, Ribeirao Preto, Brazil; LANGER, Max, University of Sao Paulo (USP), Ribeirao Preto, Brazil

Abdominal contents or cololites are the most direct and reliable evidence of predation in extinct animals. Despite the richness of Crocodyliformes in Mesozoic-Cenozoic deposits, abdominal contents were never recorded among this group. Here we report on extrinsic elements in the abdominal cavity of a baurusuchid crocodyliform. The preservation of the complete gastralia indicates that the abdominal cavity of the baurusuchid remained intact prior to and after burial, suggesting that these extrinsic elements, positioned between the gastralia and the left ribs, correspond to cololites. The baurusuchid skeleton is articulated and almost complete, and contains, ventral to its left ribs, a cluster of partial cranial bones and teeth of another crocodyliform. The tooth morphology allows the association of these elements to Sphagesauridae, due to presence of unique features, such as accessory ornamentation (basiapical keels) and distally compressed crowns, less expanded than the roots. In addition to the three isolated teeth, the frontal, parietal (articulated), palpebral and jugal bones are also preserved, and match to sphagesaurid morphology. Baurusuchids and sphagesaurids are the most common groups of the 19 species described for the Adamantina Formation (Late Cretaceous). The former were top predators of that time, whereas the smaller sphagesaurids had a generalist diet, possibly including plant material. The new fossil represents the first direct evidence of predation among different species of fossil crocodyliforms. Unlike the crocodyliforms, carnivorous and small herbivorous dinosaurs were rare at the time of deposition of the Adamantina Formation. This contrasts with likely coeval deposits of the Neuquen Basin in Argentina, which include small bodied ornithischians and a great variety of theropods. This finding corroborates that crocodyliforms were filling niches that are not usually occupied by the group, such as small- to medium-sized omnivores/herbivores and large terrestrial predators. The paucity of dinosaurs with equivalent ecological roles could be the result of competitive displacement or derived from unfavorable environmental conditions, which did not affect the crocodyliforms so severely.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

SIZING UP THE POSITION OF *GAVIALIS* USING GEOMETRIC MORPHOMETRICS OF CROCODYLIAN BRAINCASES

GOLD, Maria Eugenia Leone, American Museum of Natural History, New York, NY, United States, 10024; NORELL, Mark A., American Museum of Natural History, New York, NY, United States

The phylogenetic position of the Indian Gharial (*Gavialis gangeticus*) remains hotly contested by crocodylian systematists. Morphological characters place *Gavialis* as the sister to all other crocodylians, whereas molecular and combined analyses find *Gavialis* and *Tomistoma* to be sister taxa within Crocodylidae. Geometric morphometrics, which uses homologous landmarks to assess shape change in specimens, has only begun to be employed in this debate. However, many of the studies using this technique focus on the exterior of the skull, which is known to be highly environmentally plastic. The braincase appears less susceptible to environmental effects, and has provided useful non-geometric, phylogenetic information, but has not been explored in this context. To address whether the size and shape of the crocodylian braincase retains phylogenetic signal, we used three-dimensional geometric morphometrics. Because the braincase of crocodylians is fused to the exterior of the skull, midsagittal views are necessary to retain suture patterns for geometric morphometric analyses. These views were obtained using high-resolution computerized tomography (CT) scans to examine the interior of the post-orbital skull. We analyzed multiple individuals per species, representing a majority of extant crocodylian diversity, using Procrustes superimposition and principal components (PC) analyses. We found that the first two component axes described more than 50% of the variation but did not show groupings that divide the specimens by family. The broad overlap of *Gavialis* specimens with a diversity of other taxa indicates that 3D braincase morphology cannot resolve the phylogenetic position of *Gavialis* within Crocodylia. Instead, our results indicate that size, not phylogenetic relatedness, is the most important factor in the change in shape of the braincase. This suggests that constraints on the neurocranium (e.g., developmental, functional) are uninformative for constructing phylogenies.

Symposium 1 (Wednesday, October 30, 2013, 10:15 AM)

NEW DATA ON DEVELOPMENTAL CRANIAL ONTOGENY IN PACHYCEPHALOSAURS

GOODWIN, Mark, University of California Museum of Paleontology, Berkeley, Berkeley, CA, United States, 94720; HORNER, John, Montana State University, Museum of the Rockies, Bozeman, MT, United States; SCHOTT, Ryan, University of Toronto, Toronto, ON, Canada; EVANS, David, Univ of Toronto at Mississauga, Toronto, ON, Canada

Extended neoteny and late-stage allometric growth increases morphological disparity between growth stages in the Marginocephalia (pachycephalosaurids + ceratopsids). As a result, pachycephalosaurs undergo extreme cranial morphological change during ontogeny facilitated by "metaplasia", erosional resorption, and redeposition. We use comparative cranial morphology, histology, and high-resolution computer tomography (HRCT) to confirm these modifications.

A major pachycephalosaur ontogenetic trend is inflation of the frontoparietal dome as the skull lengthens. Lateral cranial elements are eventually incorporated into the dome as it continues to expand ontogenetically. Nasal nodal ornamentation and the location and arrangement of the squamosal horns/nodes in *Pachycephalosaurus* and the ornamented parietosquamosal bar in *Stegoceras* are conserved. HRCT reveals open intrafrontal, frontoparietal, and parietosquamosal sutures in partially domed, relatively younger individuals of *Stegoceras*. Lateral cranial elements are also unfused. A decrease in relative vascularity accompanies the development of the frontoparietal dome in *Stegoceras*. These features link ontogenetically younger "flat-headed", intermediate incipiently domed, and more fully domed ontogenetically older individuals in a growth series for *Stegoceras* and *Pachycephalosaurus*. In *Stegoceras*, the distinctive frontoparietal dome grows rostrocaudally starting with the frontals. In *Pachycephalosaurus*, inflation of the dome appears to start caudally with initial inflation of the parietosquamosal region in relatively younger individuals. Pachycephalosaur cranial sutures can be difficult to trace or appear "fused" on the dorsal surface of more complete skulls. Morphological evidence from *"Dracorex hogwartsia"* and the confirmation of open cranial sutures and cranial morphology in *"Stygimoloch spinifer"* by histology and HRCT, continue to support the reinterpretation of these taxa as earlier growth stages of *Pachycephalosaurus wyomingensis*.

An increasing sample size of pachycephalosaurs from the Upper Cretaceous of the Western Interior facilitates the mapping of morphological landmarks, sutures, and bone composition. These data show that pachycephalosaur growth stages reflect a continuum rather than specific developmental steps defined by terminal morphologies and that juveniles are not rare in the fossil record.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

INTEGRATING TEMPORAL DATA WITHIN A PHYLOGENETIC ANALYSIS: A BAYESIAN APPROACH FOR CHARACTERIZING DIVERGENCE ESTIMATES IN AN EXTINCT CLADE

GORSCAK, Eric, Ohio Univ, Athens, OH, United States, 45701; O'CONNOR, Patrick, Ohio Univ, Athens, OH, United States

Recent advances in Bayesian phylogenetics have allowed the inclusion of both extant and extinct taxa into combined analyses using molecular and morphological data. The addition of fossils can add resolution for estimating divergence dates of extant clades by constraining the ages of internal nodes. This study further explores the estimation of divergence dates, but within an exclusively extinct clade by applying different evolutionary models coupled with temporally-informed terminal taxa. Sauropod dinosaurs are an ideal case study as this clade was highly successful globally throughout

the latter half of the Mesozoic. For example, estimations of divergence dates within this clade may provide insight into various paleobiogeographical hypotheses while simultaneously accounting for uncertainty in phylogenetic relationships. Taxon dates, normally constrained to geologic stages, were obtained from the respective literature. Analyses were then conducted in the software package BEAST under a variety of evolutionary model assumptions, including character state change models (equal or variable rates), clock models (strict or uncorrelated log-normal), and tip dates (from various sampling strategies across the temporal range) under a birth-death tree model. Models were compared using the Bayes factor. Strict clock models and equal character rate models were less likely to fit the data. Regardless of tip-date sampling strategy, variable character rates and uncorrelated log-normal clock models were not substantially preferred over each other. These latter models broadly agree in: (1) an Early Cretaceous origin of titanosaurians; (2) the origin of both rebacchisaurids and basal titanosaurians of South American and African forms coincide with the onset of rifting (~late Early Cretaceous) of these continents; (3) East Gondwanan titanosaurians (e.g., *Isisaurus*) diverging during the "middle" Cretaceous; and (4) derived titanosaurians consisting of a South American and a Laurasian clade during the Late Cretaceous. These results are concordant with several key tectonic events (e.g., the rifting of South America and Africa), and represent a promising approach for integrating morphological and temporal data with evolutionary modeling under a broad phylogenetic framework. Future applications of this approach include conducting analyses across multiple clades of organisms to evaluate the timing and influence of large-scale events (e.g., plate tectonics) on macroevolutionary patterns related to the origin and diversification of extinct clades.

Symposium 4 (Saturday, November 2, 2013, 11:30 AM)

NEW BONY FISH RECORDS FROM THE CANADIAN ARCTIC EOCENE GREENHOUSE OF BANKS ISLAND, NORTHWEST TERRITORIES

GOTTFRIED, Michael, Michigan State University, East Lansing, MI, United States, 48824-1115; EBERLE, Jaelyn, Univ of Colorado Boulder, Boulder, CO, United States; HUTCHISON, J. Howard, University of California Berkeley, Escalante, UT, United States

Field investigations in recent decades have revealed a rich Eocene Greenhouse biota from the Canadian Arctic, particularly Ellesmere Island in the eastern Arctic Archipelago of Canada. These finds have contributed greatly to our understanding of the paleodiversity and paleoenvironment of northern polar regions during the warmest Cenozoic interval on record, when mild temperate to subtropical conditions were broadly established across the Northern Hemisphere. Recent field research on northern Banks Island (NWT; ~74 degrees N), western Canadian Arctic, in nearshore marine deltaic strata of the early to middle Eocene Cyclic Member of the Eureka Sound Formation, resulted in the recovery of fossil wood, bivalves, Ophiomorpha, several hundred elasmobranch teeth (mainly sand-tiger sharks), and bony fish scales and teeth. We focus here on the bony fishes, the first to be described from the Banks Island Eocene, which add new data to the emerging picture of fish diversity and distribution in the Arctic Eocene Greenhouse. Material recovered includes one well-preserved gar (lepisosteid) scale and a gar opercular element, one nearly complete and three partial non-diagnostic teleost centra, 23 as yet indeterminate bony fish teeth, 12 teleost scales, and several fragmentary pieces. The gar material is diagnostic and readily identifiable, expanding the Eocene lepisosteid record to the western edge of the Canadian Arctic in the Eocene (gars were previously recovered from the Eocene of Ellesmere and Axel Heiberg Islands), indicating a wide northern polar distribution for the group during the Eocene Greenhouse interval. The cycloid teleost scales are relatively uniform in appearance and likely pertain to a single taxon of esocid (pikes and muskellunges). Several scales bear medial furrows indicating that they were positioned along the lateral line. Fossil esocids are known from a wide range of North American Cretaceous to Holocene sites and today occur as far north as Alaska and the Mackenzie River Delta in the NWT; their Eocene occurrence on Banks Island represents a further high latitude expansion for the paleogeographic range of this freshwater family, and is consistent with recent analyses suggesting that the Eocene Arctic Ocean likely had very low salinity.

Technical Session II (Wednesday, October 30, 2013, 10:15 AM)

TO 3D OR NOT TO 3D: DO 3D SURFACE ANALYSES IMPROVE ECOMORPHOLOGICAL INFERENCES?

GOULD, Francois, unaffiliated, London, United Kingdom

The growth in three-dimensional (3D) imaging technologies has renewed interest in the study of surface morphology. Quantitative approaches to the analysis of surfaces, including quadratic function fitting, GIS, and geometric morphometrics, are increasingly used to study form-function relationships in living and fossil mammals. These methods are computationally intensive, technically demanding and time consuming, which may limit sampling potential. To date, there have been few side-by-side comparisons of their effectiveness relative to more traditional analyses of linear measurements and ratios. The distal femur of mammals has been shown to vary with locomotor mode across clades. Thus I tested whether an analysis of surface shape was superior to a multivariate analysis of ratios in uncovering ecomorphological patterns in distal femoral variation.

My sample includes 164 femora from 45 mammalian genera. Each genus was assigned to one of six locomotor categories. Six linear measurements of the distal femur were taken with calipers, from which four ratios were calculated. A 3D model was generated with a laser scanner, and analyzed using three dimensional landmarks and principal components analysis. Locomotor mode was a significant predictor of variation in distal femoral morphology for both the analysis of ratios (multivariate analysis of variance (MANOVA) on ratios Wilkes λ (4, 159)=0.5493, $p<0.001$) and the surface analysis (MANOVA on principal components (PC) scores Wilkes λ (120, 668.38) =0.0085), $p<0.001$). Effect size was larger in the geometric morphometric analysis ($\eta^2=0.52$) than in the analysis of ratios ($\eta^2=0.45$). Ordination of the data reveals a similar pattern with arboreal and cursorial taxa as extremes on a continuum of morphologies in both analyses. Discriminant functions calculated from the geometric morphometric analysis were more accurate (percent correct classification by group from 73% to 89%) than those calculated from ratios (percent correct classification by group from 23% to 93%). Analysis of ratios and geometric morphometric surface analysis uncover similar, biologically meaningful, relationships between distal femoral shape and locomotor mode. The signal-to-noise ratio is slightly higher in the geometric morphometric analysis. The practical costs of conducting these sorts of analyses should be weighed against potentially slight increases in power when designing protocols for the study of extant and fossil taxa.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

COMPARISON OF ALLOMETRIC GROWTH TRAJECTORIES OF *MEGALONYX* AND *PARAMYLODON* SCAPULAE

GRASS, Andy, University of Iowa, Iowa City, IA, United States, 52242

Megalonyx and *Paramylodon* were two of the most common and widespread of the North American Plio-Pleistocene ground sloths. They are generally considered to have had different diets; *Megalonyx* was a browser and *Paramylodon* was more of a mixed feeder, with few co-occurrences in the fossil record. *Megalonyx* is related to the Hemphillian ground sloth *Pliometanastes*, part of a lineage that presumably island hopped to Florida in the late Miocene before the Isthmus of Panama had formed. *Paramylodon* is related to *Glossotherium*, which did migrate directly from South America through Central America and Mexico in the early Pliocene. In this study the scapulae of juvenile and adult *Megalonyx jeffersonii* and *Paramylodon harlani* were analyzed using geometric morphometrics. Scapula shape has been shown in several groups to be highly influenced by function and in some groups to be a good indicator of body size. A principal components analysis performed on the procrustes coordinates shows that there are statistically significant differences between the scapula shapes of the two species. *Megalonyx* tends to have a rounder scapula with approximately equal supra and infraspinous fossae, whereas *Paramylodon* tends to have a more arrow shaped scapula with the supraspinous fossa larger than the infraspinous fossa. The shapes between juveniles and adults of each species are also significantly different, with the juveniles of each species being much more circular in appearance than the more ovoid adults. A regression was performed on the natural log of the centroid sizes and PC scores and each species shows a significant allometry. A MANCOVA found no significant interaction term between the contributions of size and species to shape, indicating that the allometric trajectories of the two species were not significantly different. They occupy different areas of morphospace, but they achieve their adult morphologies in the same way. This may be indicative of two scenarios. Despite their very disparate origins in time and space and their differing niches, *Megalonyx* and *Paramylodon* may have converged on similar growth trajectories. Alternatively, despite how distantly they are related to each other they may have both retained an ancestral growth trajectory. Either case is compelling evidence of evolutionary constraints on the shape of the scapula, which has attachment points for multiple muscles that form different functional groups. Additionally, the shape differences between juveniles and adults may prove useful in estimating age categories from scapular shape.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE INFLUENCE OF BITE FORCE ON THE FORMATION OF DENTAL MICROWEAR IN XENARTHRANS (MAMMALIA)

GREEN, Jeremy, Kent State University at Tuscarawas, New Philadelphia, OH, United States, 44663; MCAFEE, Robert, Northern Illinois Univ, Ada, OH, United States

Among the unique traits shared by the placental clade Xenarthra is a derived lack of enamel on adult dentition. Prior analyses of dental microwear on orthodentine tooth surfaces reveal a correlation between microwear patterns and feeding ecology in this group, both among living taxa (tree sloths, armadillos) and some extinct relatives (ground sloths). However, the specific formative mechanism of microwear features (e.g., scratches, pits) on xenarthran orthodentine remains poorly understood. Bite force (generated by mandibular closure during mastication) should influence the formation of microwear, but no studies have specifically tested this hypothesis. We attempt to fill this gap in our knowledge by investigating the potential effects of bite force on microwear formation in tree sloths. Relative ratios of bite force were estimated from 15 skulls of *Bradypus* (three-toed sloths) and *Choloepus* (two-toed sloths) by applying a geometric model for calculating input forces from masticatory muscles relative to lever arm moments of the mandible. Relative bite force increases posteriorly across the maxillary teeth in both taxa. For each skull, five microwear variables were quantified on three right maxillary molariforms (M2-M4) using the light microscopy method. Mann-Whitney U tests were applied to analyze changes in microwear variables at each tooth position in each taxon. Only frequency of cross scratches and hypercoarse scratches differed significantly between tooth positions in *Choloepus*, but with no consistent pattern of change. For *Bradypus*, only frequency of hypercoarse scratches changed in correlative response with increasing bite force. The overall lack of strong correlation between microwear variation and bite force suggests that tooth scars in sloths are not being generated by pure orthal closure of the mandible, but rather are more influenced from post-contact masticatory movements. Further analyses that incorporate all jaw muscles to create a three-dimensional assessment of the chewing cycle should help to clarify how microwear patterns are generated in sloths.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

EVOLUTIONARY AND ECOLOGIC IMPLICATIONS OF DIETARY VARIATION AT INDIVIDUAL AND POPULATION LEVELS IN HERBIVOROUS MAMMALS

GRESHKO, Michael, Vanderbilt University, Nashville, TN, United States, 37235-1805; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States; HULBERT, Richard, Univ of Florida, Gainesville, FL, United States

The mechanisms driving dietary variation in herbivores has been the subject of considerable debate and have important evolutionary implications. While much work is aimed at understanding the dietary ecology of extant and extinct taxa, fewer studies have assessed dietary variation through time in multiple individuals from one population. Here, we use stable carbon isotope data from serial samples collected from the literature from the Miocene to the present (n = 3,572, 266 individual teeth) and newly acquired samples of an extreme dietary generalist *Cormohipparion emsliei* (n = 52, 9 individuals), to answer the following questions: (1) are dietary generalists (i.e., mixed-feeders) composed of individual generalists (defined as having high isotopic variation) or individual specialists (defined as having low isotopic variation); and (2) how does the overall dietary strategy (i.e., browser, mixed-feeder, grazer) of herbivorous mammals affect individual isotopic variation? As *C. emsliei* from the Bone Valley of Florida (~5 Ma) has carbon isotopic variation of 13.7‰ (ranging from -12.9 to 0.8‰), individuals from the "population" were expected to have similar broad isotopic ranges. However, all 9 individuals sampled have $\delta^{13}C$ ranges of ≤2‰, with mean total ranges of 1.1‰. Further, based on published studies, mixed-feeding taxa (n = 35 individuals) exhibit significantly lower $\delta^{13}C$ ranges as compared to grazing taxa (n = 175) and browsing taxa (n = 56; Kruskal-Wallis, $p<0.0001$), with 66% of all mixed-feeding taxa sampled having ranges ≤1‰, unlike grazers (24%) and browsers (25%). These results suggest that generalist herbivores are composed primarily of individual specialists, not individual generalists, and degree of dietary variation is greatest in grazers (mean = 2.2; range of 0.3 to 8‰) and browsers (mean = 2.1; range of 0.5 to 5.9‰). Contrary to expectations, mixed feeders individually vary the least. These results have important evolutionary implications, as mixed-feeders may have greater longevity (similar to *C. emsliei* with longevity of 9.8 million years, greater than other horses), due to having populations of individual specialists that can persist despite changing environments and climates. If extreme generalists were composed of individual generalists, one might expect fitness tradeoffs with the "jack of all trades but master of none" strategy, whereas populations or species composed of individual specialists may individually lack tradeoffs but the population/species may have overall increased resilience against extinction.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

RODENTS FROM THE LOTHIDOK FORMATION, EARLY MIOCENE, WEST TURKANA, KENYA

GROSSMAN, Aryeh, Midwestern University, Glendale, AZ, United States, 85308; FLYNN, Lawrence, Harvard Univ, Cambridge, MA, United States; MANTHI, Fredrick, National Museums of Kenya, Nairobi, Kenya

The combined rodent assemblage from Kalodirr and Moruorot, two late-Early Miocene (ca. 17MA) sites of the Lothidok Formation in West Turkana, Kenya, includes novel taxa as well as new anatomical elements of previously known taxa. Like other early Miocene sites, the rodent assemblage is dominated by thryonomyids but its resemblance to other localities is only superficial. Three different species of *Paraphiomys*, one represented by several skulls and other excellent gnatho-dental material, are distinguished from each other by their size. One is large, the size of *P. pigotti*, but has simpler lower cheek teeth lacking the metalophulid II. One species is very similar to *P. renelavocati* from Rusinga Island, but is slightly more hypsodont. A third species resembles *Apodecter stromeri* in size. It differs from *P.* cf. *renelavocati* by its more triangular shaped p4. The myophiomyines are represented by a dentary and upper molar assigned to *Elmerimys woodi*, although it appears to be at the small end of the size range. The dentary bears p4m1-3, for the first time demonstrating unequivocally that *E. woodi* had four cheek teeth. The enigmatic second myophiomyine is bunodont like *Elmerimys*. The single jaw contains an anterior tooth similar to *Elmerimys* p4 followed by a molar that narrows posteriorly, which is in turn followed by the roots of a diminutive last molar. We consider these loci as p4m1-2, which implies loss of m3. A single pedetid tooth from Kalodirr is generally consistent with *Rusingapedetes* from Rusinga. Several upper and lower teeth are assigned as cf. *Notocricetodon* sp. nov. While similar in morphology to *N. petteri* from Songhor, and *N. gommeryi* from Moroto, the new species is much smaller, and has a squared M2. One additional smaller muroid jaw fragment is present. The reduced longitudinal crest of its molars, lack of mesolophid, pairing of opposite cusps, short posterolophid on m2, and diminutive m3 suggest myocricetodontine gerbil affinity.

The rodent assemblage from the Lothidok Formation resembles other early Miocene sites at the familial and generic levels but is distinctive at the specific level. This follows the same pattern previously described for the primates, sengis and the Giraffoidea. While this could represent low level regional endemism, it is equally plausible that this regional distinction may have resulted from different local environmental conditions, temporal differences with other sites, or some combination of these factors.

Technical Session XVIII (Saturday, November 2, 2013, 3:45 PM)

MORPHOLOGICAL DISPARITY OF MESOZOIC MAMMALS THROUGH TIME

GROSSNICKLE, David, University of Chicago, Chicago, IL, United States, 60637; POLLY, P. David, Indiana University, Bloomington, IN, United States; LUO, Zhe-Xi, Univ of Chicago, Chicago, IL, United States

Mesozoic mammals never attained the extensive range of adaptations found in their Cenozoic relatives. However, early mammal taxonomic diversity and morphological disparity appears to have varied considerably over their 150 million year history. Here, we offer an analysis of morphological disparity with an additional focus on how the patterns relate to global ecological changes. A discrete character matrix was used to create a time-sliced principal coordinates analysis to assess changes in morphospace occupation through time. These data are combined with molar and lower jaw lengths, body size estimates, geometric morphometric measures of jaw shape disparity, and taxon-free diversity curves of dental functional types. Three major conclusions are reached: morphological disparity in mammals (1) gradually increased with time through the Jurassic and earliest Cretaceous; (2) "bottlenecked" during the mid-Cretaceous; and (3) partially rebounded during the late Late Cretaceous. These disparity patterns were compared to ecological and biogeographical changes during the Mesozoic Era. Most notably, we examine the diversity patterns of plants and insects and their possible correlations with mammalian changes. The Jurassic diversification of mammals corresponds temporally with increases in gymnosperm and fern diversity, radiations of several insect orders, and early rifting of Pangaea. The disparity bottleneck of the mid-Cretaceous corresponds to the taxonomic rise of angiosperms, high rates of environmental disturbances, taxonomic turnover of many tetrapod groups, and the increased diversity of theropod predators. The mammalian clades of the late Cretaceous demonstrate increased experimentation with arboreality and herbivory, possibly corresponding to increases in the ecological prominence of angiosperms. Causation of the mammalian changes in morphological disparity is speculative, but this study produces a framework for future analyses of mammalian disparity and the factors affecting that disparity.

Technical Session VI (Thursday, October 31, 2013, 8:30 AM)

NEW BATS (CHIROPTERA) FROM THE EARLIEST OLIGOCENE BOUTERSEM-TGV LOCALITY IN BELGIUM DOCUMENT THE EARLIEST OCCURRENCE OF *MYOTIS*

GUNNELL, Gregg, Duke University Lemur Center, Durham, NC, United States, 27705-5000; SMITH, Richard, Laekenveld 6, Wemmel, Belgium; SMITH, Thierry, Royal Belgian Institut of Natural Sciences, Brussels, Belgium

Early Oligocene mammals from Europe are not well known. In Belgium this interval (reference level MP 21) is represented by four coeval localities, Boutersem, Boutersem-TGV, Hoogbutsel and Hoeleden. Included in a vertebrate assemblage of 20+ mammalian genera, one bat, *Quinetia misonnei*, has been previously described from Hoogbutsel, based on four lower dentitions. Twenty new specimens of *Quinetia* were recently recovered from Boutersem-TGV including six upper molars, a humerus, and thirteen lower dentitions. These new specimens confirm that *Quinetia* is a plecotine vespertilionid and consequently represents the earliest known occurrence of this tribe. Additionally, twenty five other dental specimens document the presence of a larger vespertilionid from Boutersem-TGV. These specimens are assigned to *Myotis* based on the primitive 3.1.3.3 dental formula, the presence of a single-rooted p3, myotodont lower molars, a relatively high crowned lower canine with well-developed mesial and distolingual shelves, M1 and M2 lacking both paraconules and metalophs, protofossa of M1 and M2 open posteriorly, and M3 being relatively short. The Boutersem-TGV *Myotis* specimens represent the earliest known record of this extant genus. Only some isolated potential myotine teeth from Le Batut (MP 19) in France are older but these teeth differ from *Myotis* in having upper molars with a paraloph and a protofossa closed posteriorly, both features more typical of the enigmatic "*Leuconoe*". Myotodont species, such as "*L*". *salodorensis* from Oensingen (MP 25) in Switzerland and "*L*". *lavocati* from Le Garouillas (MP 25-28) in France, both share features of upper teeth that distinguish them from *Myotis*. Younger still are three *Myotis* species from Herrlingen 8-9 (MP 29) in Germany. Compared to the Boutersem-TGV *Myotis*, *M. minor* is much smaller with a relatively smaller, shorter and more delicate p4, *M. intermedius* is somewhat smaller in molar dimensions but with a substantially smaller and shorter p4, while *M. major* has larger m1-2, similar sized m3, smaller p4, more robust M1 and a more constricted P4 lingual shelf. The origin of *Myotis* appears to be at least as old as the earliest Oligocene.

Technical Session XV (Saturday, November 2, 2013, 12:00 PM)

FACIAL MORPHOLOGY PROXIES OF SKULL PATTERNS IN TOOTHED WHALES AND THEIR IMPLICATIONS FOR STUDYING SOUND GENERATION IN FOSSIL ODONTOCETI

GUTSTEIN, Carolina, Red Paleontológica U. Chile, Universidad de Chile, Santiago, Chile; PYENSON, Nicholas, Smithsonian Institution, Washington, DC, United States; FIGUEROA-BRAVO, Constanza, Red Paleontológica U. Chile, Universidad de Chile, Santiago, Chile; CANALS, Mauricio, Red Paleontológica U. Chile, Universidad de Chile, Santiago, Chile; COZZUOL, Mario, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Echolocation is a sophisticated biosonar system. Odontocetes generate and transmit high-frequency sounds from their foreheads using a complex system of muscles, air sacs, and fat bodies (i.e., melon). The process of sound generation is relatively well understood in exemplar odontocetes from experimental studies, but the morphological diversity of facial structures is poorly documented for several reasons: the anatomical geometry of these tissues is complex and overlapping; they decay rapidly after death and rarely preserve in the fossil record; and many extant lineages are poorly sampled because of their rarity. Here, we sought to quantify the relationship between soft facial tissues and the corresponding bony skull morphology in a diversity of odontocetes, especially rarely sampled South American taxa. Combining both computed tomography (CT) and dissections, we generated a morphological dataset of bony correlates for four delphinidan clades: Iniidae, Pontoporiidae, Delphinidae, and Phocoenidae. Recognizable bony markers were evaluated, analyzed, and rendered in OsiriX, and then quantified.

In all cases, the anterior extension of the melon corresponded to the anteriormost point of the anteromedial premaxillary sulcus. To define the coronal extension (i.e., width) of the melon on the skull, we used the width of the postorbital processes of the frontals. A correspondence of the vestibular sac with the skull was only determined in Inia, where the very enlarged sac system surrounds the knob-like vertex. We observed that the nasofrontal sacs are related to the external surfaces of the maxillae. Lastly, the premaxillary sacs are delimited by the premaxilla fossae, in Delphinoidea, or bosses, in Inioidea. These soft-bony tissue correlations provide a tool for delimiting and quantifying the sound generation apparatus in fossil odontocetes, and relating these features to its function. For example, the bony features in *Inia* that reflect its high vertex, elongate melon, and extensive vestibular air sac system can also be observed in extinct inioids, such as *Ischyrorhynchus* and *Meherrinia*. In turn, we can infer that these extinct inioids had the narrow-band echolocation beam structure observed today mostly in riverine species. These proxies for sound generation can be combined with inner ear proxy measurements for sound reception, which provide a fuller picture of the evolution of echolocation in Odontoceti.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DIVERSE STRATEGIES FOR IMPROVING CT SCANS OF VERTEBRATE FOSSILS

HABERSETZER, Joerg, Senckenberg Research Institute, Frankfurt, Germany; ENGELS, Sandra, Senckenberg Research Institute, Frankfurt, Germany; SMITH, Krister, Senckenberg Research Institute, Frankfurt am Main, Germany

A broad array of different computed tomography (CT) procedures has been developed since this technology was introduced in paleontology in the 1990s, e.g., different kinds of region-of-interest (ROI) algorithms. Many different methodological approaches exist, and it is not always clear to the occasional user what exactly are the advantages of each technique. The ideal case is a CT dataset representing a premium quality scan not only sufficient for immediate scientific application but also as a state-of-the-art collection object. Here we will point out advantages and shortcomings of particular micro-CT and nano-CT techniques and define quality standards. (1) Nano-CT technology: A very high resolution in the range of <1–2 µm can be achieved with the nano-CT technology, in the boundary region between conventional micro-CT and synchrotron-CT. Isolated petrosals of fossil bats like *Pseudorhinolophus* and *Archaeonycteris* from the Quercy fossil site are eminently suitable specimens for this method because their projected overall size fits exactly into this boundary region. For larger objects like cochleae within a skull this method is of no advantage. (2) Advanced surface modeling for micro-CT data: Here, we apply a method for enhancing the quality of surface models originating from the inevitably noisy and artifact-burdened CT data of the Messel primate *Darwinius masillae*. The unfavorably large size of the fossil plate greatly limits scan resolution, even though a special ROI micro-CT technique was used. We were able to generate high-quality, exportable, and accurate 3D surface models of the dentition, thus mitigating the problem to a considerable extent. (3) Extended-time micro-CT scans: Fossil plates produce a great amount of artefacts when the scan beam runs in near-parallel to the plate surface. A much better image quality can be obtained by increasing the dynamic range and the number of projections and by decreasing noise in the projection images before reconstruction. However, each of these actions will increase scan time by several fold. This procedure was chosen for the Messel fossil *Cryptolacerta* in order to tease out more anatomical detail than has heretofore been possible. Clearly there is not a simple formula for obtaining optimal CT-scans of every object on a single device. That is to say, no device can be simply adapted to any object. The three CT scanning strategies presented above represent entirely distinct approaches with three different CT devices to fulfilling our quality demands for different fossils.

Technical Session XIV (Saturday, November 2, 2013, 8:30 AM)

EVIDENCE AGAINST RUNNING TAKEOFF IN *ARCHAEOPTERYX*: BREAKING THE TERRESTRIAL VS. ARBOREAL DICHOTOMY

HABIB, Michael, University of Southern California, Los Angeles, CA, United States, 90033

Early birds, such as *Archaeopteryx*, have been previously modeled using an extended run from the ground to become airborne. Among living birds, however, a leaping takeoff is the most widespread form of launch, rather than running. I demonstrate that a running launch does not correlate with flight muscle size or total body size in modern birds. Prior suggestions that a low pectoral muscle fraction in *Archaeopteryx* (9-10% of total mass) would have precluded a leaping takeoff seem to be based on misconceptions regarding the dynamics of avian takeoff. Instead of being related to size or muscle fraction, running takeoff is a derived state utilized almost exclusively by semi-aquatic birds, probably as an adaptation to launch from compliant surfaces (i.e. water) and to accommodate hind limb constraints associated with swimming locomotion. Utilizing a combination of linear bone measurements and cross sectional properties, I find that the limb proportions in the Munich specimen of *Archaeopteryx* are more consistent with a leaping takeoff than a running takeoff (relative failure force [rff] for the femur of 13.17 body masses; RFF for the humerus of 4.15 body masses). Examination of the experimental literature demonstrates that there is relatively little difference between perch launching and ground launching in living taxa: both are initiated by leaping. I find that there are no measurable differences in overall limb mechanical properties between living arboreal and terrestrial birds, further suggesting that the differences between "ground-up" and "trees-down" flight origins have been exaggerated. These results also have implications for our understanding of other fossil species near the origin of birds. For example, the "hindwing" feathers present in some theropods have been implicated in arguments for arboreal habits on the basis that they might interfere with a running takeoff. However, it is likely that such hind limb feathers would provide relatively less interference for leaping, and any constraints placed on takeoff would affect both terrestrial and arboreal launch, since both are forms of a leaping takeoff.

Technical Session XIV (Saturday, November 2, 2013, 9:15 AM)

FUNCTIONAL SIGNIFICANCE OF FEATHER ASYMMETRY IN EXTANT AVIANS AND PREDICTED FLIGHT PERFORMANCE IN EXTINCT TAXA

HALL, Justin, University of Southern California, Los Angeles, CA, United States, 90089; HABIB, Michael, University of Southern California, Los Angeles, CA, United States

The presence of asymmetric feathers has been regularly used as an indicator of aerodynamic function and flight capacity in fossil birds and non-avian dinosaurs. However, most of the flight feathers in living flying birds are not highly asymmetric. Only the most lateral primaries, which are held perpendicular to airflow, show extreme asymmetry. Secondaries, which are held parallel to airflow and generate much of the lift to support body weight, are typically symmetrical. The effects of feather asymmetry are more complex than simple presence or absence metrics indicate. Complex twisting occurs in the lateral primaries of living birds, which delays stall and promotes dynamic maneuvers and rigorous flapping flight at low speeds. This effect will only tend to occur in feathers with vane depth ratios over 4:1 (with the lateral/anterior vane being the smaller of the two surfaces). Because the center of lift on a flat plate sits near 1/4 chord, feathers with vane depth ratios of 4:1 or less are loaded primarily in bending. Using an open source database of high resolution, sorted feather images from modern birds, we demonstrate that the feathers transition from torsion-dominated to bending-dominated morphology (i.e. 4:1 vane ratio) near primary position III to V, depending on the species. The degree of asymmetry is therefore related to specific position on the wing, just as predicted by fluid loading theory. These patterns can be applied to fossil taxa to draw more precise conclusions about wing, hindwing, and tail functions. *Microraptor gui* possessed asymmetric hindwing feathers, which has been previously used to support a transverse orientation for these feathers (in either a biplane or sprawling model). However, the hindwing feathers of *Microraptor* do not appear to be asymmetric enough to indicate an orientation of the long axis perpendicular to flow as in a lateral primary feather. Instead, their morphology is more consistent with the medial primaries of living birds, which are held oblique to flow and loaded mostly in bending. The feather asymmetry in *Microraptor* is therefore more consistent with vertical limb orientation models, and could easily be a result of developmental constraints.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A PHYLOGENETIC ANALYSIS OF PALAEOCENE MAMMALS: IMPLICATIONS FOR THE ORIGIN OF PLACENTAL MAMMAL ORDERS

HALLIDAY, Thomas, University College London, London, United Kingdom; UPCHURCH, Paul, University College London, London, United Kingdom; GOSWAMI, Anjali, University College London, London, United Kingdom

The Palaeocene is arguably the most important interval in mammalian evolution. Prior to the Cretaceous-Palaeogene (K-Pg) extinction, the mammal fauna is largely, though not exclusively, restricted to the scansorial or terrestrial insectivore niche; afterwards, there is a broad diversity of large herbivores, large carnivores, and later gliders, flyers and aquatic forms quickly evolved.

The majority of the taxa known from the Palaeocene, however, belong to 'wastebasket' taxa or clades of unknown affinity – these include cimolestids, pantodonts, and the "condylarths". Only Rodentia, Carnivora and possibly Primates have well-supported Palaeocene members. Clarifying the relationships of Palaeocene mammals is thus essential for any reliable macroevolutionary study into the early phases of placental mammal evolution.

Here we present the results of an extensive cladistic study of fossil mammals, focusing on Laurasiatheria and possible laurasiatheres, with 130 taxa coded for 681 dental, cranial and postcranial characters. Preliminary analyses in TNT resulted in 2448 trees of length 6474 steps when constraining Afrotheria as a monophyletic group. A strict consensus after pruning the seven least stable taxa yields highly resolved relationships for the enigmatic Palaeocene mammals, including the majority of the "condylarth" groups. Relationships between extant taxa are largely upheld, although miacid and viverravid carnivorans are not recovered as monophyletic, and Eulipotyphla is not recovered.

"Condylarths" are found to be polyphyletic, as expected, with apheliscids and pleuraspidotheres falling closest to Artiodactyla, and phenacodontids closest to Perissodactyla. Arctocyonids are reconstructed as a paraphyletic lineage leading to miacid carnivorans, while periptychids lie at the base of a clade containing the majority of the non-euungulate Laurasiatheria. Cimolestids lie on the eutherian stem and are separate from Pantodonta. One novel result is the placement of Leptictida as sister taxon to Afrotheria. With the exception of the leptictid *Gypsonictops*, all Cretaceous taxa are resolved as stem Eutheria, supporting a Palaeocene origin for the majority of placental orders.

There is much debate over the role of the K-Pg extinction in the origin of the placental mammal orders. This phylogenetic analysis will provide a useful basis for many future studies of major evolutionary patterns in early crown placental mammals.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

FIRST VIRTUAL ENDOCAST OF AN EOCENE NORTH AMERICAN ADAPIFORM PRIMATE

HARRINGTON, Arianna, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States, 32611; SILCOX, Mary, University of Toronto Scarborough, Toronto, ON, Canada; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

The first euprimates appear about 56 million years ago and are known almost exclusively from partial dentitions. Nevertheless, it is still widely assumed that they

shared a common ancestor with a relatively large brain compared to more primitive stem primates. Adapiformes is one of the first groups of euprimates to appear in the fossil record. While natural and latex endocasts of adapiforms have previously been described, we document the first virtual endocast extracted from a nearly complete and mostly undistorted skull of *Notharctus tenebrosus* (AMNH 127167), a notharctine adapiform from the middle Eocene Bridger Formation of Wyoming, using high-resolution X-ray computed tomography. The neuroanatomy of *N. tenebrosus* was typical for an adapiform with (1) small frontal lobes, (2) non-overlap of the cerebrum on the olfactory bulbs or cerebellum, and relative to plesiadapiforms (3) more globular temporal and occipital lobes with (4) a more ventral position of the rhinal fissure separating the neocortex from the paleocortex. However, unlike that documented for its close relative *Smilodectes gracilis*, the endocast of *N. tenebrosus* preserves a sylvian sulcus, a morphological feature present on the brain of all other known euprimates. This could reflect the higher resolution possible for a virtual endocast, which lacks some of the preservation problems associated with natural endocasts. The endocranial volume of AMNH 127167 is 7.38 mL, with an olfactory bulb volume of 0.16mL or about 2.11% of the total endocast volume. In comparison, the olfactory bulbs account for more than 5% of the volume in plesiadapiforms, supporting the inference that there was a relative reduction of this part of the brain in early primate evolution. The range of encephalization quotient estimates (calculated with a coefficient of 0.055 and an allometric exponent of 0.74) for AMNH 127167 (0.47-1.02) and other adapiforms (0.47-0.71) was found to overlap with that estimated for stem primates (plesiadapiforms; 0.32-0.72) and to be lower on average than that of omomyiforms (0.65-1.76), fossil anthropoids (0.90-1.33), and extant non-hominin primate taxa (0.86-3.98). The contrast with omomyiforms suggests that even in the earliest phases of euprimate evolution factors such as dietary preference, social system, and degree of development of the visual regions of the brain were contributing to variation amongst taxa. This contrast also implies that some of the relative brain enlargement characteristic of all living primates arose in parallel.

Symposium 2 (Thursday, October 31, 2013, 1:45 PM)

EX* RANCHO LA BREA" *SEMPER ALIQUID NOVUM

HARRIS, John, George C. Page Museum, Los Angeles, CA, United States, 91105; FARRELL, Aisling, George C. Page Museum, Los Angeles, CA, United States; TAKEUCHI, Gary, George C. Page Museum, Los Angeles, CA, United States; COX, Shelley, George C Page Museum, Los Angeles, CA, United States; HOWARD, Carrie, George C. Page Museum, Los Angeles, CA, United States

This year marks the centenary both of the Los Angeles County Museum and of its excavations at Rancho La Brea. The site became a State Historic Landmark in 1940 and a National Natural Landmark in 1963. The 1913-15 excavations recovered some 292 species of animals and plants that helped define the Rancholabrean NALMA. Pit 91, re-opened in 1969 but placed on hiatus in 2006, documented the sagebrush scrub, riparian woodland, and chaparral vegetation that prevailed locally during the late Pleistocene, provided a foundation for exploring the taphonomy of the asphaltic deposits, and added more than 300 species to the biota. The range of radiometric dates for most La Brea localities is consistent with episodic entrapment in seeps from intermittently active asphalt vents. Deposit geometry and paucity of associated skeletal material indicate post-mortem relocation of many of the accumulated fossils.

Serendipitous discoveries of a tabular deposit with partial skeletons during the construction of the Page Museum in 1975 and 16 asphaltic deposits during construction at the neighboring Museum of Art in 2006 (Project 23) have yet to be fully excavated but provide new insight into the origin and taphonomy of asphaltic fossil deposits while yielding insects, herps, and small mammal remains that enhance paleoenvironmental interpretation. The recovery of the entire asphaltic deposits of Project 23 facilitates three-dimensional reconstruction of the vents and seeps in which the fossils were preserved.

An asphaltic pipe, 1 m in diameter and 2 m deep, from Project 23 Box 1 yielded more than 12,000 fossils that were carefully plotted before extraction. These include associated elements of at least 17 felids, 12 canids and 8 ungulates. Small mammals (22%), reptiles (12%) and insects (10%) contribute a significant portion of the assemblage. One relatively complete feline skeleton was distributed throughout the deposit. Dates for this skeleton and other individuals document the degree of time averaging within this deposit. These dates and the orientation of the framework bones within this deposit provide the basis for testing alternative taphonomical hypotheses.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A MICROVERTEBRATE ASSEMBLAGE FROM THE UPPER TRIASSIC BLUE MESA MEMBER, PETRIFIED FOREST FORMATION (ADAMANIAN) OF THE BLUE HILLS IN EAST-CENTRAL ARIZONA

HARRISON, Alex, Appalachian State University, Boone, NC, United States, 28607; HECKERT, Andrew, Appalachian State Univ, Boone, NC, United States; KRZYZANOWSKI, Stan, New Mexico Museum of Natural History and Science, Albuquerque, NM, United States

Bulk screen washing of sediment from the Upper Triassic Blue Mesa Member of the Petrified Forest Formation in the Blue Hills of east-central Arizona has yielded a diverse microvertebrate assemblage, including the first occurrence of the rare chondrichthyan "*Xenacanthus*" *moorei* within the Blue Hills. The site (NMMNH L-4127) is stratigraphically approximately 4 meters above Charles Camp's macrovertebrate localities, and occurs within a horizon that is stratigraphically equivalent to at least one other microvertebrate site (NMMNH L-6818) within the Blue Mesa Member. Tetrapods from this assemblage, specifically the aetosaur *Stagonolepis* and the archosauriforms *Krzyzanowskisaurus hunti* and *Crosbysaurus harrisae* indicate an Adamanian age. Additionally, Ur-Pb radiometric dates obtained from detrital zircons at the base of the Blue Mesa Member indicate a maximum depositional age of 219.74 Ma (+1.68 Myr, -0.98 Myr), and therefore strengthen the biostratigraphic correlation to age-equivalent strata in the Petrified Forest National Park. Archosauriform reptiles dominate this assemblage; specifically phytosaurs and archosauriforms represented by isolated teeth consistent with morphotypes previously identified from other localities and designated morphotypes A-C, E, H-J, and M-N. We erect a new morphotype (U) to describe taller, strongly recurved and laterally compressed teeth that likely represent theropods, rauisuchian-grade archosaurs, or other indeterminate archosauriforms. Three teeth, including two "maxillary/dentary" and one "premaxillary" tooth, represent *Crosbysaurus harrisae*, and further validate designation of this species as an Adamanian index taxon. Aetosaur material is limited to isolated osteoderms assigned to *Desmatosuchus* (=*Acaenasuchus*). Additional osteoderms lacking external pitting likely pertain to sphenosuchians. Temnospondyls include metoposaurids, represented by a partial skull of a juvenile *Koskinonodon perfectum* (=*Buettneria perfecta*), as well as preserved centra, isolated labyrinthodont teeth, and several jaw fragments. Several isolated hybodont shark spines also represent chondrichthyans. Actinopterygian fossils consist of numerous scales and several isolated teeth, the former principally of paleoniscids, redfieldiids, and coelacanths, and the latter pertaining to indeterminate actinopterygians. Trace fossils are limited to coprolites, which are numerous and variable in size. All co-occur with some well-preserved calamite stems.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

BROKEN AND HEALED BACULA OF LA BREA: A WHOLE NEW DEFINITION OF TOUGH TIMES!

HARTSTONE-ROSE, Adam, University of South Carolina School of Medicine, Columbia, SC, United States, 29209; DONADEO, Brett, University of South Carolina, Columbia, SC, United States; BOYDE, Bryttin, University of South Carolina, Columbia, SC, United States; LONG, Ryan, George C. Page Museum, Los Angeles, CA, United States; FARRELL, Aisling, George C. Page Museum of La Brea Discoveries, Los Angeles, CA, United States

By almost every measure, the Rancho La Brea (RLB) collection at the George C. Page Museum represents the largest assemblage of carnivoran fossils in the world. This is certainly true of the bacula; the collection houses several hundred bacula specimens of *Canis dirus*, more than a dozen of *C. latrans*, several of mustelids, and a single of *Urocyon*. One specimen that was previously thought to be a baculum of *Smilodon fatalis* turns out to have been misidentified, and no bacula from any of the RLB bears has yet been recovered. In the current study, we compared these fossil bacula to those of modern analogues to examine variation between the fossil and modern populations. Width and height was measured at the proximal, distal and mid-shaft. Total length was also measured and a proxy for size of each specimen was calculated as an elliptical cylinder from this length and the two mid-shaft diameters. The *Mustela* and *Taxidea* specimens are both similar to their modern congeners, but the *Urocyon* specimen is significantly smaller than three modern specimens. The sample of 18 *C. latrans* fossils is relatively similar to the 21 modern conspecific sample from across their current geographic range – with broadly overlapping measures – though the mean of the fossil sample is larger than the modern sample for nine of the ten measures.

Of the large collection of *C. dirus* bacula, 159 are complete. They have been recovered from nearly all of the fossiliferous pits and thus span the entire time represented at the site. The *C. dirus* bacula are nearly an order of magnitude larger than those of *C. lupus* (N = 10) in terms of the volumetric proxy and the *C. dirus* mean total bacular length exceeds that in *C. lupus* by 41%. The *C. dirus* bacular width and height variables are even more dramatic in comparison, ranging from 146% to 231% the size of those of *C. lupus*. No statistically discernable size or shape pattern emerges when considering the chronological sequence of the specimens, but the sample is large enough to see ontogenetic differences within it. In this respect, though there are a few clearly juvenile bacula, the sample heavily skews to older, more robust, apparent age classes. Furthermore, there are eight *C. dirus* bacula that remain in the sample that are clearly broken and healed – possibly suggesting direct aggression during mating.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW ELASMOBRANCH ASSEMBLAGE FROM THE LATE MIOCENE OF AUSTRALIA SHEDS LIGHT ON THE EVOLUTION OF SHARK DIVERSITY IN THE SOUTHERN OCEAN

HASTIE, Darren, Deakin University, Burwood, Australia; FITZGERALD, Erich, Museum Victoria, Melbourne, Australia

The Late Miocene is considered to be an important stage in the timing and pattern of assembly of modern marine vertebrate diversity in the Southern Ocean. While elasmobranchs have been recorded from Late Miocene sites on the fringes of the Southern Ocean, they are underworked when compared to other marine vertebrates. Fossil elasmobranchs from the Late Miocene (7.2-8.0 Ma) Port Campbell Limestone of Portland, in Victoria, Australia, represent a previously undescribed fauna that comprise the most diverse assemblage to be recorded from the Late Miocene of the Southern Ocean. The assemblage comprises 16 genera: *Notorynchus*, *Squalus*, *Pristiophorus*, *Squatina*, *Heterodontus*, *Orectolobus*, *Carcharias*, *Odontaspis*, *Mitsukurina*, *Carcharodon* (2 spp), *Carcharocles*, *Isurus*, *Galeorhinus*, *Galeocerdo*, *Carcharhinus*, and *Sphyrna*. This includes the first Australian fossil records for *Squalus*, *Squatina* and *Galeocerdo contortus*. Seven taxa (*Notorynchus cepedianus*, *Carcharias taurus*, *Carcharodon carcharias*, *Isurus oxyrinchus*, *Galeorhinus* cf. *galeus*, *Carcharhinus* cf. *brachyurus*, and *Sphyrna zygaena*) are extant off southern Australia. Four extinct taxa are cosmopolitan species (*Carcharocles megalodon*, *Carcharodon hastalis*, *Isurus retroflexus*, and *Galeocerdo contortus*), along with a single extinct Australian endemic species (*Heterodontus cainozoicus*). Previous records of elasmobranchs from Late Miocene sites of the Southern Ocean have primarily consisted of larger specimens including *Carcharocles*, *Carcharodon*, *Lamna*, and *Carcharias*. The assemblage includes the oldest confirmed *Carcharodon carcharias* fossils recorded from Australia. These specimens exhibit coarse serrations typical of *C. carcharias* that are more pronounced than the recently described *Carcharodon hubbelli*. The presence of these specimens in

near contemporaneous deposits suggests that *C. carcharias* and *C. hubbelli* may have been sister species rather than chronospecies as discussed in previous literature. This material is amongst the earliest confirmed records of *C. carcharias* known worldwide.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW FOSSIL LUNGFISHES (DIPNOI, LEPIDOSIRENIDAE) FROM THE PALEOGENE OF NORTHERN SOUTH AMERICA AND NEW METHODS FOR TOOTHPLATE IDENTIFICATION

HASTINGS, Alexander, Georgia Southern University, Statesboro, GA, United States, 30458; BOURQUE, Jason, Florida Museum of Natural History, Gainesville, FL, United States; BLOCH, Jonathan, Univ of Florida, Gainesville, FL, United States; RINCON BURBANO, Aldo Fernando, Univ of Florida, GAINESVILLE, FL, United States; JARAMILLO, Carlos, Smithsonian Tropical Research Institute, Balboa-Ancon, Panama

South American lungfish (Lepidosirenidae) are known from a single extant species, *Lepidosiren paradoxa*, that lives in swamps and slow-moving waters primarily in subtropical climates of the Amazon, Paraguay, and lower Paraná River basins. While the fossil record of lepidosirenids documents a more widespread past distribution in Africa and South America, their history in the New World Tropics is largely unknown. Here we report new lungfish fossils from the Paleocene Cerrejón and Eocene Bogotá Formations in Colombia. Two relatively large (maximum jaw length: 73 mm) lungfish species (a lepidosirenid and a ceratodontid) were recovered from the middle Paleocene Cerrejón Formation of northeastern Colombia from the same localities that have yielded a diversity of reptiles including pleurodire turtles, dyrosaurid crocodyliforms, and the giant snake *Titanoboa*. The depositional environment of the Cerrejón Formation from where the fossils were recovered has been reconstructed as a freshwater portion of a deltaic coastal plain. Three additional lepidosirenid fossils of much smaller size (maximum jaw length: 22 mm) have been recovered from two levels in the early Eocene fluvial deposits of the Bogotá Formation in central Colombia. The shift from the Cerrejón to the Bogotá formations represents a transitional facies change from a low-energy, coastal plain to a higher-energy fluvial system, higher up within the drainage network. A younger Miocene lungfish discovered in the Acre state of Brazil, *Lepidosiren megalos*, is slightly larger than the Cerrejón forms (jaw length: 76 mm), when this area was a similar, low-energy freshwater environment.

The Paleogene fossils from Colombia have a snout shape (length: width ratio of the prearticular = 1.0-1.5) that is intermediate between that of extant *Lepidosiren* (> 1.5) and the extant African lungfish, *Protopterus* (< 1.0). In contrast, Miocene *L. megalos* has a snout shape (ratio of 1.47) closest to that of extant *Lepidosiren*. Based on this and other characters related to the angle at which the tooth ridges diverge, we have identified two new genera including three or four new species of fossil lungfishes from Colombia. Discovery of new fossils will help test correlation of body size with the evolution of Amazonia and tooth ridge evolution within Lepidosirenidae.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EVOLUTION OF THE PEDAL FUNCTION IN NON-AVIAN THEROPODS

HATTORI, Soki, University of Tokyo, Tokyo, Japan

Most theropods have four pedal digits, and their grasping function is relevant to arboreality and/or hunting ability. Although an opposable digit I (hallux) in birds clearly indicates their grasping ability, functional diversity of the pes in non-avian theropods possessing a non-reversed hallux has not been fully explored.

To clarify pedal functions in non-avian theropods, principal component analyses were conducted based on four datasets based on linear measurements on all non-ungual pedal phalanges of extant birds and several non-avian theropods.

In one of these analyses, functional categories observed in extant birds were successfully differentiated with plots of non-avian theropods lying close to plots of ground foraging birds.

Additionally, detailed morphological observations suggest that the axis of movement of the hallucal metatarso-phalangeal joint in non-avian theropods was more restricted to vertical motion than in extant ground-foraging birds. This might indicate the mechanical function of hallux, such as prey holding. In three specimens of *Velociraptor* (Dromaeosauridae), the attachment site of metatarsal (MT) I on MT II varied from the medial to the plantar sides, with the distal articular facet of MT I and associated phalanges correspondingly varying from lateral and posterior directions. A similar variation in the articulation of MT I was observed in several troodontid specimens. Moreover, the proximal articular facet of MT I in both dromaeosaurid and troodontid specimens was convex as in extant birds, rather than concave as in more basal non-avian theropods. These characters indicates that the mobility of the intermetatarsal joint between MT I and II was increased so that the range of hallucal movement was extended in Paraves, presumably leading to acquisition of the perching function in basal birds.

In conclusion, although non-ungual pedal phalanges of non-avian theropods in general show adaptation for ground foraging, the hallux of derived non-avian theropods shows development of the primitive grasping function, which would have presumably been exalted to subsequent acquisition of the arboreality in more derived theropods.

Symposium 2 (Thursday, October 31, 2013, 3:30 PM)

INSIGHTS FROM DENTAL MICROWEAR TEXTURE ANALYSIS INTO THE SURVIVAL OF COUGARS (*PUMA CONCOLOR*) THROUGH THE LATE PLEISTOCENE EXTINCTION

HAUPT, Ryan, University of Wyoming, Laramie, WY, United States, 82071-2000; DESANTIS, Larsia, Vanderbilt University, Nashville, TN, United States

Cougars (*Puma concolor*) are one of only two large cats in North America to have survived the Late Pleistocene Extinction (LPE). Currently, cougars maintain the largest latitudinal range of any extant terrestrial mammal in the Western Hemisphere, yet the keys to their relative success remain unknown. Here we compare dental microwear textures of cougars (n=12) and sympatric felids, *Smilodon fatalis* (n=15) and *Panthera atrox* (n=15), from the La Brea tar pits to clarify potential dietary factors that led to the cougar's survival. We further assess if the dental textures of their teeth have changed in response to different prey items between Pleistocene cougars and those residing in southern California today (n=17). Using dental microwear texture analysis (DMTA), which quantifies surface features in 3-D, we find that, consistent with modern cougars, La Brea cougars showed no significant differences in any DMTA attribute when compared to modern lions, suggesting moderate durophagy. However, Pleistocene cougars differ from their extant counterparts in southern California by having higher textural fill volume (*Tfv*, which correlates to abrasive particle size; p=0.034). In comparison to sympatric felids, Pleistocene cougars from La Brea have significantly greater *Asfc* and *Tfv* than *P. atrox* (p=0.011 and p=0.002, respectively), but do not differ significantly from *S. fatalis*. The lower complexity in *P. atrox* suggests that it might have been feeding on only the softest parts of prey item (e.g. viscera and/or muscle from megaherbivores that were also victims of the LPE), in contrast to cougars who may have eaten whole smaller, and potentially more abundant, prey. As there are only significant differences in *Tfv* between modern and Pleistocene cougars from southern California, their diets were likely similar through time and may have been a key to their survival through the LPE. However, greater *Tfv* values during the Pleistocene, suggests that La Brea cougars may have consumed slightly harder objects and/or more fully consumed prey than today, perhaps due to increased competition with larger carnivores. Ultimately the generalist diet of cougars may have been key to their survival through the LPE. Further, DMTA here sheds light on the survival potential of large cats through time, which has important implications for conservation of large carnivores in the face of habitat destruction and changing climates.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

RECONSTRUCTING QUATERNARY PALEOENVIRONMENTS IN THE GREAT PLAINS USING GEOGRAPHIC RANGES OF EXTANT SPECIES

HAVELES, Andrew, University of Minnesota, Minneapolis, MN, United States, 55455; FOX, David, Univ of Minnesota, Minneapolis, MN, United States

Geographic distributions of extant terrestrial mammals are determined in part by the climatic conditions tolerated by constituent populations, which is a measure of the ecological niche of the species. Assuming niche conservatism, past populations of a species should have had the same climate tolerances as extant populations, thus past biogeographic distributions for extant species might be used to estimate paleoclimate quantitatively. The Quaternary fossil record of small mammals in the Great Plains is a good test case for this approach as many extant species have multiple occurrences over the last million years. We have developed a GIS based method that uses modern species ranges and environmental parameters that relate quantitatively to extant species distributions in North America (e.g., mean annual temperature or MAT and mean annual precipitation or MAP). Geographic ranges for 92 extant species of rodents, lagomorphs, and soricomorphs were used to determine climatic conditions where species ranges overlap. Forty-two fossil collections in the Great Plains contain at least three of the 56 extant species in the region with fossil occurrences, potentially allowing us to constrain paleoclimate for those collections. We assessed reliability of this method by varying the number of extant species for a given location used to determine range overlap and the distribution of climate variables in the area of overlap, then compared estimated and known values. For locations spanning the region, we rarefied complete extant species lists to sample sizes of 20, 15, 10, 5, and 3 species and at each sample size estimated climate variables from range overlaps for 100 randomly sampled replicates, yielding 500 total replicates at each location. Accuracy of climate estimates increased with sample size up to 10 species, but more than 10 species did not improve accuracy substantially. On average, using 10 species underestimated modern MAT by 0.3°C and overestimated MAP by 142 mm. Fossil localities were binned into four time intervals: 1.0-0.75 Ma, 0.55-0.4 Ma, 0.3-0.2 Ma, and <0.068 Ma. Based on modern tolerances of co-occurring extant species, MAT increased from 9.5±3.1°C to 10±4.7°, cooled to 7.9±5.3°, and finally increased to 13.4±5.3°C, which is close to the MAT in western Kansas today. Estimated MAP increased from 506±122 mm to 703±251 mm, then decreased to 577±233 mm, and then increased to 735±383 mm, which is similar to eastern Kansas today. This method shows promise and fossil collections with at least 10 species should yield reliable climate estimates.

Technical Session V (Wednesday, October 30, 2013, 2:00 PM)

CRANIAL OSTEOLOGY, BODY SIZE, SYSTEMATICS, AND ECOLOGY OF THE GIANT PALEOCENE SNAKE *TITANOBOA CERREJONENSIS*

HEAD, Jason, University of Nebraska-Lincoln, Lincoln, NE, United States, 68588-0340; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; MORENO-BERNAL, Jorge, Univ of Nebraska Lincoln, Lincoln, NE, United States; RINCON BURBANO, Aldo Fernando, Florida Museum of Natural History, University of Florida, GAINESVILLE, FL, United States; BOURQUE, Jason, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

Titanoboa cerrejonensis from the Cerrejón Formation (middle to late Paleocene; 58-60 My) of Colombia, is the largest known snake. The taxon was originally diagnosed, assigned to the clade Boinae, and estimated to be approximately 12.8 m (±2.18 m) in total body length on the basis of precloacal vertebral morphology and size, but the absence of cranial remains prohibited a more precise size estimate and robust phylogenetic hypothesis. Recent fieldwork in the type locality has resulted in the recovery of several new specimens of *Titanoboa* including parts of the cranium and mandible (maxillae, palatine, pterygoid, quadrate, dentary, and compound elements) associated with partial

axial skeletons. We estimate skull length from cranial elements to be 40 cm, corresponding to a total body length of 14.3 m (±1.28 m) based on the scaling relationship of head length to body length in the extant boine *Eunectes*. Phylogenetic analyses of *Titanoboa* and extant macrostomatan snakes using cranial and postcranial osteology, and including analyses incorporating a molecular scaffold for extant taxa, supports boine affinities of *Titanoboa*, based on the extreme reduction of the palatine choanal and posteromedial processes as well as vertebral anatomy. Within Boinae, *Titanoboa* shares a close relationship with Pacific Island-Madagascan taxa. These results are the first historical evidence linking Neotropical and Old World boines, and constrain divergence timing of the clades to no younger than 58 My. Cranial elements of *Titanoboa* possess unique features relative to other boids, including high palatal and marginal tooth position counts, low-angled quadrate orientation, and reduced palatine-pterygoid and pterygoid-quadrate articulations. These characters, combined with weakly ankylosed teeth in *Titanoboa*, are characteristic of piscivorous feeding ecology in extant caenophidian snakes. Preservation in the large-scale fluvial depositional environments of the Cerrejón Formation, combined with the recovery of associated fossils of large dipnoan and osteoglossomorph fishes, also suggests a dominantly piscivorous feeding ecology for *Titanoboa*, which is unique among living and fossil boids.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EVALUATING DEFORMATION IN *SPHEROOLITHUS* DINOSAUR EGGS FROM ZHEJIANG, CHINA

HECK, Christian, Montana State University, Bozeman, MT, United States, 59715; WILSON, Hannah, Montana State University, Bozeman, MT, United States; VARRICCHIO, David, Montana State Univ, Bozeman, MT, United States; JACKSON, Frankie, Montana State UnivMuseum of the Rockies, Bozeman, MT, United States; JIN, Xinsheng, Zhejiang Museum of Natural History, Hangzhou, China

A lack of stratigraphic context for dinosaur eggs inhibits understanding of dinosaur reproductive biology and the taphonomic processes of egg preservation. Past taphonomic work suggests two features, compression ridges (sharp edge of broken eggshell around the egg circumference) and deformation asymmetry (proportion of crushed to rounded sides of the egg), as geopetal structures. We examined these features across a large sample of both isolated *Spheroolithus* eggs and *Spheroolithus* egg clusters housed in the Zhejiang Museum of Natural History from the Cretaceous of Zhejiang, China to test their utility. On 103 isolated eggs, we determined asymmetry ratios by dividing the crushed side egg height by the rounded side height. The strike and dip of compression ridges on eggs within egg clusters were measured for comparative use across egg clusters. An average asymmetry ratio of 0.71 was measured for the isolated eggs. Additional observations of in situ eggs demonstrate the stratigraphic-down side as more rounded and less fractured, the stratigraphic-up side as flatter with heavier fracturing, and compression ridges as parallel to original bedding plane. We propose fractures associated with the burial process on the upper side of the egg allowed sediment to partially fill the egg, subsequently supporting the bottom portion before the top of the egg collapsed. Examining compression ridges and deformation asymmetry within 16 egg clusters allowed differentiation of biotic versus taphonomically altered arrangements. Three common cluster arrangements were observed: planar (minimal egg overlap), offset (extreme overlap), and agglomerate (randomly arranged, closely packed). Qualitative observations of fracture levels, degree of deformation, and analysis of egg strike and dip across egg clusters reveals planar and offset arrangements as partial clutches, and agglomerate arrangements as the result of intense post burial displacement.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE POWER OF TOOTH MORPHOLOGY IN THE INTERPRETATION OF CERVID EVOLUTION (RUMINANTIA, ARTIODACTYLA, MAMMALIA)

HECKEBERG, Nicola, Ludwig-Maximilians-Universität Munich, Munich, Germany; ROESSNER, Gertrud, Bayerische Staatssammlung fur Palaontologie und Geologie, Munich, Germany; ASHER, Robert J., Department of Zoology, University of Cambridge, Cambridge, United Kingdom

Tooth morphology has been a strong and well-tried tool for identification, taxonomic classification and dietary indication in palaeontology. However, it has not been used for a comprehensive classification of extant cervids so far. Systematics in fossil cervids is primarily based on antler morphology and other cranial or postcranial features, whereas the same questions in extant cervids are primarily approached by analysing molecular data (DNA sequences).

In this study, a detailed comparative analysis of the occlusal surface of the upper and lower postcanine dentition of almost all extant and about 30 fossil species of cervids has been compiled for the first time. It allows for the identification of indicative characters for each genus, which can be used in approaches dealing with evolutionary history of cervids (e.g. phylogeny, palaeobiogeography, palaeoecology). The compiled overview of the diversity in tooth morphology ranging from the Miocene until today documents trends in character evolution for Cervidae in general and lower hierarchical taxa specifically. For example, the progressive molarisation of the p4 can be detected as a trend throughout the geological time scale, where all Miocene cervids show an unmolarised condition; development of the molarisation can already be observed in some Pliocene species. Among extant taxa, *Muntiacus*, for example, shows a rather unmolarised condition of the p4, whereas *Cervus* or *Dama* have strongly a molarised p4. A presumably even more specialised condition can be found in *Rangifer* and *Alces*, which transformed lingual and labial crown elements to diagonally oriented parallel crests on the p4. These results enable linking of fossil taxa with extant representatives and show the importance of tooth morphology in palaeontology and neontology to provide a more conclusive picture of cervid phylogeny and evolution.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE AETOSAUR (ARCHOSAURIA: SUCHIA) FAUNA OF THE UPPER TRIASSIC PEKIN FORMATION (NEWARK SUPERGROUP), DEEP RIVER BASIN, NORTH CAROLINA, USA, AND ITS IMPLICATIONS FOR THE PHYLOGENY AND BIOSTRATIGRAPHY OF AETOSAURS

HECKERT, Andrew, Appalachian State University, Boone, NC, United States, 28608-2067; SCHNEIDER, Vincent, North Carolina Museum of Natural Sciences, Raleigh, NC, United States; FRASER, Nicholas, National Museums Scotland, Edinburgh, United Kingdom; WEBB, Richard, North Carolina Museum of Natural Sciences, Raleigh, NC, United States

Aetosaur fossils, principally osteoderms, from the Upper Triassic Pekin Formation in the Deep River Basin of North Carolina represent at least three aetosaur genera: *Lucasuchus*, *Coahomasuchus*, and a new taxon based on an associated incomplete anterior carapace (North Carolina Museum of Natural Sciences specimen NCSM 21723). An important feature of the new taxon is an articulated fifth row of cervical osteoderms that almost encloses the neck, with prominent spines on both the dorsal and lateral osteoderms; a novel configuration among aetosaurs. Otherwise it preserves a mosaic of character states found in the desmatosuchine aetosaurs, while simultaneously preserving several more primitive character states, such as cervical osteoderms that are wider than long. A new specimen of *Coahomasuchus* (NCSM 23168) preserves more of the skull and dentition than does the holotype of *C. kahleorum*. Our reevaluation of other Pekin Formation specimens that various authors have assigned to *Desmatosuchus*, *Longosuchus*, or *Lucasuchus* confirms that some possess characteristics of *Lucasuchus*, whereas others are not generically determinate.

We updated existing phylogenetic hypotheses by incorporating changes dictated by recent taxonomic work on *Longosuchus* and *Lucasuchus* and updating character scorings based on NCSM 23168. These analyses, conducted using the software package TNT, resulted in a reshuffling of basal aetosaur relationships, including recovering the recently named taxon *Aetobarbakinoides* basal to *Revueltosaurus* and therefore outside of Aetosauria. We then added the new taxon represented by NCSM 21723 to the analyses, where it was consistently recovered as a basal desmatosuchine, but also collapsed typothoracines to a polytomy comprised of *Typothorax*, *Redondasuchus*, and Paratypothoracinae. This topology is conserved even when we removed *Aetobarbakinoides* from the analysis because it is necessarily ambiguous in its relationships to the many aetosaurs known solely from osteoderms, which have not been coded in *Aetobarbakinoides*. Support for many of the recovered relationships are low, and the topologies remain labile.

Previous authors have consistently assigned the Pekin Formation a Carnian age, even after the advent of the "long Norian," based on a variety of constraints, principally palynomorphs and cycle stratigraphy. The shared presence of the aetosaurs *Lucasuchus* and *Coahomasuchus* in the Pekin Formation and the Colorado City Formation of West Texas implies a similar, Carnian age, for the latter unit, including the type Otischalkian land-vertebrate faunachron.

Technical Session III (Wednesday, October 30, 2013, 3:30 PM)

LUJIATUN PSITTACOSAURIDS: UNDERSTANDING INDIVIDUAL AND TAPHONOMIC VARIATION USING 3D GEOMETRIC MORPHOMETRICS

HEDRICK, Brandon, University of Pennsylvania, Philadelphia, PA, United States, 19104-5269; DODSON, Peter, University of Pennsylvania, Philadelphia, PA, United States

Psittacosaurus is one of the most abundant and speciose genera in the Dinosauria, with fifteen named species. The genus is geographically and temporally widespread with large sample sizes of several of the nominal species allowing detailed analysis of intra- and interspecific variation. We present a reanalysis of three separate, coeval taxa within the Psittacosauridae, *P. lujiatunensis*, *P. major*, and *Hongshanosaurus houi* from the Lujiatun beds of the Yixian Formation, northeastern China, using three-dimensional geometric morphometrics on a sample set of thirty skulls in combination with a reevaluation of the proposed character states for each species. Using these complementary methods, we show that individual and taphonomic variation are the joint causes of a large range of variation among the skulls when they are plotted in a morphospace. Our results demonstrate that there is only one species of *Psittacosaurus* within the Lujiatun beds and that the three nominal species represent different taphomorphotypes of *P. lujiatunensis*. The wide range of geometric morphometric variation in a single species of *Psittacosaurus* implies that the range of variation found in other dinosaurian groups may also reflect taphonomic distortion rather than interspecific variation. As the morphospace is driven primarily by variation resulting from taphonomic distortion, this study demonstrates that the geometric morphometric approach must be used with great caution to delineate interspecific variation in *Psittacosaurus* and likely other dinosaur groups without a complementary evaluation of character states.

We have additionally added a number of other psittacosaur species as well as basal ceratopsian genera to the analysis in order to determine when interspecific and intergeneric variation dominates taphonomic variation. Certain retrodeformational techniques create a greater degree of bilateral symmetry of distorted objects, but fail to restore the original form. New retrodeformational methods are necessary before small-scale shape changes, such as those between species, can be delineated by 3D geometric morphometrics alone without character evaluation. This study presents the first application of 3D geometric morphometrics to a dinosaurian morphospace and the first attempt to quantify taphonomic variation in dinosaur skulls.

Technical Session XIV (Saturday, November 2, 2013, 8:45 AM)

WINGS VERSUS LEGS IN THE THEROPOD-AVIAN LINEAGE: MECHANISTIC UNDERPINNINGS OF VARIATION IN LOCOMOTOR STRATEGIES

HEERS, Ashley, University of Montana, Missoula, MT, United States, 59802; DIAL, Kenneth, University of Montana, Missoula, MT, United States

Among the 10 000 species of living birds and their extinct dinosaurian ancestors, relative musculoskeletal investment in wings versus legs is highly diverse, varying both across species and throughout ontogeny. Such variation likely has profound effects on locomotor performance and many related aspects of bird ecology, including habitat preferences, foraging strategies, migration patterns, and parental care. During aerial locomotion, high leg investment may hinder wing performance, since legs must be carried as baggage by the wings during flight. Likewise, high wing investment may hinder leg performance during terrestrial locomotion. Given these potential relationships between body modules, do tradeoffs between wings and legs influence locomotor ontogeny and evolution? To explore this question and better understand the ecological ramifications of how wings and legs function both independently and cooperatively during ontogeny and evolution, we used published and new data to compare wing and leg morphology and locomotor performance (i) across adult birds of different species and (ii) during ontogeny, in three precocial anseriform-galliform species with distinctly different sequences of locomotor development. Our findings suggest that birds with high wing investment may have reduced mass-specific leg performance and rely on wing-dominated locomotor behaviors, while birds with high leg investment may have reduced wing performance and rely on leg-dominated locomotor behaviors. For example, among adults, wing and leg investment are negatively correlated. Similarly, ontogenetic increases in wing investment and performance can compromise leg investment and performance, and vice versa. Collectively, these results provide new insight into the mechanistic underpinnings of variation in locomotor strategies among birds, and indicate that performance tradeoffs between different body modules may be important during ontogeny and evolution. Potential tradeoffs can be ameliorated by using wings and legs cooperatively, suggesting that wing-leg cooperation may have been particularly important during the origin and early evolution of flight.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

EVOLUTIONARY DYNAMICS OF THE LIMBS OF BIRDS AND THEROPOD DINOSAURS: TESTING THE INFLUENCE OF FUNCTIONAL CONSTRAINTS

HELLERT, Spencer, University of Illinois Urbana-Champaign, Urbana, IL, United States, 1821; MARCOT, Jonathan, Univ of Illinois, Urbana, IL, United States

*The origin of birds and associated transition to flight fundamentally changed fore- and hind limb function. As the forelimbs became dedicated to locomotion, the biomechanical requirements of powered flight likely placed substantially different selective regimes on the skeletal elements of the limbs. Specifically, it has been shown that the relative sizes of the humerus and ulna are closely related to flight style in various clades of birds. This pattern suggests a tight link between locomotor function and wing skeletal morphology, and potentially a constraint on the evolution of these elements. In contrast, non-avian theropods and flightless birds likely had more relaxed biomechanical constraints on these elements, and therefore the potential for greater evolutionary lability.

In this study, we tested whether the relationships among limb elements show different evolutionary dynamics in flying and flightless theropods (including birds). We used published databases of element lengths supplemented with measurements from the literature. We also constructed a composite phylogeny including theropods and both extant and extinct birds. Using these data and this tree, we statistically tested whether the rates and patterns of evolutionary correlation between the humerus and ulna differ between flying and flightless species. Specifically, we tested four models using a likelihood-ratio test and the Akaike information criterion (AIC): 1) flying and flightless theropods shared common rates and evolutionary correlations between the humerus and ulna, 2) different rates, but a shared correlation, 3) shared correlation, but different rates, and 4) different rates and patterns of correlation.

Results differed somewhat based on the particular phylogenetic tree used, but most replicate analyses suggest flying and flightless species share neither rates nor patterns of correlation between the humerus and ulna. Flightless theropods generally show a considerably higher rate of humerus than ulna evolution, whereas rates for these elements are generally similar in flying birds. Furthermore, flying birds show much higher evolutionary correlations between the two elements, consistent with a biomechanical constraint.

Symposium 3 (Friday, November 1, 2013, 8:45 AM)

40AR/39AR SANIDINE AND U-PB ZIRCON TESTS FOR A CARBONIFEROUS-AGE NATURAL GEOCHRONOLOGY STANDARD

HEMMING, Sidney, Columbia University, Palisades, NY, United States, 10964; FIRE CLAY GROUP, EARTHTIME, Columbia University, Palisades, NY, United States

Highly accurate ages are essential for understanding rates of evolution, long-distance correlations and cause and effect in major extinction events. A major issue facing the geochronology community is that biases between chronometers, and between laboratories using the same chronometer, have become significant as we interrogate the rock record at levels of precision that are achievable internally. Achieving the community goal of highly precise $^{40}Ar/^{39}Ar$ ages that can are consistent between labs and with U-Pb, depends on using well-characterized mineral standards of different ages so that "age appropriate" standards can be irradiated along with unknowns. We have used the Fire Clay tonstein, kaolinized volcanic ash from a Middle Pennsylvanian coal bed of the Hyden Formation in the Breathitt Group from the southern Appalachian Basin, to test for homogeneity at the single crystal scale for $^{40}Ar/^{39}Ar$ from sanidine and U-Pb from zircon separates. With careful selection of high aspect-ratio zircon crystals with axial melt inclusions the U-Pb lab at MIT has acquired a preliminary, highly precise U-Pb zircon result with no evidence of xenocrystic inheritance. At LDEO 223 individual crystals of Fire Clay sanidine and 125 individual crystals of Fish Canyon sanidine were measured in eight populations from three different irradiations, yielding RFC = 12.1196±0.0042 (1 sigma), where (based on the published definition) RFC is the $^{40}Ar^*/^{39}Ar$ of the sample divided by the $^{40}Ar^*/^{39}Ar$ of the Fish Canyon sanidine from the same irradiation ($^{40}Ar^*$ is the portion of ^{40}Ar that is radiogenic). Four other labs (Berkeley Geochronology Center, New Mexico Tech, Rutgers, and University of Wisconsin) reported 12.0481±0.0130 to 12.0919±0.0038 from one population measurement each. While promising, the 0.59% range of these results is significantly greater than the precisions would predict, and continues to point to the need for additional strategies for evaluation of age biases among labs where great precision and accuracy is needed. However, the results suggest the potential for providing a Paleozoic sanidine monitor for $^{40}Ar/^{39}Ar$ and a high quality zircon population to be distributed among U-Pb labs.

EARTHTIME Fire Clay Group= SA Bowring, MT Heizler, B Jicha, M Machlus, ET Rasbury, PR Renne, E Shea, BS Singer, CC Swisher III, BD Turrin

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

***HIPPOPOTAMUS* AT OLDUVAI GORGE INDICATES PERSISTENT WETLAND ENVIRONMENTS DURING A PERIOD OF INCREASING ARIDIFICATION IN EARLY HOMININ EVOLUTION**

HENSLEY-MARSCHAND, Blaire, Indiana University, Bloomington, IN, United States, 47401; NJAU, Jackson, Indiana University, Bloomington, IN, United States; VERMILLION, Wesley, Indiana University, Bloomington, IN, United States

Olduvai Gorge is a large paleoanthropological and paleontological site located in the East African Rift Valley of Tanzania. The gorge is nearly 30 km in length and exposes up to 90 vertical meters of Pleistocene sediments along its course. A recent excavation conducted by the Olduvai Landscape Paleoanthropology Project (OLAPP) uncovered a new paleoanthropological site that included the partial skeleton of a hippopotamus. The remains include both cranial and postcranial elements and represent a minimum of one individual; their large size and morphology indicate an affinity with the highly amphibious *Hippopotamus gorgops*. The fossil remains are located in Bed I within a lens of clay to volcaniclastic sandstone that lies directly above Tuff 1E and below the Ng'eju Tuff. New dates for these tuffs provide an age for this excavation of 1.81–1.83 million years old. The climate at Olduvai during this time was one of increasing aridification, causing a contraction of paleo-Lake Olduvai. This excavation, with such tightly constrained dates and strict stratigraphic control, provides critical paleoecological information regarding the extent of wetlands within the lake margin setting that was also utilized by multiple species of Pleistocene hominins at this time. These hippopotamus remains were found in association with a dense concentration of Oldowan stone tools, demonstrating the presence of hominin activities at this site and posing further questions about the evolution of the early land-use behavior of our ancestors.

Technical Session VI (Thursday, October 31, 2013, 11:30 AM)

EUROPEAN ARTIODACTYLS THROUGH THE EOCENE: UPDATED BIOSTRATIGRAPHY AND A TIMELINE OF FAUNAL TURNOVER

HIARD, Florent, University of Fribourg, Fribourg, Switzerland; MENNECART, Bastien, University of Fribourg, Fribourg, Switzerland

During the Eocene, two mammalian turnover events occurred in Europe, one extending from the middle Geiseltalian to the early Robiacian, the other from the late Robiacian to the early Headonian. The causes of these two events remain unclear. An updated biostratigraphy of terrestrial artiodactyls, based on literature sources and personal observations, allows better characterization of the evolutionary steps that occurred during these events.

Although the diversity of European terrestrial artiodactyls increased slowly from the Grauvian to the middle Geiseltalian, with the notable appearance of Dichobunidae and Choeropotamidae, a major diversification event occurred at MP13 (late Geiseltalian) with the simultaneous appearances of more than thirty species, mainly attributable to fifteen new genera and five new families, including the first four families of Selenodontia and Cebochoeridae. This sudden increase in diversity, even at higher taxonomic levels, suggests an important migratory event, probably from Asia. The end of this renewal event is marked by the appearance of Cainotheriidae during MP14 (early Robiacian) but the lack of a good phylogeny for Eocene artiodactyls prevents any conclusion about the origin of this family. A period of stability and slow increase of diversity occurred next during the second part of the Robiacian and the early Headonian. The first Anoplotheriinae appeared during this period whereas the diversity of Xiphodontidae and Amphymericidae increased notably towards the end. Starting at MP18, a significant decrease of diversity occurred at the specific level, with exception of Anoplotheriinae, which increased its diversity. The first Anthracotheriidae appeared in Europe at the same time. At the well-known *Grande Coupure* event, almost all Eocene genera disappeared and new migrants arrived, including the first Palaeochoeridae and the first ruminants.

The two main events at MP13 and MP18 do not seem to be correlated with the already known Eocene climatic events, such as the ETMs, the EECO, or the MECO, which occurred when the diversity of artiodactyls is relatively stable. However, the migratory event during MP13 is contemporaneous with an increase of the $\delta^{13}C$ curve and the succession of extinctions between MP18 and MP20 correlates with a cooling period that starts at the same time, just after a short warm period occurring in the earliest Headonian and just before the *Grande Coupure*. A better understanding of the palaeoecology of Anoplotheriidae may reveal why this is the only group to diversify during this period.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DECIPHERING THE LINKS BETWEEN LANDSCAPE CHANGE AND VERTEBRATE EVOLUTION USING U/PB GEOCHRONOLOGY AND DETRITAL THERMOCHRONOLOGY: A CASE STUDY FROM THE RUKWA RIFT BASIN

HILBERT-WOLF, Hannah, James Cook University, Townsville, Australia; ROBERTS, Eric, James Cook University, Townsville, Australia; BROWN, Roderick, University of Glasgow, Glasgow, United Kingdom; O'CONNOR, Patrick, University of Ohio, Athens, OH, United States; STEVENS, Nancy, Ohio Univ, Athens, OH, United States

Whereas vertebrate fossils contain information about the paleobiology and paleoecology of a fauna, the sediments that host these remains store equally robust information about the environment, physical landscape, and depositional processes at the time of burial. The appearance, dispersal and evolution of taxa are closely linked to large-scale environmental and climatic changes. Tectonic activity plays a major role in driving the timing and character of climatic changes, and directly influences the evolution of landscapes. We use an approach that integrates geochronologic, thermochronologic, and provenance-based methods to both date faunas and decipher the timing of critical landscape changes (e.g. uplift, erosion events, and drainage patterns) that are considered key drivers for environmental and evolutionary changes through time. We have dated a suite of 9 samples that span Cretaceous, Paleogene, and Neogene sedimentary sequences from the Rukwa Rift Basin, a key segment of the East African Rift. This work realizes the potential of rift deposits for paleontological, paleoenvironmental, and evolutionary reconstructions of sub-equatorial African ecosystems during critical time periods.

Our approach benefits from the preservation of volcanic ashes throughout portions of the stratigraphy that bracket key fossil localities and form a robust chronostratigraphic framework in which to place the detrital samples. These samples consist of detrital minerals from fluvial and lacustrine sediments sourced from the uplifted rift flanks, reflecting the internally draining nature of a rift basin. We take advantage of this depositional setting by integrating zircon and apatite provenance analyses. The triple dating of detrital apatite grains involves: (1) radiometric age dating using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS); (2) fission track analysis; and (3) (U-Th)/He thermochronology analysis. Dating detrital and tuffaceous zircon grains involves: (1) radiometric dating using LA-ICPMS; and (2) Lu-Hf isotope measurements. This comprehensive data set from the Rukwa Rift Basin establishes the age of key taxa, the timing of deposition and uplift (denudation), sediment sources, drainage patterns, and the time between sediment uplift and final deposition in the rift. This is the first study to apply all of these techniques in concert to understand the role of active tectonics in shaping dynamic landscapes that serve as key influences of vertebrate evolution in the East African Rift.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEW SPECIMEN OF *CUORA MIYATAI*, A PLEISTOCENE ASIAN BOX TURTLE FROM JAPAN

HIRAYAMA, Ren, Waseda Univ, Shinjuku-ku, Tokyo, Japan; KON, Hiroo, Honjo Archaeological Data Museum of Waseda University, Honjo, Japan; YOSHIDA, Masataka, Waseda Univ, Shinjuku-ku, Tokyo, Japan

Cuora, or the Asian box turtle, is the most diverse genus of geoemydid turtles. Nonetheless, its fossil record is rather poor and restricted to the Neogene of China, Japan and Thailand. *Cuora miyatai* is an extinct species from middle to late Pleistocene fissure deposits of limestone quarries in Japan. Although five specimens were previously known from Tochigi, Yamaguchi, and Oita Prefectures, its description was hitherto limited to the external shell morphology, such as the uniquely narrow anal scute.

A new specimen of *C. miyatai* was recently re-discovered in the archaeological collection of the Honjo Archaeological Data Museum of Waseda University. This specimen was collected by the late Professor Nobuo Naora of Waseda University in the 1950s from the limestone quarry of Kuzuu, Sano, Tochigi Prefecture. The specimen was removed from the calcareous matrix in which it was encased using formic acid, revealing a large part of the skull, most cervical vertebrae, the pectoral and pelvic girdles, and the dorsal surface of the plastron. The following features are considered to be the synapomorphies shared with the extant taxon *C. flavomarginata*: extremely small dorsal exposure of the parietal bones as a result of deep development of the upper temporal emargination, carapace decorated by distinct growth annuli, and a discontinuous dorsal keel formed by the neural plates. The morphology of the plastron and of the pelvic girdles suggests that *C. miyatai* had a well developed plastral hinge similar to that of *C. flavomarginata*. Otherwise, *C. miyatai* retains the laterally closed foramen palatinum posterius, a presumed primitive feature. This contrasts with *C. flavomarginata*, which has an open foramen. Thus, both taxa are hypothesized to form a sister group and to represent the most northern distribution of this genus. *Cuora miyatai* may have gone extinct during the glacial epoch of the late Pleistocene together with other geoemydids such as *Ocadia nipponica* and *Mauremys yabei* on the Japanese main islands.

Technical Session XVIII (Saturday, November 2, 2013, 3:00 PM)

FIRST ENDOCRANIAL RECONSTRUCTION OF A GONDWANATHERIAN MAMMAL

HOFFMANN, Simone, Stony Brook University, Stony Brook, NY, United States, 11794; O'CONNOR, Patrick, Ohio Univ, Athens, OH, United States; KRAUSE, David, Stony Brook Univ, Stony Brook, NY, United States

Endocranial morphology has been described for only a few Mesozoic mammaliaforms, including the basal members *Morganucodon* and *Hadrocodium*, several multituberculates, the stem therian *Vincelestes*, and various extinct crown therians. Here we present the first endocranial reconstruction of a gondwanatherian mammal based on a virtually complete and exceptionally well-preserved cranium recovered from the Upper Cretaceous Maevarano Formation of Madagascar. The enigmatic clade Gondwanatheria is known from the Cretaceous and Paleogene of Gondwana but was previously only represented by isolated teeth and fragmentary dentaries. The well-preserved cranium provides the first opportunity to digitally reconstruct the endocranium and endosseous labyrinth in a gondwanatherian mammal.

The gondwanatherian brain is characterized by a number of unique features, the most peculiar of which is its orientation within the cranium. Unlike that of other mammaliaforms, the brain is not positioned horizontally but instead is obliquely inclined within the cranium. The long axis of the brain deviates by 30° from the horizontal plane. This atypical orientation might be associated with the overall height (~ 68 mm) of the cranium itself, as it is the tallest known for any Mesozoic mammal. In general, the endocranium is relatively small and slender. Approximately 15% of the total endocranial volume is occupied by the greatly enlarged, oval olfactory bulbs. The exact extent of the olfactory cortex is uncertain in the Malagasy form, as the rhinal fissure is not visible. However, a bulbous structure on each side is tentatively identified as olfactory cortex, indicating a significantly larger size compared to the neocortex.

In addition to the endocranium, the pathways of most cranial nerves and the bony labyrinth are well preserved in the Malagasy specimen. The endosseous labyrinth displays a mix of plesiomorphic and derived features. A secondary crus commune and an elongate, gently curved cochlea represent primitive characteristics of the mammaliaform inner ear. By contrast, the semicircular canals are therian-like in being relatively large and slender.

Enhancement of the olfactory bulbs and cortex in the gondwanatherian brain is comparable to that in *Morganucodon* and *Hadrocodium*. This condition is representative of the first pulse of increasing brain size within basal mammaliforms. Further enlargement of the brain, driven by expansion of the neocortex relative to the paleocortex, is not yet developed in the Malagasy form.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

REEVALUATION OF HYPOTHESES OF PERISSODACTYL (MAMMALIA) ORIGINS AND THE PROBLEM OF "UNGULATE" PHYLOGENY

HOLBROOK, Luke, Rowan University, Glassboro, NJ, United States, 08028-1701

Hypotheses of the origin of perissodactyls have centered on several candidates for closest relatives of perissodactyls and several proposed geographic areas of origin. The most frequently proposed areas of origin are North America and Asia, based on the geography of the earliest fossils of perissodactyls and putative close relatives found on these continents. Advocates for a North American origin have typically favored the origin of perissodactyls being found among phenacodontids, although the discovery of the putative phenacodontid *Lophocion* made plausible an Asian origin for perissodactyls from phenacodontids. Other arguments for Asian origins of perissodactyls involve the Asian genus *Radinskya*, which was originally described as a possible phenacolophid with perissodactyl affinities. Previous phylogenetic studies of perissodactyls and other "ungulates" gave conflicting results, even when reanalyzed with additional information from *Radinskya*. A new combined phylogenetic analysis based largely on data from previous studies supports neither an Asian nor a North American origin for perissodactyls. This analysis also does not support a sister-taxon relationship between perissodactyls and phenacodontids, nor between perissodactyls and *Radinskya*, although *Radinskya* is consistently placed closer to perissodactyls than are phenacodontids. The position of *Lophocion* is highly volatile but never especially close to perissodactyls. Paenungulates are placed as sister-taxon to perissodactyls, a result that conflicts with the relative placement of perissodactyls, artiodactyls, and paenugulates in studies incorporating molecular data. Resolving these discrepancies, as well as resolving the issues of perissodactyl origins and the relationships of archaic "ungulates" in general, requires an expansion of the taxonomic scope typically used to analyze these questions.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PALEOECOLOGICAL AND TAPHONOMIC IMPLICATIONS OF INSECT-DAMAGED VERTEBRATE REMAINS FROM RANCHO LA BREA, SOUTHERN CALIFORNIA

HOLDEN, Anna, The Natural History Museum of Los Angeles County, Los Angeles, CA, United States, 90007; HARRIS, John, George C Page Museum, Los Angeles, CA, United States; TIMM, Robert, Kansas Unversity, Lawrence, KS, United States

Relatively few fossil mammal bones recovered from Rancho La Brea display insect trace damage but when present this provides useful paleoecological and taphonomic information. Thus far, insect damage has been mainly recognized on foot bones of large herbivores (bison, camel, and horse) despite careful search of the more numerous carnivoran and bird remains. This apparent bias may reflect differences in mammalian foot structure because the subcutaneous environments and skin thickness of large herbivores provide an optimal environment for insect pupation. We replicated the bone damage with laboratory experiments using dermestid and tenebrionid beetle larvae. Numerous specimens of both beetle families have been recovered from Rancho La Brea. Both consume bone and produce different characteristic feeding traces. Tenebrionids were not previously known to modify bone. The sequence of dermestid, tenebrionid, and other insect traces on mammalian foot elements from Rancho La Brea combined with the climate restrictions and life cycles of the trace-makers provide an estimate of the time that carcasses could remain unsubmerged in the asphalt (at least 17–20 weeks). Attribution of these traces also suggests that the fossils could only have accumulated in asphalt seeps during warmer intervals of the Late Pleistocene.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW SPECIMEN OF *ENCHODUS* (ACTINOPTERYGII: PROTACANTHOPTERYGII) FROM THE LATE CRETACEOUS OF EGYPT AND ITS CONTRIBUTION TO THE WESTERN TETHYAN DISTRIBUTION OF THE GENUS

HOLLOWAY, Waymon, Ohio University, Athens, OH, United States, 45701; CLAESON, Kerin, Philadelphia College of Osteopathic Medicine, Philadelphia, PA, United States; SERTICH, Joseph, Denver Museum of Nature and Science, Denver, CO, United States; SALLAM, Hesham, Mansoura University, Mansoura, Egypt; O'CONNOR, Patrick, Ohio University, Athens, OH, United States

The protacanthopterygian fish *Enchodus* was a widespread, speciose genus consisting of approximately 30 recognized species that were temporally distributed from the late Early Cretaceous to the Paleocene. Many *Enchodus* specimens are fragmentary cranial remains or isolated dental elements, as is the case for previously reported occurrences in Egypt. Here, we present the most complete, and first confirmed, specimen of *Enchodus* to be recovered from the Late Cretaceous of Egypt. The specimen was recovered from the upper Campanian Duwi Formation exposed near the village of Teneida (Dakhla Oasis, Western Desert, Egypt). The new specimen consists of right and left dentaries, a partial ectopterygoid, an articular, and various other cranial elements. The size of the specimen is well into the upper range for the genus (e.g., dentary = 26.36 cm). The palatine tooth, an element often useful for diagnosing *Enchodus* to the species level, is not preserved, but a combination of mandibular characters supports the referral of this specimen to *Enchodus*. The dentaries are complete, except for the posterior-most portion of each. They preserve a symphyseal surface with a slot-ridge assembly and exhibit a bumper-like ridge ventromedial to the entire double row of dentition, both of which are features typical for *Enchodus*. The outer row of dentition consists of a margin of small denticles (~ 2.2 mm in crown height). The inner row of massive, labiolingually compressed teeth exhibits varying crown heights, with the anterior-most tooth being the tallest (26.6 mm), and the next anterior-most tooth being the shortest (7.9 mm). These eleven preserved teeth are distributed across the dentary in a unique pattern (e.g., two doublets and a triplet clustered within the posterior one half of the element), relative to other species of *Enchodus*. This arrangement is symmetrical on both dentaries, indicating that the distribution is not random and may represent an autapomorphy of a new species. Additionally, the suite of characters exhibited by the elements preserved for this specimen (e.g., lack of superficial ornamentation, lack of a mental foramen, etc.) is inconsistent with that of any previously described species of *Enchodus*. Along with previously described materials from Israel, Jordan, Syria, Lebanon, Italy, Morocco, and Libya, this specimen adds a potential thirteenth species to the Northeastern Tethyan geographic distribution of *Enchodus* that ranges from the Cenomanian to the Danian in age.

Technical Session XI (Friday, November 1, 2013, 2:00 PM)

THE MYSTERY OF THE MISSING MARSUPIALS AND THE PROBLEM OF DETECTION BIAS

HOLROYD, Patricia, University of California, Berkeley, CA, United States, 94720; RANKIN, Brian, University of Calgary, Calgary, AB, Canada; FERRER, Elizabeth, University of California, Berkeley, CA, United States

Assumptions of accurate, or at least predictably biased, estimates of abundance underlie most of our work in the study of past diversity. Taphonomic biases have been comparatively well-studied. By contrast, taxonomic detection bias, i.e., the degree to which we can accurately recognize a taxon when it is present, has remained relatively unexplored. Taxonomic detection bias can result from incomplete anatomical knowledge or lack of diagnostic elements in an assemblage. We explored the effects of taxonomic detection bias using the well-characterized latest Cretaceous mammal fauna of the Lance Formation as a study system. Taphonomic biases are similar among taxa, and the assemblages are primarily composed of isolated teeth. Three morphologically distinctive clades (multituberculates, marsupials, and eutherians) and a minimum of 17 genera and 25 species are represented. Changes in the relative abundance of many of these taxa across the latest Cretaceous landscape have been attributed to faunal provinciality, and changes in rank abundance have commonly been related to regional climate change. The use of relative abundance data within these studies allows us to explicitly test the effects of taxonomic detection bias on the results.

To measure the magnitude and test the effects of taxonomic detection bias in Lance mammals, we determined taxon-specific detection probabilities at multiple taxonomic levels, developed a new method to correct for differential detection, and computed recalibrated specimen counts and minimum numbers of individuals, based on a sample of 3552 teeth. Using these recalibrated data, we assessed the effects of detection bias on measures of richness, relative abundance, and rank ordering. Almost all specimens are identifiable to a major clade, but more than half of all marsupial and fifteen percent of multituberculate specimens cannot be identified confidently to genus. Pediomyid marsupials are particularly difficult to identify and are dramatically underrepresented in counts. Measures of taxonomic richness are largely insensitive to this taxonomic bias; however, all measures of abundance are dramatically affected. Due to high detectability, eutherians are comparatively overrepresented, and marsupial and multituberculate abundance measures are depressed. Taxonomic detection bias results in extensive underreporting of specimen counts in assemblages and complicates interpretation of published data sets. These effects may be as great as or greater than those resulting from taphonomic bias.

Technical Session VI (Thursday, October 31, 2013, 9:15 AM)

NEW POSTCRANIALS OF THE EXTINCT FAMILY NYCTITHERIIDAE FROM THE LATE EOCENE: IMPLICATIONS FOR LIFESTYLE AND AFFINITIES

HOOKER, Jeremy, The Natural History Museum, London, United Kingdom

The family Nyctitheriidae has long been placed in Order Lipotyphla, close to shrews, based on dental characters. Isolated calcanea and astragali, discovered in the UK Late Eocene, however, have shown substantial differences from this order and suggested a scansorial lifestyle and a relationship instead to Euarchonta. Further collecting by screen washing of the same strata has now yielded nyctithere humeri, proximal radii, femora, distal tibiae, naviculars, cuboids, metapodials and phalanges. Identity with other contemporaneous similar sized mammals can be excluded by direct articulation with calcaneum and astragalus and by comparison with modern relatives. These new elements provide further support for scansoriality in nyctitheres. A nearly spherical humeral head projecting proximally of the greater tuberosity, a femur with a greater trochanter scarcely higher than the head and a medial lesser trochanter indicate mobile shoulders and hips consistent with climbing. A distally projecting subspherical humeral capitulum, well separated from a short convex trochlea, a shallow olecranon fossa and an ovoid radial head with a strongly convex ulnar articulation demonstrate pronation-supination but limited forearm extension at the elbow. Foot inversion was restricted to the astragalocalcaneal joint, with no calcaneocuboid rotation. Deep grooves posteriorly on the distal tibia indicate powerful flexor muscles, likely involved in foot inversion. Extension of the foot was restricted, but a distal anterior tibial tubercle stabilized the ankle when dorsiflexed. Nyctithere climbing appears to have been dominated by flexion of the forearms and feet, some supination and inversion, allowing head first descent, but not upside down hanging. Unlike nyctitheres, shrews have: radius with a strong capitular eminence and a flat ulnar facet; humerus with an anteroposteriorly elongate head, cylindrical capitulum, concave trochlea with sharp projecting medial ridge and no coronoid fossa; femur lacking trochanteric fossa; tibia without grooves for foot flexors, a short medial malleolus and no distal anterior tubercle; navicular with a prominent tuber tibialis and the ectocuneiform facet longer than the mesocuneiform facet; and cuboid with a weak plantar process. Although many nyctithere characters are primitive for placentals, extension of the medial trochlear ridge onto the astragalar neck and the distally projecting humeral capitulum suggest euarchontan affinities.

Technical Session II (Wednesday, October 30, 2013, 9:30 AM)

DIFFERENTIAL TIMING OF HYPSODONTY EVOLUTION IN LARGE AND SMALL MAMMALS INDICATES COMPLEX FORCING OF CROWN HEIGHT EVOLUTION

HOPKINS, Samantha, Univ of Oregon, Eugene, OR, United States, 97403

Hypsodonty has evolved repeatedly in the history of herbivorous mammals as an adaptation to tooth abrasion, although the primary driver of this dental attrition remains controversial. A number of recent studies have used the precise timing of hypsodonty evolution in different lineages or in communities as a whole to argue for particular drivers of hypsodonty evolution. The results of these studies have been transformative. In the past, it was assumed that hypsodonty was an adaptation to resist the abrasion from the silica content of grasses, but the pattern of hypsodonty evolution more closely tracks increases in exogenous grit than it does the ingestion of grass. A diet of grasses seems to precede hypsodonty evolution in some cases (e.g., squirrels, and perhaps horses), and to appear substantially after the evolution of high-crowned teeth in others (e.g., many South American ungulates). However, if it were only the presence of environmental grit that drove increasing crown height, one might expect to find entire communities evolving increased crown height simultaneously. This is not the case in general; acquisition of hypsodonty evolves in mosaic fashion through the mid-Cenozoic, appearing in different lineages over a period of roughly 30 million years in North America. An interesting aspect of this pattern is that, in many cases, hypsodonty seems to evolve much earlier in small herbivores than in large species. A better description of patterns of hypsodonty acquisition is needed to pinpoint the common processes driving the convergent evolution of high-crowned teeth in so many mammalian clades. New methods in phylogenetic comparative analysis enable us to examine the timing and rates of hypsodonty evolution in more detail. I use time-scaled phylogenies of several clades of fossil and extinct herbivorous mammals to determine the timing of onset and rates of hypsodonty acquisition in clades of large and small herbivores. I find that the onset of hypsodonty increase occurs substantially earlier in small mammals (more than 10 Ma earlier, on average), and often proceeds to a greater maximum hypsodonty, although evolutionary rates seem to be similar. This pattern suggests that the driver of hypsodonty evolution has a more severe effect on smaller herbivores, indicating that, if exogenous grit is the driver, the conditions that cause herbivores to ingest more grit seem to be ecologically selective. Hence, the acquisition of hypsodonty in mammalian herbivores seems to be a response to a combination of environmental forcing and the organisms' autecology.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

MAKING FOOTPRINTS WITHOUT LIMBS: SIMILARITIES BETWEEN TRACES LEFT BY LUNGFISH TERRESTRIAL LOCOMOTION AND PRIMITIVE TETRAPOD TRACKWAYS

HORNER, Angela, Brown University, Providence, RI, United States, 02912; FALKINGHAM, Peter L., , London, United Kingdom

Many primitive tetrapod tracks are comprised of little more than roughly circular impressions arranged in pairs around a midline. Details of the foot anatomy are obscured both by the soft tissue anatomy of the organism, and from the soft, water logged substrates the tracks are often formed (and subsequently preserved) in. Various aquatic limbless vertebrates also create trackways during brief forays onto land, but the details of

how and with what anatomical structures these trackways are formed have been largely ignored. The apparent sister taxon to tetrapods, lungfish (Dipnoi: Sarcopterygii) first appeared in the early Devonian, and were sympatric with early tetrapod faunas. Of the six extant species, terrestrial locomotion is prevalent in the African genus *Protopterus*.

In order to characterize non-limbed terrestrial trackways, we placed a 35 cm West African lungfish (*Protopterus annectens*) on a 1 m x 1 m tray filled with saturated ball clay to a depth of 2 cm, and encouraged the animal to move across the surface. Terrestrial locomotion of the lungfish involves planting the head and then pivoting the trunk about the anchored head. If the pivot begins on the left, the lungfish then plants the head on the right for the second 'head crutch' forward. In doing so, deep impressions are left where the head implants in the substrate, while the body and fins produce little in the way of observable traces.

The repeatable, left-right trajectory of terrestrial locomotion means that the lungfish leaves behind a series of alternating deep impressions about a mid-line. In cases where the head has not penetrated the substrate to a great extent, the head plant can appear as two separate, semi-circular impressions created by the upper jaw and depressed lower jaw.

Without knowing the track maker, it is easily conceivable that such marks could be interpreted as the trackways of small tetrapods, particularly if the head plant results in the mouth producing two impressions, impressions which bear a striking similarity to manus-pes pairs.

Symposium 1 (Wednesday, October 30, 2013, 8:30 AM)

ONTOGENETIC ASSESSMENT OF DINOSAURS USING CRANIAL AND POSTCRANIAL OSTEOHISTOLOGY

HORNER, John, Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States, 59717-2730; RIFE, Jill, nonaffiliated, Soldotna, AK, United States

The ontogenetic status of dinosaur specimens has been hypothesized using a variety of methods, in particular cranial and vertebral fusion, surface texture changes, and bone histology. Ontogenetic assessments are often made based solely on skeletal fusion and surface textures. However, studies of these methods have been extremely limited within **. In contrast, bone histology has been extensively studied and tested and is the only reliable method for determining ontogenetic status in dinosaurs. The osteohistologic ontogeny of long bones and cranial ornamental tissues are nearly identical, and both can be used to assess maturity. The general histologic progression found to characterize most dinosaurian taxa is as follows: 1) The cortex of embryonic long bones of dinosaurs are highly vascularized and composed of fibrolamellar tissues with some osteocyte organization around vascular spaces. 2) Post hatchling neonate bone is similar to that of the embryos, but with initial osteonal organization of fibrolamellar tissues around vascular spaces. 3) Juvenile bone is characterized by the presence of primary osteons at various levels of organization, occasionally some interior erosion rooms, and initial formation of a few secondary osteons. Lines of arrested growth (LAGs) can also exist, but are limited to one or two widely spaced lines. 4) Subadult bone is characterized by more extensive secondary reconstruction and many more LAGs. In most taxa the primary tissues are highly organized in plexiform or circumferential patterns, although some smaller taxa possess longitudinal canals throughout ontogeny. 5) Somatically mature dinosaurs possess an external fundamental system, and their cortices are often primarily composed of secondary osteons, most often as dense Haversian tissue. Sauropod dinosaurs are characterized as having this dense Haversian tissue from their late juvenile stages through somatic maturity. The primary difference between the osteohistology of cranial ornamental tissues and long bones is that the cranial structures do not generally possess LAGs, and do not acquire an external fundamental system. In addition, many taxa undergo some form of cranial resorption that alters the final architecture of the ornamented structures.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A NEW DATABASE OF DINOSAURIAN PALEOPATHOLOGY

HOWELL, Logan, Appalachian State University, Boone, NC, United States, 28608; HECKERT, Andrew, Appalachian State Univ, Boone, NC, United States

We have compiled a database of verifiable pathological non-avian dinosaur specimens as a first step to better evaluate the paleobiology of dinosaur disease and injury. To date there are approximately 130 documented (peer-reviewed) paleopathological dinosaur specimens in the fossil record, although the incidence of pathology is actually higher as some specimens in the database preserve multiple pathologies (e.g., Field Museum of Natural History specimen FMNH 2081 "Sue"). Each specimen is indexed by its museum catalog number, major clade (e.g., "Theropoda"), genus, species, provenance, pathologies present, and references to the relevant literature. Results obtained by comparing pathologic records by geologic time, body mass, and generalized ecology are particularly interesting. We sorted occurrences by geologic age (period and stage), the first such compilation of which we are aware. The time bins used include the Late Triassic (3 specimens), Early Jurassic (6), Middle Jurassic (5), Late Jurassic (29), Early Cretaceous (13), and Late Cretaceous (74). Although there are some similarities to others' estimates of dinosaur diversity, there is a significant departure in the Early Cretaceous, where paleopathologies appear to be under-reported relative to dinosaur occurrences. Normalizing these data will be difficult, but we suspect that this reflects both a research bias toward North American assemblages (e.g, Upper Jurassic Morrison Formation, numerous Upper Cretaceous dinosaur-bearing units) and the high incidence of pathologies in common Late Cretaceous dinosaurs, especially ceratopsians. The distribution of pathologies by body mass is also interesting: we grouped specimens based on estimated body mass categories of small (<100 kg), medium (100-1000 kg), large (1000-10 000 kg), and giant (10 000+ kg). The overwhelming majority of pathological records (107 of 130) occur in taxa of large or giant size. Pathological incidences are more common in herbivores than carnivores (88 of 130), but again, this will be difficult to normalize to overall specimen numbers. As seen in previous compilations, some taxa appear susceptible to diseases associated with longevity and/or great size (sauropods) and others appear to experience injury more frequently (ceratopsians, large theropods), generalizations complicated by the fact that many diseases, especially infectious diseases, may result from injuries that are not preserved. Future plans include expanding the database and normalizing the data to facilitate comparisons to the Paleobiology Database.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ASSESSING GENOMIC VARIATION IN PATAGONIAN SOCIAL TUCO-TUCOS (*CTENOMYS SOCIABILIS*) USING ANCIENT DNA

HSU, Jeremy, Stanford University, Stanford, CA, United States, 94305; LACEY, Eileen, University of California, Berkeley, Berkeley, CA, United States; HADLY, Elizabeth, Stanford University, Stanford, CA, United States

Genetic analyses of fossil material provide particularly direct insights into patterns of evolutionary change. In general, however, the amplification and sequencing of genetic information from fossilized bones has long proven difficult due to the low concentration of DNA and high levels of DNA degradation and fragmentation. As a result, such analyses have been limited until recently to short fragments of DNA sequences. Here, we describe the use of a new, high-throughput sequencing strategy to examine genetic polymorphisms in fossilized bones from the colonial tuco-tuco (*Ctenomys sociabilis*). This group-living, subterranean rodent is endemic to Neuquen Province in southern Argentina, and is currently characterized by extremely limited genetic variation throughout its geographic range. Analyses of short mitochondrial DNA fragments extracted from fossils dating back to 10,000 years before present suggest that this species underwent a significant historical reduction in genetic diversity some 3,000 to 5,000 bp, likely in response to a significant volcanic eruption in this region. To explore the effects of this apparent bottleneck in greater detail and to trace the changing evolutionary history from 10,000 bp, we performed double digest restriction-site associated DNA (RAD) sequencing, using an Illumina HiSeq platform, on ancient DNA extracted from two samples dating from approximately 7500 to 6000 bp. With this procedure, we were able to identify nearly 200 unique single nucleotide polymorphisms (SNPs) in these samples, providing the markers needed to characterize historical patterns of genetic variability in this species. Comparisons with modern DNA from *C. sociabilis* sequenced and analyzed with the same protocol allow unusually direct comparisons of population-level variability and genetic structure over time, including determination of the impacts of a significant 2011 volcanic eruption in this region. Thus, this rapid, cost-effective method for detecting genetic variability in ancient DNA samples promises to facilitate analyses of genomic variation over extended periods of time.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEW LARGE ENANTIORNITHINE BIRD FROM THE LOWER CRETACEOUS OF WESTERN LIAONING, CHINA

HU, Dongyu, Shenyang Normal University, Shenyang, China; LIU, Ying, Shenyang Normal University, Shenyang, China; LI, Jinhua, Shenyang Normal University, Shenyang, China; HOU, Lianhai, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China

In the last two decades, numerous enantiornithine fossils have been recovered from the Early Cretaceous Jehol Biota of western Liaoning, China, and these discoveries have greatly improved our understanding of the early evolution of the group. Here we describe a new enantiornithine bird based on a nearly complete, mostly articulated postcranial skeleton, Paleontological Museum of Liaoning (PMOL)-AB00032 from the Lower Cretaceous Jiufotang Formation (120 Ma) of Chaoyang City, western Liaoning, China. Although the only known specimen is probably a sub-adult individual, as indicated by the incomplete fusion of the semilunate carpal to the metacarpals, it is the second-largest known Early Cretaceous enantiornithine. The new bird resembles *Bohaiornis guoi* from the lower Yixian Formation in body size and length proportion of limb segments, but differs from the latter taxon and other known enantiornithines by the longitudinally grooved ventral surface of the synsacrum and the oval outline of the sternum with the xiphoid process distinctly wider than caudolateral processes, as well as a unique combination of following features: large size, forelimb and hind limb subequal in length, neural spines of thoracic vertebrae with craniocaudally strongly expanded tips, coracoid with straight lateral margin, clavicular rami medially curved, humeral head flat and alular digit extending almost as far distally as major metacarpal. A comparative analysis of some sacral features suggests that enantiornithines might have a uniquely shaped synsacrum, which is significantly different from those of more basal birds and ornithurines as well.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PALEOHISTOLOGY AND BIOGEOCHEMISTRY OF TRIASSIC TEMNOSPONDYLS FROM TANZANIA AND ZAMBIA: IMPLICATIONS FOR TAPHONOMY OF THE KAROO SYSTEM

HUERTAS, Sebastien , Universite Pierre et Marie Curie, Paris, France; STEYER, Jean Sebastien, Museum National d'Histoire Naturelle, Paris, France; SEGALEN, Loic, Universite Pierre et Marie Curie, Paris, France; SIDOR, Christian, Burke Museum, Seattle, WA, United States; ANGIELCZYK, Kenneth, Field Museum of Natural History, Chicago, IL, United States

Recent fieldwork in the Triassic Ntawere Formation of the Luangwa Basin in Zambia and Lifua Member of the Manda beds in the Ruhuhu Basin in Tanzania allowed for i) the discovery of endemic post-recovery terrestrial faunas including new synapsids,

archosauriforms, and temnospondyls, and ii) biostratigraphic correlations with coeval rocks from South Africa that indicate that the Ntawere Formation and Lifua Member are Anisian (early Middle Triassic) in age. To clarify the taphonomy of these Zambian and Tanzanian deposits, temnospondyl specimens were analyzed using paleohistology and biogeochemistry. The material, consisting of large undetermined mastodonsaurid mandibles, is of special interest: the bone microstructure preserved both vascular (Haversian canals) and cellular (osteocytes, caniculi) patterns, as well as muscular attachment zones (Sharpey's fibers) and lines of arrested growth. These structures indicate relatively high metabolic rates for these large (> 2 m) poikilothermous ectothermic amphibians. Biogeochemical analyses of major and trace elements (Ca/P, [F], [Sr], [Ba], [Fe], [Mn]) as well as scanning electron microscopy and optical cathodoluminescence observations on the same temnospondyl material show, however, that the mineralogical and chemical compositions of the bones underwent post-mortem alteration. The Haversian bone is filled by secondary crystallizations (Calcite, Fe-Mn-Ba oxyhydroxides), whereas the carbonate hydroxylapatite of the bones has altered to carbonate-fluorapatite. As a next step, similar analyses will be carried out on Late Permian fossils from the same basins to determine whether preservation processes varied over time. Analyses of stable isotopes (^{13}C and ^{18}O) of carbonates and phosphates also will be carried out to gain additional insight into diagenetic processes in both the Permian and Triassic.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PALEOFAUNA OF THE WILLIAMS FORK FORMATION (UPPER CRETACEOUS), NORTHWESTERN COLORADO: COASTAL DELTAIC DEPOSITS DOMINATED BY FRESHWATER TAXA

HUNT-FOSTER, ReBecca, Bureau of Land Management, Moab, UT, United States, 84532; FOSTER, John, Museum of Western Colorado, Grand Junction, CO, United States

The Williams Fork Formation is a late Campanian-early Maastrichtian unit of the Mesaverde Group, and this study focuses on the exposures found on Bureau of Land Management-administered lands in northwestern Colorado. The formation is comprised of thick sandstones, dark, often carbonaceous mudstones, and coals representing a coastal, prograding deltaic sequence bordering the Western Interior Seaway. Previously reported vertebrates in the Williams Fork Formation include mostly terrestrial taxa such as an indeterminate tyrannosaurid, an indeterminate hadrosaur, several other ornithischians (identified from teeth), and the ceratopsian *Pentaceratops*; at least four genera of small theropods have been identified by isolated teeth as well. In addition, at least 15 species of mammals have also been reported. Although a number of non-dinosaurian, non-mammalian taxa have been mentioned previously, none has received much attention in this important formation. A survey of more than a dozen localities in the upper Williams Fork Formation reveals a paleofauna that reflects the freshwater, channel and swamp setting of the formation in this area. The paleofauna includes: the ray *Myledaphus*, represented by teeth; the gar *Lepisosteus*, represented by scales, teeth, and a fin spine; the giant amioid *Melvius*, represented by at least one 6 cm-diameter vertebra, plus smaller individual amioids represented by teeth; the turtles *Adocus*, *Aspideretoides*, and indeterminate Macrobaenidae?, represented by shell elements; indeterminate Crocodylia represented by teeth, osteoderms, and a vertebra; indeterminate hadrosaurids represented by a femur, metatarsal, and phalanx (from different localities); an indeterminate ceratopsian, represented by a horn core fragment; and many indeterminate bone fragments. The biota sampled during this study also included plants, represented by petrified wood, leaf fragments, and amber, and mollusks, including bivalves and both lymnaeid and viviparid gastropods. The sample includes more than 290 specimens; of more than 170 identifiable specimens, 89.1% are freshwater aquatic or semi-aquatic species, and chondrichthyan and actinopterygian elements alone account for 47.4% of the sample. Turtles and crocodylians comprise 23.1% and 8.7% of the sample, respectively. These aquatic and semi-aquatic taxa thus likely dominate the Williams Fork Formation paleofauna overall.

Romer Prize Session (Thursday, October 31, 2013, 9:45 AM)

THE MEANING AND MECHANISM OF 'LILLIPUT' PATTERNS IN NONMAMMALIAN THERAPSIDS IN THE AFTERMATH OF THE END-PERMIAN EXTINCTION

HUTTENLOCKER, Adam K., University of Washington, Seattle, WA, United States, 98195-1800

Mass extinctions are often followed by body size reductions in survivor lineages, a pattern known as the 'Lilliput effect.' However, in the absence of adequate phylogenetic and life history data, the mechanisms of size reductions can be unclear and may differ across environments, taxonomic groups, and extinction events. Lilliput patterns have been identified in Triassic *Lystrosaurus* Assemblage Zone faunas following the end-Permian extinction in South Africa (ca. 252.3 Ma), but growth dynamics underlying these patterns are not fully understood. Therocephalians, for example, were a diverse clade of therapsids that thrived from the Middle Permian to Middle Triassic and important components of Triassic survivor and recovery faunas. To facilitate interpretations of the processes that underpinned Lilliput effects in this group, histological sections were prepared from 71 limb bones from 11 genera of Permian through Triassic therocephalians. Existing samples of other predatory therapsids (theriodonts) were examined to identify more general patterns in the therapsid forerunners of mammals. Histological indicators of growth, including cortical vascularity (%CV) and growth mark counts, were examined in multiple elements. When corrected for phylogeny, changes in %CV of propodials correlate strongly with evolutionary changes in body size (i.e., large-bodied lineages have higher %CV). However, patterns of variation in microvasculature differ across biological hierarchies and geologic time; although large theriodonts (e.g., *Cynognathus*, *Moschorhinus*, and *Theriognathus*) generally have higher vascularity than their smaller-bodied relatives, Early Triassic taxa may have equivalent or higher %CV compared to their Permian relatives, despite smaller body sizes. *Moschorhinus*, one of few therapsid genera to span the extinction boundary, demonstrates the highest %CV of any theriodont studied. Results support that Triassic Lilliput taxa grew at equivalent (or faster) rates compared to their Permian predecessors, but over a shorter growth period. These findings contrast with studies of marine invertebrates that demonstrate slowed growth in survivor taxa, casting doubt on a common cause of Lilliput effects at this time. Differences in marine and non-marine lineages highlight the need to unravel the phylogenetic and life history components of body size distributions, enhancing our ability to address causality during mass extinctions.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

CONVERGENCES AND TRENDS IN THE EVOLUTION OF THE ARCHOSAUR PELVIS

IIJIMA, Masaya, Hokkaido University, Sapporo, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan

Pelvic structure in non-avian archosaurs plays a key role in understanding the evolution of terrestrial/semi-aquatic locomotor patterns because the pelvis contains major attachment sites for proximal hind limb musculature. In order to investigate the patterns of pelvic evolution in archosaurs, this study compiles three variables for 91 archosaur taxa: relative anterior projection of the ilium, angle between the pubis and sacrum, and angle between the ischium and sacrum. Also, femoral head orientation, relative to the transverse axis of the femoral condyles, is categorized as a binary character (anteromedial or fully medial). Statistical analyses are performed to examine differences in variables between the femoral categories (non-parametric Wilcoxon test), correlations among the variables (principal component analysis), and evolutionary trends of the variables in a supertree (evolutionary model fitting). The Wilcoxon text shows that archosaurs with medially directed femoral heads have more cranially expanded ilia and more posteriorly rotated pubes than the taxa with anteromedially directed femoral heads. Principal component analysis demonstrates that the anterior projection of the ilium is related to the posterior rotation of the pubis. The pelvic structure of pterosaurs, ornithischians, sauropods, and avetheropods occupies a different morphospace from basal archosaurs, pseudosuchians, basal dinosauromorphs, basal theropods, and basal sauropodomorphs in having more cranially expanded ilia, more posteriorly rotated pubes, and medially deflected femoral heads. This implies that pterosaurs and those derived dinosaurs independently underwent similar shifts of thigh muscles and locomotion. Evolutionary model fitting shows that the anterior projection of ilium is driven by within-lineage trends for most of the archosaur subclades, suggesting a selective pressure on the iliac morphology. However, the pubic retroversion is not favored by a driven trend in many of the archosaur subclades including Theropoda, indicating an intricate process in the acquisition of a retroverted pubis leading to birds.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

SEDIMENTOLOGICAL ANALYSES OF EGGSHELL TRANSPORT AND DEPOSITION: IMPLICATIONS AND APPLICATION TO EGGSHELL TAPHONOMY

IMAI, TAKUYA, Montana State University, Bozeman, MT, United States, 59717-3480; VARRICCHIO, DAVID, Montana State Univ, Bozeman, MT, United States; CAHOON, JOEL, Montana State University, Bozeman, MT, United States; PLYMESSER, KATEY, Montana State University, Bozeman, MT, United States

Fossil eggshells often occur in floodplain and alluvial fan deposits. Failure to recognize transported eggshells within these environments may lead to erroneous interpretation of the reproductive behavior and ecology of parent animals. Available analytical techniques to assess eggshell transport have been limited to preferred eggshell orientation and abrasion. Here, a series of flume studies was undertaken with a variety of eggshell types and substrates to provide further analytical techniques that can be used to assess eggshell transport in fossil record. We tested the preferred orientation of eggshell after transport and also estimated the size of hydraulically equivalent clasts, i.e. grains expected to be observed within a matrix of transported eggshells. The samples included 24 eggshell fragments each of Emu, goose, and Ostrich (1 to 5 cm in diameter, and 0.1 to 1 cm in height). To simulate hydraulic transport of eggshells, a decelerating flow was established in a rectangular flume with a smooth polyvinyl-chloride substrate. In a single trial, six water-saturated eggshells of the same type were released, and five minutes after the release, orientation and position of the eggshells in a flume were recorded. Five trials were performed for each eggshell. This procedure was repeated with three additional immobile substrates (coarse sand, sparse gravel, dense gravel). Throughout, bed shear stress at the point of each eggshell deposition was estimated based on the flow depth at that spot. Using logistic regression models, the probability of concave-down orientation after deposition was estimated for each eggshell type transported on each substrate. The size of hydraulically equivalent clastic grains were estimated based on the bed shear stress of eggshell deposition, using equations derived from empirical studies of particle incipient motion under unidirectional hydraulic flows. The probability of concave-down orientation after transport was > 85 % regardless of eggshell types and substrates. Size of clastic grains expected to be present at eggshell deposition were estimated to range from coarse sand to larger, depending on substrates. Eggshell orientation can be a reliable indicator of hydraulic transport in the fossil record. Eggshells that are 1-5cm in diameter may be deposited on coarse sediment after transport, but unlikely with fine sediment such as mud. Further studies are necessary to test reliability of these techniques and to broaden their applicability to fossil eggshells of various size and shape.

Symposium 3 (Friday, November 1, 2013, 9:30 AM)

U-PB DATING OF REDEPOSITED VOLCANICS IN NON-MARINE SEDIMENTARY STRATA: CASE STUDIES FROM THE EARLY MESOZOIC

IRMIS, Randall, University of Utah, Salt Lake City, UT, United States, 84108-1214; MUNDIL, Roland, Berkeley Geochronology Center, Berkeley, CA, United States; MARSICANO, Claudia, Universidad de Buenos Aires, Buenos Aires, Argentina; MANCUSO, Adriana, Ianigla, CCT-CONICET, Mendoza, Argentina

Radioisotopic dating of vertebrate fossil assemblages typically relies on primary volcanic deposits interbedded with the fossiliferous strata, such as airfall tuffs and ashes. However, the nature of non-marine sedimentary systems means that these units are often altered or destroyed before they can be preserved by final burial. Therefore, finding suitable material to analyze can be difficult, particularly in settings with lower sedimentation rates. The recent application of CA-thermal ionization mass spectrometry (TIMS) analyses to individual detrital zircons from redeposited volcanics (e.g., fluvial sandstones containing volcanic detritus) has greatly improved our ability to provide absolute age constraints for vertebrate fossil assemblages in the form of maximum depositional ages. When multiple ages are consistent with stratigraphic superposition, and combined with other geochronologic data (e.g., biostratigraphy and magnetostratigraphy), they can precisely date evolutionary events that were previously poorly constrained by the lack of primary volcanic deposits.

We have recently successfully applied these methods to a variety of early Mesozoic non-marine records that preserve important records of vertebrate evolution. Samples from the Middle Triassic Chañares Formation of northwestern Argentina reveal that its assemblage of early dinosauromorphs and cynodont synapsids is likely to be no older than middle Ladinian, and therefore only a few million years older than the oldest dinosaurs. Our recent work in the Upper Triassic Chinle Formation of northern Arizona has demonstrated that the major biotic turnover in the middle of the unit is dated to the middle Norian, rather than Carnian-Norian boundary. Finally, new analyses from the La Quinta Formation of Venezuela demonstrate that a bonebed of a critical new taxon of early ornithischian dinosaur, which was previously dated to anywhere between the Late Triassic and middle Cretaceous, has a maximum depositional age of earliest Jurassic. These data collectively demonstrate that U-Pb zircon ages of redeposited volcanics from mixed sources can provide precise age constraints on the tempo of non-marine vertebrate evolution.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

REDISCOVERY OF THE HOLOTYPE OF *EDESTUS MINOR* AND A TAXONOMIC REASSESSMENT OF THE *EDESTUS MINOR* SPECIES GROUP

ITANO, Wayne, University of Colorado, Boulder, CO, United States, 80305

Species of the Carboniferous chondrichthyan genus *Edestus* have been described based on single tooth whorls or even single, isolated teeth, without knowledge of variation due to ontogeny or position (upper versus lower jaw). The *Edestus minor* species group comprises species having crowns with an apical angle of less than about 35 degrees and which lean anteriorly. In contrast, the crowns of *E. newtoni* point roughly perpendicular to the margin between the crown and base, while all other *Edestus* species have crowns with much greater apical angles. *E. minor* was described by Newberry on the basis of a single, isolated tooth. A tooth whorl (Beneski Museum of Natural History, Amherst College specimen ACM85) containing seven teeth was later referred to *E. minor* by Newberry, and he treated it as if it were the type specimen. However, the isolated tooth remains the holotype, since it is the sole specimen on which the original description was based. The distinction is not trivial, because the shape of the crown of the type of *E. minor* differs from the shapes of the crowns of ACM85. *E. mirus* was described as a new species based on differences from ACM85, although the crowns are essentially identical to the crown of the type of *E. minor*. Thus, *E. mirus* is almost certainly a junior synonym of *E. minor*, while ACM85 may require a new name. Recently, the type specimen of *E. minor* was located in the collections of the American Museum of Natural History, with catalog number FF477, apparently having been transferred from Columbia University at some time after Newberry's death in 1892. It was not listed in the card catalog as a type specimen, nor was it listed in Hussakof's 1908 catalog of type and figured specimens, which includes other specimens from Newberry's collection, such as the type specimen of *E. giganteus*, FF225. Examination of FF477 reveals some details which are not present in the published drawing, such as subdivided serrations, which were used to establish *E. triserratus* as a separate species. Thus, *E. triserratus* may be a junior synonym of *E. minor*. The crown shapes of the type and referred specimens of all members of the *Edestus minor* group, comprising *E. minor*, *E. minusculus*, *E. triserratus*, *E. pringlei*, *E. kolomnensis*, and the species represented by ACM85, show variations, but these variations are correlated with size, so that they could represent different ontogenetic stages. Thus, they all may belong to the same species, with the name *Edestus minor* having priority.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DESCRIPTION, CLASSIFICATION, AND PALEOECOLOGY OF THE OLIGOCENE SALAMANDERS OF OREGON.

JACISIN, John, University of Oregon, Eugene, OR, United States, 97405; HOPKINS, Samantha, Univ of Oregon, Eugene, OR, United States

The fossil record of North American salamanders is sparse, so their evolution, phylogenetic relationships, and times of origin are unclear. They are often only represented by isolated vertebrae or other fragmentary fossils, and are only rarely found as carbonized imprints or articulated skeletons. Several partial to nearly complete skeletons and multiple carbonized imprints from Oligocene localities in the John Day and Fisher Formations of Oregon represent post-metamorphic individuals for at least two genera and three species of salamanders. Morphological comparison with extinct and extant North American salamanders and body length measurements indicate numerous specimens of *Taricha oligocenica*, *Taricha lindoei*, one additional, more robust genus containing one or more species previously unseen in the Oregon fossil record. Subgenus *Palaeotaricha* is characterized by a narrow scapular portion of the scapulocoracoid and high to moderately high neural crests that are expanded dorsally and possess a dermal cap, while subgenus *Taricha* includes all living species and is characterized by a broad scapula and elongate vertebra with low neural crests and no dermal capping plates. The new specimens of *T. oligocenica* from these sites support *Paleotaricha* as a separate and valid subgenera within the *Taricha* genus based on differences in the scapulocoracoid, vertebrae, and skull. The new specimens of *T. lindoei* shares features of both extinct and extant subgenera, and may support this species as a transitional form between the subgenera. The increased resolution of the fossil salamander record in Oregon in volcanic-rich shales indicates a transitional open to closed forest affected by volcanic activity.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CT SCANING AND 3D IMAGE ANALYSIS OF THE POSTCRANIAL SKELETON OF *HENKELOTHERIUM GUIMAROTAE* (CLADOTHERIA, MAMMALIA) FROM THE LATE JURASSIC OF PORTUGAL AND ITS LOCOMOTOR ADAPTATIONS

JÄGER, Kai, Universität Bonn, Bonn, Germany; LUO, Zhe-Xi, Univ of Chicago, Chicago, IL, United States; MARTIN, Thomas, Universität Bonn, Bonn, Germany

The dryolestoid *Henkelotherium guimarotae* from the Late Jurassic of the Guimarota coal mine in Portugal is represented by a largely complete postcranial skeleton and fragmentary skull. Although the postcranium has been described earlier, several details could not be examined previously because they were hidden in the plastic matrix to which the skeleton was transferred during preparation. Here we used x-ray computed tomography (μCT) and virtual image rendering (Avizo) to further study the postcranium of *Henkelotherium*. Some previously inaccessible features of the articulated bones and unexposed bone elements are described. Contrary to earlier description, *Henkelotherium* shows a plesiomorphic condition like *Dryolestes leiriensis* in having individual radial and ulnar condyles on the anterior aspect of the distal humerus. Only an incipient trochlea is present on the posterior aspect of the humerus, with the ulnar condyle spiraling posteriorly to some extent. The scapula is also more plesiomorphic than previously assumed with a laterally flared rim on the posterior border of the scapula. In this regard it is similar to the scapula of such symmetrodontans as *Zhangheotherium* but more derived than symmetrodontans in having a larger supraspinous fossa. The previously unknown interclavicle and several unfused sternal elements have now been recognized through CT scans.

The ratio of the sum of the lengths of the proximal and intermediate phalanges divided by the metatarsal length of digit ray 3 of the completely preserved left foot is 153.8%. This exceeds ratios of extant primates as well as terrestrial Mesozoic mammals. The caudal vertebrae show a length/width ratio similar to those of extant arboreal mammals without grasping tails. Several additional characters of hind limb and pelvis (e.g., the absence of a parafibular process, a slender femur with a long neck, slightly asymetrical distal femoral condyles) suggest a more derived posture, closer to that of *Didelphis* than extant monotremes. Our new study has corroborated a previous hypothesis that *Henkelotherium* had an arboreal lifestyle.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE ELBOW JOINT OF THE MARSUPIAL LION, *THYLACOLEO CARNIFEX*: IMPLICATIONS FOR PREDATORY BEHAVIOR

JANIS, Christine, Brown University, Providence, RI, United States, 02906; FIGUEIRIDO, Borja, University of Malaga, Malaga, Spain

Thylacoleo carnifex, known from the Pleistocene of Australia, is the last (and the largest) of the lineage of thylacoleonids first known from the Miocene. In contrast to other carnivorous marsupials, thylacoleonids belong to the otherwise herbivorous order Diprotodontia (possums, koalas, wombats, and kangaroos), and there is speculation that some or all of them were at least partially arboreal. Craniodental studies confirm that *T. carnifex* had a highly carnivorous diet, but its predatory behavior has been a matter of speculation: it lacks the canines used for killing in other carnivores, and has the unique feature of a large, opposable thumb that bears a huge sheathed retractile claw. We used landmark-based methods of geometric morphometrics from the anterior surface of the humerus distal epiphysis (i.e., the elbow-joint) to explore its ability to rotate the arm and deploy this claw. Elbow-joint shape is a determinate of the ability to rotate the arm and hand, and is an established morphological indicator of locomotor/predatory behavior in mammals. We used a canonical variates analysis performed from the shape of this joint to discriminate between living arboreal and terrestrial mammals (129 specimens) including both marsupials and placentals. The discrimination between these groups was significant using the Mahalanobis distance (P-value <0.0001). Four specimens of *T. carnifex*, and one of the smaller Miocene *Wakaleo hilmeri*, were included as unknowns. The data show that *T. carnifex* had a unique elbow morphology (also seen in *Wakaleo*), which combines the ability for supination in arboreal forms with the ability to lock the arm in the prone position of terrestrial forms. The data do not support the hypothesis of arboreal adaptations: indeed the extant mammal that is most similar to thylacoleonids is the wombat, while the koala clusters with the placental arboreal forms. The ability to supinate the forelimb in *T. carnifex* may ultimately reflect an arboreal ancestry, but an ability to lock the arm in a prone position indicates a primarily terrestrial mode of life. We suggest that the pronounced ability for supination could reflect the use of the large claw on the thumb in a type of flick-knife fashion for killing prey. Other researchers have speculated on the use of the claw in predation, but none have noted this ability to supinate the forearm in a fashion unlike that of any other carnivorous mammal.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW BASAL DINOCEPHALIAN FROM THE MIDDLE PERMIAN MEZEN FAUNA (RUSSIA)

JANSEN, Maren, Museum für Naturkunde, Berlin, Germany; REISZ, Robert, Univ of Toronto at Mississauga, Mississauga, ON, Canada; KAMMERER, Christian, Museum für Naturkunde, Berlin, Germany; FRÖBISCH, Jörg, Museum für Naturkunde, Berlin, Germany

The transition from pelycosaur-grade synapsids to therapsids documents a major macroevolutionary transition with early therapsids providing important information on the evolutionary history of the mammalian body plan. Dinocephalians were an early therapsid group that occupied a wide range of ecological niches and dominated terrestrial ecosystems during the middle Permian. The Mezen fauna (Roadian/Wordian in age) of northern European Russia yields one of the most basal known therapsid faunas, including the enigmatic and poorly known genera *Alrausuchus*, *Niaftasuchus*, *Nikkasaurus*, and *Reiszia*. For the present study, we investigated a new skull, representing an additional basal therapsid from Mezen, via three-dimensional computed tomography (micro-CT) and a detailed retro-deformed reconstruction. Additional isolated cranial and postcranial material can also be assigned to the new taxon. The new taxon has a complex heterodont dentition, with intermeshing, heeled incisors, small precanines, a very small canine, and nine postcanines. Inclusion of the new taxon in a phylogenetic analysis of early therapsids recovers it as a basal dinocephalian, although its precise position is variable (as the most basal dinocephalian or the most basal member of either of the major dinocephalian subclades, Tapinocephalia and Anteosauria). This taxon exhibits a mosaic of tapinocephalian and anteosaur characters, including roughly denticulated, leaf-shaped postcanine teeth, a temporal fenestra that undercuts the orbit, and restriction of the palatine dentition to a small, reniform boss. Remarkably, this taxon bears a distinct prearietal bone at the anterior edge of the pineal foramen, a feature widely distributed in basal therapsids but previously unknown in dinocephalians. The new taxon provides novel insight into the early evolution of dinocephalians specifically and therapsids in general.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW CENOMANIAN-TURONIAN PONTOSAUR FROM CROATIA

JAPUNDZIC, Drazen, Croatian Natural History Museum, Zagreb, Croatia; CAMPBELL, Michelle, University of Alberta, Edmonton, AB, Canada; KRIZMANIC, Katerina, Croatian Natural History Museum, Zagreb, Croatia; CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada

The Upper Cretaceous platy limestones from the Dalmatian Coast of Croatia and the Komen Plateau of Eastern Italy and Slovenia have produced a large number of well-preserved fossil aquatic marine ophidiomorphs with distinctively long, cylindrical bodies and small reduced limbs. These include *Acetosaurus tommasinii, Adriosaurus suessi, Adriosaurus skrbinensis, Adriosaurus microbrachis, Mesoleptos zendrinii*, and *Pontosaurus lesinensis*. These same rock units have also produced well preserved pythonomorphs/basal mosasauroids including *Aigialosaurus dalmaticus, Aigialosaurus bucchichi, Komensaurus carrolli*, and *Carsosaurus marchesetti*. In the late 18th century, a fossil lizard was found in Upper Cenomanian platy limestones on Hvar Island, Croatia. It was in the possession of a local collector until 1982 when it was donated to the Croatian Natural History Museum in Zagreb, Croatia. The 357 mm long fossil is well preserved and articulated, missing only the tip of the skull and the greater part of the tail. The remnants of the elongate skull are pontosaur-like in general appearance; the appendicular skeleton displays a reduction of the long bones, flatter joints, and a broadening of the manus and pes. The specimen is placed into the family Dolichosauridae based on the long, slender neck, the elongate and cylindrical body, the robust, semi-circularly curved ribs and the long, flat tail. Furthermore, the weakly attached appendages indicate that this animal was adapted for axial swimming. The vertebral number (9 cervical, 30 dorsal, 2 sacral), topological relations of the cranial elements, reduced pelvic and pectoral girdle, forelimbs that are significantly shorter than the hind limbs, and absence of hyperphalangy, indicate that the correct alpha taxic placement of this animal is within the genus *Pontosaurus*.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE UTILITY OF SOFT-TISSUE CHARACTERS IN UNDERSTANDING THE PHYLOGENETIC RELATIONSHIPS OF FOSSIL TAXA: EVIDENCE FROM THE EVOLUTION OF THE TURTLE FAMILY EMYDIDAE

JASINSKI, Steven, State Museum of Pennsylvania, Harrisburg, PA, United States, 17120

Fossil taxa commonly leave us with only osteological remains, while soft tissue is almost never recovered, particularly from pre-Pleistocene specimens. Many fossil taxa, however, are closely related to modern taxa, particularly those recovered from younger Cenozoic and Neogene strata. When reconstructing the phylogenetic relationships of modern taxa and in particular when using morphological data, soft-tissue characters are often vital. Many subspecies, and even some species and genera, are distinguished most easily, and sometimes entirely, using soft-tissue characters. While soft-tissue characters can sometimes be inferred from the osteology of an animal, like the scute patterns of turtles, this is not always the case, especially for things such as colors and color patterns. Evolutionarily important characters often evolve more quickly in soft-tissue characters and may appear earlier than osteological characters in the evolution of a taxon. Utilizing soft-tissue characters to better understand the relationships of modern taxa can translate to their fossil relatives. This is evident when investigating the relationships of the modern turtle family Emydidae (box turtles, painted turtles, and slider turtles). Phylogenetic analyses run with and without soft-tissue characters provide different phylogenetic trees. While some currently recognized modern genera were recovered in analyses run without soft-tissue characters, several, including *Graptemys* and *Trachemys*, were commonly not. Previous studies that have investigated all modern genera within Emydidae have routinely not recovered all genera as monophyletic clades. However, analyses run with soft-tissue characters provide monophyletic clades of all modern recognized genera, and allow fossil taxa to be placed within this phylogenetic framework. It is found that few fossil taxa belong to modern genera, and there are less fossil representatives of the modern emydid turtle fauna than previously believed. The utility of soft-tissue characters is inferred to be strong in investigating the evolution of modern animal groups.

Technical Session VII (Thursday, October 31, 2013, 2:30 PM)

BIG-BRAINED DINOSAURS AND THEIR BODIES

JERISON, Harry, UCLA, Los Angeles, CA, United States, 90402

The endocasts of two ostrich-like dinosaurs are frequently treated as within the range of living birds in brain size. I present a detailed analysis of laser scans of these endocasts, including data on body size to judge their encephalization. The two endocasts, *Troodon* and *Dromeceiomimus*, are only of the dorsal surface. Surface area of visible forebrain can be compared with that of living birds. The dorsal forebrain of *Troodon* measured 17 cm^2, that of *Dromeceiomimus* 23 cm^2. Reported body size for *Troodon* is 45 kg. Lacking estimates for the second species, I worked with a laser scan of an accurate model of *Gallimimus* of similar shape, and estimate *Dromeceiomimus* body size as 325 kg, larger than some word-of-mouth guesses but a computer-based estimate for a body length of 3.66 m. These compare with endocast volumes of 27 mL in albatross and 31 mL in Ostrich, which weigh about 10 kg and 100 kg respectively. The "big-brained" Ostrich-like dinosaurs were measurably among the bigger-brained nonavian dinosaurs but, unlike *Archaeopteryx*, were at least slightly below the range of brain sizes of living birds.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW SPECIMEN OF *NOTHOSAURUS YOUNGI* FROM THE MIDDLE TRIASSIC OF SOUTH CHINA BLURRING THE DISTINCTION BETWEEN *NOTHOSAURUS* AND *LARIOSAURUS*

JI, Cheng, Peking Univ, Beijing, China; JIANG, Da-yong, Peking Univ, Beijing, China; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States; MOTANI, Ryosuke, Univ of California - Davis, Davis, CA, United States; TINTORI, Andrea, University of Milano, Milano, Italy

Nothosaurus and *Lariosaurus* are sister taxa in the Triassic stem sauropterygian group, and were believed to be distinguished by the following characters based on European (Anisian–Ladinian) and Chinese (Anisian) material: the ratio between the longitudinal diameter of the upper temporal fenestra and the orbit, the sacral vertebral count, the morphology of humerus and ulna, the number of carpal ossifications, and the phalangeal formula. However, thanks to new material from the Xingyi Fauna (Guizhou, South China) collected during the last decade, the differences between *Nothosaurus* and *Lariosaurus* now appear blurred.

During excavations in 2012, we collected a well-preserved skeleton of *Nothosaurus youngi* and one of *Lariosaurus xingyiensis* from a single bed within the Zhuganpo Member of Falang Formation (latest Ladinian, Middle Triassic) of Xingyi. These coeval specimens suggest that the traditional diagnoses may no longer be applicable to the two genera, while allowing substantial additions to the knowledge of the postcranial osteology of *N. youngi*.

The new material shares two diagnostic characters of the skull with the holotype: the presence of a jugal and the parietal foramen located in a trough on the parietal. Furthermore, it shares many characters with *Lariosaurus* which have never before been observed in *Nothosaurus*: the longitudinal diameter of the upper temporal fossa divided by that of the orbit yielding a ratio of 1.93, in the range of Lariosaurus (usually less than 2.0), the presence of five ossified carpals, forelimb hyperphalangy in digits I and III indicated by the phalangeal formula 3-3-5-5-4, and four sacral ribs. The humerus is weakly angled preaxially and the medial constriction is not remarkable, revealing the morphology of the humerus to be closer to the *Lariosaurus* than to the *Nothosaurus* condition.

Many of the above characters are reported for the first time in *Nothosaurus*, blurring the distinction between the two genera. This probably results from our the incomplete nature of previously known materials; *Nothosaurus* is mainly known from cranial remains while for *Lariosaurus* is better known from postcranial skeletons. Another possible interpretation is that the latest Ladinian *Nothosaurus* convergently evolved morphologies similar to *Lariosaurus*, both genera being very close to extinction. This could lead to a global reconsideration of nothosaurid systematics following reexamination of all the species within the two genera.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

EFFECT OF NEW RECORDS OF EARLY AND MIDDLE TRIASSIC EOSAUROPTERYGIANS FROM SOUTH CHINA ON RECONSTRUCITON OF SAUROPTERYGIAN TREE TOPOLOGY

JIANG, Da-yong, Peking University, Beijing, China; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States; MOTANI, Ryosuke, Univ of California - Davis, Davis, CA, United States; TINTORI, Andrea, Università degli Studi di Milano, Milano, Italy; JI, Cheng, Peking University, Beijing, China

*Recently, several cladistic analyses on the interrelationship of Sauropterygia were conducted, as the new Middle Triassic fossils from south China were described one by one. The results disagreed with each other in some major aspects of tree topology, even though all of them ultimately originated from a single data matrix by Rieppel in 2002. We added two new species from south China, including the stratigraphically oldest form, to the analysis in an attempt to resolve the confusion.

The two new Triassic eosauropterygians that we added benefit from very precise information on stratigraphy and locality because we collected these specimens through targeted excavations. The older of the two is from the Lower Triassic (Spathian, Olenekian) in Chaohu, Anhui, SE China, and has a pachypleurosaur-like postcranial skeleton. The younger taxon is represented by a complete skeleton from the Middle Triassic (Ladinian) in Xingyi, Guizhou, SW China, exhibiting a mosaic of pistosaur- and nothosaur-like features. Our analysis included in total 37 taxa and 137 characters, and shows that the new Early Triassic Chaohu eosauropterygian is the most basal member of Eosauropterygia, placed as the sister taxon to the clade ((*Wumengosaurus*, European pachypleurosaurs) ((*Dianopachysaurus, Keichousaurus*) (*Hanosaurus* (eusauropterygians)))), showing close affinity to taxa traditionally called pachypleurosaurs. A monophyletic Pachypleurosauria is not recovered, but the positions of the pachypleurosaur-like forms on the tree topology match the sequence of their stratigraphic occurrence very well, indicating that this new phylogenetic structure is congruent with stratigraphy.

The new Middle Triassic Xingyi pistosaur-like eusauropterygian was placed as sister taxon to the clade (*Yunguisaurus* (Pistosauridae, Plesiosauria)). The monophyly of Pistosauridae and Cymatosauridae are strongly supported again, but the monophyletic Pistosauroidea is not recovered. These results differ from the most recent result published to test the phylogenetic position of the eosauropterygian *Qianxisaurus*.

The positions of these two new eosauropterygians are fairly stable, but the resolution of the analysis is low, which is probably because the new Early Triassic Chaohu eosauropterygian could be coded only for 38.7% of the characters, and some newly named taxa from southwestern China need to be reinvestigated. Our results greatly advance our understanding of sauropterygian phylogeny but more work is required to fully resolve sauropterygian interrelationships.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

TYLOSAURUS KANSASENSIS, _T. PRORIGER_, AND _T. NEPAEOLICUS_: CAN THEY BE DIFFERENTIALLY DIAGNOSED?

JIMENEZ-HUIDOBRO, Paulina, University of Alberta, Edmonton, AB, Canada, T6G 2E9; CALDWELL, Michael W, University of Alberta, Edmonton, AB, Canada

The first described tylosaurine mosasaur, *Tylosaurus proriger*, was described from a partial snout and thirteen associated vertebrae (Harvard University Museum of Comparative Zoology specimen MCZ 4374) near Monument Rocks, Gove County, Kansas, (upper Smoky Hill Chalk; upper Campanian); the current species range is upper Santonian – upper Campanian. The second described taxon, *T. nepaeolicus* was found along the Solomon River (lower Smoky Hill Chalk; upper Coniacian); the current species range is upper Coniacian – lower Santonian. *T. proriger* and *T. nepaeolicus* are currently recognized from hundreds of skulls and skeletal remains. The most recently described Kansas tylosaur species, *T. kansasensis*, was characterized from the type specimen (Fort Hays Sternberg Museum specimen FHSM VP-2295) found near Ellis, Ellis County (lower Smoky Hill Chalk; upper Coniacian), and twelve other paratype and referred specimens; this new species is only recognized from upper Coniacian sediments. Assessing the alpha taxic stability of species assigned to *Tylosaurus* is the requisite first step in initiating a systematic revision of the clade Tylosaurinae. We report here on the a reanalysis of the taxic diagnoses of two of the species, and the character states used to define *T. kansasensis* in the absence of a formal diagnosis: position of pineal foramen; posteroventral angle of jugal (~ 90 degrees); frontal medial sutural flanges extend onto parietal, premaxillary rostral foramina large; quadrate ala thick. We find all of these diagnostic characters to be inconsistently distributed between all three species, with the balance being shared with *Tylosaurus proriger*. Comparisons to *T. pembinensis*, *T. "saskatchewanensis"*, and *"Hainosaurus" bernardi*, indicate that most if not all currently recognized species of these tylosaurs are very hard to distinguish from *T. proriger*. The key problem in drawing such broad conclusions resides in the utility, or lack thereof, of drawing such conclusions from the holotype specimen (MCZ 4374).

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

POTENTIAL OF DETRITAL ZIRCONS FOR PROVIDING AGE CONSTRAINTS FOR KAROO SUPERGROUP VERTEBRATES

JINNAH, Zubair, University of the WItwatersrand, Johannesburg, South Africa; ROBERTS, Eric, James Cook University, Townsville, Australia; DIRKS, Paul, James Cook University, Townsville, Australia

Detrital zircon geochronology is a widely used technique in sedimentary basin analysis and has become important in finding maximum depositional ages and source areas for otherwise poorly constrained stratigraphic units. The Jurassic Clarens Formation, which is the uppermost sedimentary unit in the Karoo Supergroup of South Africa, is a prime locality for detrital zircon analysis because Clarens sediment is derived largely from reworking of sediment from older Karoo units. Zircon populations in the Clarens Formation therefore potentially contain recycled grains from all significant sources of the Karoo Basin. The study of zircon populations from the Clarens Formation could therefore indicate the abundance of zircon grains close to depositional age in the Karoo Supergroup and the utility of detrital zircon geochronology for providing age constraint for these important fossil-bearing strata.

The Clarens Formation was sampled in the northwest, south, and east of the extent of outcrop. A total of 152 zircons were dated by laser ablation inductively coupled plasma mass spectrometry, revealing that zircon populations are dominated by groups of Precambrian age. Phanerozoic zircons include populations from the Ordovician, Silurian, Permian, and Triassic. Ordovician and Silurian grains are potentially recycled from the Cape Supergroup, and may be ultimately derived from Antarctica or South America, whereas Permian zircons may potentially be derived from reworked ash beds in the Karoo Supergroup. A small population of Triassic grains, the youngest with an age of 212.7±5.6 Ma, is much younger than any ash bed documented from the Karoo Supergroup, and does not overlap temporally with any known kimberlites in the region. These grains may be derived from unknown or unpreserved arc-related igneous rocks. The presence of Mesozoic grains in the Clarens Formation suggests that detrital zircon geochronology can provide age constraint in the Karoo Supergroup; however large sample sizes are required as Mesozoic source rocks form a small proportion of sediment input into the Karoo Basin.

Technical Session XIII (Friday, November 1, 2013, 3:15 PM)

INVASIVE DENTINE GROWTH IN A 380-MILLION YEAR OLD FISH IS CO-OPTED FOR WOUND REPAIR IN DERMAL BONE AS THE FIRST STEP IN THE EVOLUTION OF DAMAGE REPAIR

JOHANSON, Zerina, Natural History Museum, London, United Kingdom; MEREDITH SMITH, Moya, King's College London, London, United Kingdom; KEARSLEY, Anton, Natural History Museum, London, United Kingdom; MARK-KURIK, Elga, Tallinn University of Technology, Tallinn, Estonia; HOWARD, Charles, Macabee Health Clinic, Beer-Sheva, Israel

The skeleton of early vertebrates such as heterostracans is dominated by dermal bone (aspidin) with dentine restricted to tubercles ornamenting the bone surface. In genera such as *Psammolepis* (Heterostraci, Psammosteida), there is a response to gradual surface wear of the tubercles by dentine invading and spreading through the vascular spaces in the spongy bone. This consolidates and compacts the tubercles and supporting bone. It is known that this invasive dentine derives from cells (odontoblasts) in the tubercle pulp cavities. We found that this invasive property was co-opted to repair a deep wound to the *Psammolepis* dermal bony armor (Middle Devonian Gauja Formation, Estonia), exclusively with dentine and with little contribution from bone. Ground sections were produced (80-100µm), cut transversely through the wound area, with remaining blocks photographed under immersion oil or polished for backscattered electron imaging. Energy Dispersive X-ray Spectroscopy (EDX) was used to estimate the mineral composition of reparative tissue and non-biological grains included in the tissue. We found that repair occurred by massive, invasive growth of dentine into the wound and onto the remaining bony scaffold. Dentine forms in a chaotic manner in the wound, also incorporating sand grains into this hard tissue repair.

Reparative dentine is derived from migratory odontoblasts, which develop not only from the

Psammolepis tubercle pulp cavities but also from the surrounding flask-shaped crypts located at the base of the tubercle. Today, in human teeth, reparative dentine derives from pulpal cells and cells of the adjacent attachment tissues, both depositing dentine onto a scaffold in vivo. We suggest that the crypts in *Psammolepis*, associated with surface pores, are stem cell niches. Cells in these crypts are capable of producing odontoblasts for secondary dentine for invasive repair, within the complex canal system linked within bone. We suggest that this dentine-based repair process has been evolutionarily conserved over 380-million years and precedes osteogenic repair, seen today in tetrapod dermal bones.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

LUMBAR MORPHOLOGY OF _ARENAHIPPUS_ AND _MESOHIPPUS_ WITH IMPLICATIONS FOR THE EVOLUTION OF EQUID LOCOMOTION

JONES, Katrina, Johns Hopkins School of Medicine, Baltimore, MD, United States, 21205; WOOD, Aaron, University of Florida, Gainesville, FL, United States

Horse evolution is one of the best documented examples of locomotor specialization within Mammalia. Although horse evolution exhibits a complexly-branching phylogenetic pattern, locomotory grades among horses include polydactyl-digitigrade (e.g., Eocene *Arenahippus*), tridactyl-subunguligrade (e.g., Eocene-Oligocene *Mesohippus*), and monodactyl-unguligrade (e.g., modern *Equus*). In addition to limb adaptations, stabilization of the vertebral column is also associated with cursoriality among ungulates. We quantitatively assess lumbar vertebral morphology in *Arenahippus*, *Mesohippus*, and *Equus* to understand how lumbar stability varies across equid locomotory grades. Comparisons are also made with modern artiodactyls of known body size and locomotory behavior. Relative lumbar length, which reflects the moment arm of the mobile lumbar region, was calculated as a percentage of total thoracolumbar length by summing centrum lengths. Lumbar joint morphology is also vital in determining column flexibility and was measured using geometric morphometrics. Three-dimensional models of L1 and the penultimate lumbar vertebra were created with a surface scanner and were used to measure joint morphology in axial view. Eighty sliding semi-landmarks were placed on the centrum and post-zygapophyseal surfaces of the first and last joints between adjacent lumbar vertebrae, representing functionally equivalent points in the anterior and posterior lumbar spine. Variation in joint morphology was analyzed using principal components analysis. The lumbar region of *Mesohippus* and *Arenahippus* represents around 37% of total thoracolumbar length, which is longer than dorsostable extant horses (25-30%). PC1 explained 70% of variation in lumbar joint shape and described variation from a mediolaterally broad centrum with embracing zygapophyses to a dorsoventrally tall centrum with revolute zygapophyses. These differences in shape are interpreted as adaptations to resist lateral bending and dorsoventral bending, respectively. The L1-L2 joint of the fossil equids suggested greater dorsoventral flexibility than any of the modern ungulates sampled, whereas the last joint between adjacent lumbar vertebrae was similar to small agile artiodactyls such as the dik-dik. These data suggest that smaller-bodied, primitive equids were capable of greater dorsoventral mobility of the spine than modern horses.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEW APPROACH FOR UNDERSTANDING THE DIVERSITY OF TOOTH ATTACHMENT IN TETRAPODS

JONES, Marc, UCL, University College London, London, United Kingdom; BENSON, Roger, University of Oxford, Oxford, United Kingdom

Tooth implantation is informative to both ecomorphology and phylogeny. To maximise its use in functional and evolutionary studies, observed variation must be interpreted objectively across taxa. Four categories of implantation are commonly recognised: thecodonty (teeth in sockets: mammals, crocodilians); acrodonty (teeth attached to crest of the jaw, lacking roots: agamid lizards, most rhynchocephalians); pleurodonty (teeth attached to the inside of the jaw bone: many lizards); and subthecodonty (teeth held in a shallow gutter: some early diapsids and synapsids). However, the dental anatomy of many early tetrapods and extant lizards conforms poorly to these categories, and although various subcategories have been proposed (e.g. subpleurodonty), they are not consistently used. We examined tooth implantation in a phylogenetically wide sample of specimens, compiling a set of discrete characters to describe its morphology (e.g. tooth location, root length, height of the labial wall, height and structure of the lingual wall, mode of tooth replacement, fusion or non fusion). Although many of these characters are linked together in classic categorizations (e.g. thecodonty), lizards and many fossil taxa show they actually vary independently. Principal co-ordinates analysis shows variation in dental attachment of extant lizards is almost as great as that of all amniotes, both living and fossil. Acrodonty is a distinct category involving several correlated traits: absence of roots, replacement, a labial shelf, or an obvious boundary between tooth and bone. However, although a small zone of "true thecodonty" is evident (occupied by modern mammals and crocodilians), stem group synapsids and many Mesozoic archosaurs are disributed in a separate larger continuum according to differences in lingual wall structure. Taxa with rapid tooth replacement (e.g. hadrosaur dinosaurs, snakes, salamanders) occupy disparate regions of dental attachment space, demonstrating that other functional aspects may be more important determinants of dental attachment mode.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

RECOGNIZING BAT TRACKS AND TRACKWAYS IN THE FOSSIL RECORD: PROPOSED MORPHOLOGICAL CRITERIA BASED ON TRACKWAYS OF THE NEOTROPICAL FRUIT BAT *CAROLLIA PERSPICILLATA*

JONES, Matthew, University of Kansas, Lawrence, KS, United States, 66045

Modern bats (Order: Chiroptera) are the second most diverse group of mammals, with over 1200 species recognized. Bats have a worldwide distribution and are found on all continents except Antarctica. Bat body fossils are known from as early as the Eocene of North America, Europe, Australia, India, and South America, with at least 24 genera identified worldwide by the end of the Eocene. Little is known of the track-making ability of fossil or extant bats, and no known trace fossils have been attributed to bats. Our goal is to create a database of criteria to recognize bat tracks and trackways in modern and ancient settings. Presented here are a variety of track and trackway morphologies produced by the neotropical fruit bat *Carollia perspicillata* (Chiroptera: Phyllostomidae) in observational neoichnological experiments. Four *C. perspicillata* individuals were observed walking on moist (12–21% by weight), medium-grain sand that resulted in four distinct locomotion behaviors: an alternating walk, a breaststroke-like "swimming" walk, a one-armed swim variant, and a hop. The bats also frequently utilized a "searching" maneuver with their hind feet that resulted in no forward motion, but produced distinctive traces. The alternating walk pattern produced drag marks corresponding to the first digit of the manus, which are 1.5 to 2 mm wide and from 2 to 22 mm long, with the longer axis oriented parallel to the direction of locomotion. The average distance between left and right manus tracks is approximately 81 mm. The breaststroke-like "swimming" walk pattern produced arcuate traces that also correspond to digit one of the manus. These tracks range in width from 2 to 3.5 mm and measure between 22 and 99.5 mm in a straight line from tip to tip of the arcuate trace. The searching maneuver pattern produced traces that consist of four or five parallel claw marks with total widths between 9 and 15.5 mm and lengths from 4 to 15 mm. Individual claw marks within the pedal tracks are between 1 and 1.5 mm. When only four claw marks are preserved the absent digit is digit one, whereas the longest, widest, and deepest pedal claw mark is almost always produced by digit five. Pedal tracks are observed elsewhere in the trackways, but are most commonly produced by the searching maneuver. The distinctive morphologies of tracks produced by the four locomotion behaviors and the searching maneuver will allow traces of bats that are poor walkers, like *C. perspicillata*, to be easily recognized in both modern and ancient settings.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A NEW LARGE-BODIED THEROPOD DINOSAUR FROM THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION (RUBY RANCH MEMBER) IN CENTRAL UTAH

JUDD, Heather, University of Utah, Salt Lake City, UT, United States, 84112; IRMIS, Randall, University of Utah and Natural History Museum of Utah, Salt Lake City, UT, United States; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, United States

Early Cretaceous large-bodied theropod dinosaurs of North America are very poorly known compared with those from Jurassic and Late Cretaceous assemblages. The Lower Cretaceous Cedar Mountain Formation of Utah preserves key assemblages documenting North American Early Cretaceous ecosystems from between 130-95 million years ago (Ma). Nonetheless, little is known about the apex predators of these ecosystems, because existing large theropod fossils from the formation are limited to a single partial skeleton and isolated dental remains. Here, we report a new associated partial large theropod skeleton from the lowermost Ruby Ranch Member of the Cedar Mountain Formation near Capital Reef National Park in central Utah. The local base of this unit has been radioisotopically dated to ~105 Ma. The partial skeleton consists of a cervical vertebra, parts of the sacrum and pelvis, and a femur. We assessed the phylogenetic position of this specimen by identifying unambiguous apomorphies whose distribution is based on the current understanding of theropod dinosaur evolutionary relationships. The specimen can be placed within Tetanurae based on a convex anterior face of the presacral vertebrae and a femoral head oriented dorsomedially. It appears to be nested within Allosauroidea because the anterior pleurocoel of the cervical vertebra is anteroposteriorly elongate, the parapophysis is located in the middle of the centrum, and there is no articular groove on the proximal surface of the head of the femur. In contrast, unlike other known allosauroids, but similar to megalosaurids, the oblique ligament groove does not extend past the posterior surface of the femoral head. These data suggest that an allosauroid was one of the apex predators during Ruby Ranch time. Intriguingly, though carcharodontosaurians are widespread in other Early Cretaceous assemblages, we have not identified any apomorphies of this clade in the specimen, though this could be due to its incompleteness. These data suggest that allosauroids continued to dominate the apex predator role from the Late Jurassic well into the Early Cretaceous in western North American ecosystems.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

EXTREMELY COARSE USE WEAR FEATURES IN TEETH OF AARDVARKS (MAMMALIA, TUBULIDENTATA, *ORYCTEROPUS AFER*)

KALTHOFF, Daniela, Swedish Museum of Natural History, Stockholm, Sweden

Enamel-free teeth with a columnar build-up are key characters of the aardvark *Orycteropus afer*, sole recent member of the order Tubulidentata which can be traced back until the early Miocene. Aardvarks feed almost exclusively on ants and termites. But unlike other mammals with a specialized mymecophagous diet, aardvarks did not become edentulous. They retain functional teeth which in addition are continuously growing, suggesting a considerable tooth abrasion. Striations on the occlusal surface display a predominantly proal direction of the mastication movements which even create a shallow but distinct tooth relief. However, behavior studies show that aardvarks perform only few chewing cycles per food intake. Dental microwear analysis of *Orycteropus* teeth show extremely rough use wear features with numerous deep pits and scratches. Features are best visible on the tooth margins while the tooth centers are very irregular and columns are regularly eroded and visible as morphological highs. The coarse microwear features are understood as a predominantly environmental signal of high grit intake when feeding on ants and termites, especially during the dry season. This is supported by earlier studies of stomach contents showing a high percentage (up to 47%) of debris like sand and small stones. To retain a functional dentition aardvarks evolved euhypsodont teeth to cope with high abrasion by intaken grit particles. Use wear analysis of *Orycteropys* teeth shows the high influence of environmental factors and the need for a careful evaluation of microwear features and their interpretations.

Technical Session VIII (Thursday, October 31, 2013, 2:15 PM)

THERAPSID PHYLOGENY REVISITED

KAMMERER, Christian, Museum für Naturkunde, Berlin, Germany; JANSEN, Maren, Museum für Naturkunde, Berlin, Germany; FRÖBISCH, Jörg, Museum für Naturkunde, Berlin, Germany

Therapsida is comprised of five well-characterized major subclades, all of which appear simultaneously in the middle Permian fossil record: Biarmosuchia, Dinocephalia, Anomodontia, Gorgonopsia, and Eutheriodontia (containing Therocephalia and Cynodontia). Although these subclades have generally been recovered as reciprocal monophyla, the relationships between them has been subject to little consensus. In the past few decades the best-supported topology for therapsids has been a pectinate tree composed of the higher-level clades Theriodontia (Gorgonopsia+Eutheriodontia), Neotherapsida (Anomodontia+Theriodontia), and Eutherapsida (Dinocephalia+Neotherapsida). Recently, numerous advances have been made in our knowledge of the diversity and anatomy of the earliest therapsids, including new discoveries (e.g., *Raranimus*, *Tiarajudens*) and redescriptions (e.g., of the earliest known anomodont, *Biseridens*, and the earliest known gorgonopsian, *Eriphostoma*). Utilizing this new information, we have produced the most comprehensive phylogenetic analysis of early therapsid relationships yet, including almost every biarmosuchian, dinocephalian, and basal anomodont as well as representative basal dicynodonts, gorgonopsians, therocephalians, and cynodonts. The results of this analysis indicate that therapsid phylogeny is split into two major subclades (Dinocephalia+Anomodontia and Biarmosuchia+Theriodontia), with only *Raranimus* falling outside of this dichotomy. "Biarmosuchia" is found to be paraphyletic with regards to Theriodontia, with the South African "ictidorhinids" more closely related to theriodonts than *Biarmosuchus*. Dinocephalian monophyly is poorly supported, although its component subclades Anteosauria and Tapinocephalia are recovered with strong support. "Neotherapsida" is found to be an artifact of long branch attraction; with the exception of the freestanding dentary coronoid process, all the characters traditionally used to support this clade are absent in early anomodonts like *Biseridens*. Intriguingly, this topology conforms with prominent pre-cladistic classifications of Therapsida, albeit with different characters supporting these relationships. Characters related to simplification of the palate and expansion of the jaw muscles are reconstructed as particularly homoplastic, with parallel trends in multiple therapsid clades. New work in the middle Permian is of vital importance towards documenting character acquisition during the rapid initial radiation of therapsids.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEW ANGLE ON MESOWEAR - ANGULAR CRITERIA FOR FAST AND CONSISTENT RECORDING OF MESOWEAR DATA

KARME, Aleksis, University of Helsinki, Helsinki, Finland; SAARINEN, Juha, University of Helsinki, Helsinki, Finland

Mesowear (the relief and sharpness) of worn ungulate molars has been widely used for paleodiet reconstructions. It has been shown that the method is a robust proxy for the abrasiveness of herbivore diets. A major challenge of mesowear has been achieving consistency of the subjective scoring procedure and the awkwardness of the objective criteria, especially for scoring relief. We introduce a new method replacing linear measurements with angles and provide simple tools for easy scoring. We used the threshold values that separate high and low relief, defined originally as the ratio of cusp height and molar length, for calculating corresponding mesowear angles by using trigonometry. These mesowear angles have been tested for all the groups for which mesowear was originally designed (selenodonts and plagiolophodont horses, rhinoceroses and hyracoids). The new method and tools were found to be readily applicable by comparing them to traditional measuring of cusp height ratio in mesowear scoring. This was done for approximately 1000 samples, which were correctly classified with no exceptions. The tools include a reference plate, which is a simple sheet of translucent plastic, and a 3D printable tool, both with angles for the different animal groups. Mesowear angles can be used for analyzing complete ungulate communities, also from paleoanthropological and archaeological localities, to gain information about feeding ecology and local environmental conditions. It is an easy and reliable tool for researchers without earlier experience in mesowear scoring and for experienced mesowear users a quick one for measuring cases close to the high/low boundary. Compared to mesowear scoring by visual inspection, the mesowear tools allow more objective, more accurate and faster data collection.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

TOOTH IMPLANTATION AND REPLACEMENT IN POLYCOTYLID PLESIOSAURS

KATO, Taichi, Ibaraki Nature Museum, Ibaraki, Japan; TANABE, Kazushige, The University of Tokyo, Tokyo, Japan

Tooth implantation and replacement have been documented in several Mesozoic marine reptiles in previous studies of phylogeny and functional morphology. In the Sauropterygia, the details of tooth implantation and replacement have been described in nothosaurs and placodonts. In several long-necked plesiosaurs the replacement tooth foramina on the lingual side of functional teeth have been reported; however, the details of replacement teeth have yet to be described. Furthermore, in polycotylid plesiosaurs, foramina are not observed and the tooth replacement mechanism is poorly understood. This is the first study of the tooth implantation and replacement mechanism of polycotylid plesiosaurs, using data acquired by computed tomography (CT) scans of a newly reported skull specimen collected from the Akrabou Formation in the Errachidia province on the south east of Morocco in 1998. The analysis revealed the following features of polycotylids. The position of the replacement tooth is not on the lingual side of the functional tooth, and this differs from replacement in nothosaurs and long-necked plesiosaurs. In the symphyseal area, the replacement teeth are formed on the caudal side of functional teeth. Replacement is bilaterally simultaneous in each tooth row in the mandible. These characteristics of the tooth replacement mechanism in polycotylid plesiosaurs are related to structural and functional restrictions. The plesiomorphic position of tooth replacement in plesiosaurs is on the lingual side of the functional tooth; however, the rostrum is elongate and narrow in polycotylids, meaning that the space for the replacement tooth is more limited along the transverse axis than along the sagittal axis. The space required for tooth replacement may be minimized along the transverse axis; however, tooth diameter must be sufficient to enable the catching of prey such as cephalopods. Consequently, in polycotylids the replacement tooth is located on the caudal side of the functional tooth, which enables both a narrow rostrum and sufficient tooth diameter for feeding.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ESTIMATING BASAL METABOLIC RATE OF EXTANT AND EXTINCT VERTEBRATES FROM NASAL CROSS SECTIONAL AREA AND BODY MASS

KATZ, Eric, Diablo Valley College, San Ramon, CA, United States, 94582; TAMBUSSO, P. Sebastián, Universidad de la República, Montevideo, Uruguay; FARLOW, James, Indiana Purdue Univ Fort Wayne, Fort Wayne, IN, United States

Inferences about the metabolic status of fossil species are complex and often speculative because few osteological features are clearly related to metabolic requirements. Furthermore, at least in mammals and birds, several factors affect whole-animal metabolic rate, including body mass (the most important variable), diet, climate, habitat, and phylogeny.

Studies on the relationship between the cross sectional area of the nasal cavity and body mass in several vertebrates have shown that endotherms and ectotherms express this relationship quite differently. Endotherms have much wider nasal passages than ectotherms of a similar size. However, no one has yet tested the direct relationship between these variables and basal metabolic rate.

In this work 178 species of vertebrates, including extant and fossil mammals, birds and reptiles, have been analyzed to evaluate whether nasal cross sectional area, internal choana cross sectional area and body mass can be used as predictors of basal metabolic rate. Data on basal metabolic rate were collected from the literature, and the cross sectional area of nasal cavity and internal choana has been measured from computed tomograms.

Our results corroborate previous conclusions about differences in the relation between nasal cross sectional area and body mass in endotherms as opposed to ectotherms. In addition, our data show that there are significant differences between endotherm groups.

Multiple regression on a subset of 38 mammal species, with basal metabolic rate as the dependent variable, and body mass and nasal cross sectional area as the independent variables, showed a high r-squared: 0.932. A comparable analysis substituting choana cross sectional area for nasal cross sectional area had a similar result, with r-squared value of 0.937. Thus these skeletal features, along with body mass, are highly correlated with basal metabolic rate, and could be measured in fossil specimens to provide estimates of the basal metabolic rate of extinct species.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ENIGMATIC AFFINITY IN BRAIN MORPHOLOGY BETWEEN PLOTOPTERIDS AND PENGUINS WITH COMPREHENSIVE COMPARISON AMONG WATER BIRDS

KAWABE, Soichiro, The University of Tokyo/ Gifu Prefectural Museum, Seki, Gifu, Japan

Plotopterids (Aves: Plotopteridae) are extinct flightless birds, endemic to the North Pacific Ocean. As flightless, wing-propelled diving birds, they exhibit similar skeletal morphology to Sphenisciformes (penguins), especially in their wings. In contrast to the similarity, Plotopteridae have been placed in (traditional) Pelecaniformes in most paleontological and phylogenetic studies, based on the shared characters which are absent in penguins. The postcranial morphology of Plotopteridae has been well-studied, but little is known about the cranial morphology, particularly the nervous system. The brain morphology of Plotopteridae, compared to other water birds, could prompt a reconsideration of those previous phylogenetic hypotheses since the cranial morphology is conservative and can provide powerful signals for phylogenetic reconstruction. In order to compare the brain morphology of Plotopteridae to that in other water birds (Ciconiiformes, Pelecaniformes, Suliformes, Procellariiformes, and Sphenisciformes), I generated virtual endocasts of Plotopteridae and extant water birds. I investigated the brain morphology of those birds using three-dimensional geometric morphometrical and linear measuring methods. The width of the cerebellum and floccular lobe varied considerably among water birds, and the relative widths separate Procellariiformes + Sphenisciformes from Ciconiiformes + Pelecaniformes + Suliformes. The former group had a relatively wider cerebellum and floccular lobe, whereas the latter group had a relatively narrower cerebellum and floccular lobe. The relative width of the cerebellum and floccular lobe in Plotopteridae was comparable to that of the former group, in addition to many morphological similarities to the Sphenisciformes brain. I refrain from concluding that Plotopteridae forms a clade with or belongs to Sphenisciformes only based on the brain morphology, however, the brain configuration of Plotopteridae is distinctly closer to that of penguins and could possibly reflect their phylogenetic relationship.

Technical Session I (Wednesday, October 30, 2013, 8:15 AM)

FUNCTIONAL COMPARISONS BETWEEN FINS AND LIMBS DURING TERRESTRIAL LOCOMOTION: BIOMECHANICAL IMPLICATIONS FOR THE EVOLUTIONARY INVASION OF LAND

KAWANO, Sandy, Clemson University, Clemson , SC, United States, 29634; BLOB, Richard, Clemson University, Clemson, SC, United States

Discoveries and experimental analyses of key fossil tetrapodomorphs over the past few decades have transformed interpretations of how vertebrates were able to conquer land following an aquatic ancestry. The advent of limbs was once thought to be synchronous with moving onto land, but the fossil record indicates that limb-like appendages likely originated in aquatic environments. Although terrestriality may not have led to the emergence of limbs with digits and distinct wrists/ankles, these morphological modifications could have been co-opted for terrestrial locomotion. Direct comparisons of the functional consequences of using limbs with digits, rather than fins, for terrestrial locomotion have not been performed. As a result, the advantages that tetrapods with limbs had for moving onto land during the Devonian, while finned fishes remained in water, have not been resolved; moreover, the relative roles of the forelimb and hind limb during this transition remain unclear. To evaluate how fins and limbs facilitated the initial capacity for terrestrial locomotion in stem tetrapods, we compared three-dimensional ground reaction forces (GRFs) produced by isolated pectoral fins of mudskipper fishes (*Periophthalmus barbarus*) during terrestrial crutching, and isolated footfalls by the forelimbs and hind limbs of walking tiger salamanders (*Ambystoma tigrinum*). These extant taxa exhibit numerous similarities to early tetrapods that make them appropriate functional models. Our results show that salamanders' forelimbs and mudskippers' pectoral fins exhibit similar magnitudes and timings of the peak net GRF; however, pectoral fins had a lower vertical component and more medial inclination of the GRF. Forelimbs and hind limbs of salamanders demonstrated numerous similarities at the peak net GRF (e.g., vertical and medial components), suggesting comparable capabilities for body support and a potentially important locomotor role of the forelimb during hind limb-driven locomotion in basal tetrapods. These data establish a foundation to compare the functional properties of fins and limbs for terrestrial locomotion, and help provide insight into the biomechanics that could have influenced the water-to-land transition in tetrapod evolution. In particular, GRF data from mudskippers could further our understanding of the locomotor capabilities of elpistostegalids, such as *Tiktaalik*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

EVOLUTION OF CERATOPSIAN DENTAL MICROSTRUCTURE

KAY, David, Florida State University, Tallahassee, FL, United States, 32306; ERICKSON, Gregory, Florida State University, Tallahassee, FL, United States; NORELL, Mark, American Museum of Natural History, New York, NY, United States

Throughout vertebrate evolution, a number of lineages evolved dental occlusion, whereby the contact faces of the teeth self-wear to their functional morphology. It has been shown that in mammals, increases in dental complexity accompany such changes. These presumably allowed for modifications in biomechanical form, function and performance relevant to dietary ecology. Recently, it was shown that a lineage of reptiles, the duck-billed dinosaurs (Hadrosauridae), evolved among the most architecturally sophisticated teeth known in association with their acquisition of a grinding dentition. Independently, another lineage of ornithischian dinosaurs, the horned-dinosaurs (Ceratopsia), evolved dental occlusion in the form of slicing cheek teeth. Here, we tested the hypothesis that ceratopsian teeth increased in complexity in association with their evolution of shearing. Transverse and occlusal plane histological sections were made using cheek teeth from representative Ornithischia spanning the transformation series leading to the evolution of slicing in ceratopsians. The sections were viewed with dissecting and polarizing light microscopy. The microstructure was described and mapped as a phylogenetic character in association with whole tooth and wear facet morphological attributes. Our results show that ceratopsian teeth are considerably more complex than those of the outgroup ornithischians in possessing four distinct tissues: enamel, orthodentine, coronal cementum, and osteodentine. Coronal cementum evolved in association with shearing in the common ancestor of *Leptoceratops* + *Triceratops*. Osteodentine appeared in the common ancestor of *Protoceratops* + *Triceratops* with the advent of slicing. These findings represent the second demonstration of complex dental architecture outside of Mammalia, and show that some reptiles rivaled if not exceeded most mammals in dental complexity.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DENTAL MORPHOMETRICS PREDICT SPECIFIC TROPHIC CATEGORIES IN RODENTS

KELLER, Jonathan, University of Minnesota, Saint Paul, MN, United States, 55108; FOX, David, Univ of Minnesota, Minneapolis, MN, United States; BAGLEY, Brian, University of Minnesota, St. Paul, MN, United States

*Advances in laser scanning and X-ray microtomography (μCT) have led to rapid expansion in nondestructive collection of phenotypic data from fossils. Previously, such data were often linear measurements between landmarks, gross area and volume ratios in homologous regions, or categorical descriptions. Recently, traditional methods have been supplanted by high-throughput, orientation and homology-independent morphometric analyses emphasizing geometry, precise area or subvolume measurements, and holistic mathematical surface attributes. Rodents are ideal subjects for such approaches because high taxonomic and morphological diversity renders traditional, homology-based metrics inapplicable, and fewer paleodiet studies have focused on rodents relative to larger bodied mammals (e.g. ungulates, carnivorans). Here, we measure Dirichlet Normal Energy (DNE, a measure of tooth curvature), Orientation Patch Count (OPC, a measure of tooth complexity), M2 mesiodistal length, Relief Index (RFI), and Volumetric Hypsodonty Index (HI) in μCT-computed surfaces of North American small mammal teeth with the goal of differentiating folivores, granivores, omnivores, and insectivores. We scanned upper and lower tooth rows of 25 species at 10–30 μm resolution, created 3D surfaces, and designed new reproducible cropping protocols to better capture the functional tooth crown as defined by the enamel-dentin junction (EDJ). X-ray attenuation produces grayscale values that clearly demarcate dentin and enamel allowing segmentation by thresholding. Feature extraction with manual corrections in RapidForm XOR then segments tooth meshes to produce well-defined crown surfaces. However, in truly hypsodont taxa such as lagomorphs and arvicolines, molars are ever-growing, and enamel extends to the teeth roots. For these species, we fit a spline to the alveolar margin and extracted a best-fit plane to define the crown as the surface projecting above the plane. Preliminary intraobserver variation for EDJ-delineated tooth crown volumes and areas was lower than 2%. Mean RFI of M1 and OPCR of all molars are statistically distinct for granivores and folivores based on t-tests. RFI for other molars, HI, and DNE appear to cluster by trophic category, but mean differences are not statistically distinct, perhaps because of currently small sample sizes. As taxon sampling increases, we will analyze species for which continuous measures of diet composition are available and will more rigorously assess statistical differences between trophic categories.

Romer Prize Session (Thursday, October 31, 2013, 10:15 AM)

ECOMORPHOLOGICAL DIVERSITY OF TRIASSIC MARINE REPTILES

KELLEY, Neil, Vanderbilt University, Nashville, TN, United States, 37208

The evolution of multiple clades of marine reptile during the Triassic coincided with the recovery of marine ecosystems from the end-Permian mass extinction. However, the role that marine reptiles played in Triassic ecosystems remains uncertain, and the trophic habits of many of these taxa continue to be debated. I compiled dietary data from eighty-three species of living aquatic tetrapods (mammals and reptiles) and utilized linear discriminant analysis of seventeen cranial, jaw and tooth measurements to develop a framework to correlate skull morphology with adaptation to specific feeding strategies. This analysis found a strong connection between diet and morphology that applies across a phylogenetically broad sample of extant aquatic tetrapod taxa. I then employed this framework to generate hypotheses about the trophic ecology of fifty-one species of Triassic marine reptiles. I compared these hypotheses with direct evidence of marine reptile dietary habits based on preserved gut contents, and found them to be largely concordant. These results indicate that Triassic marine reptiles included small-bodied aquatic invertebrate specialists, medium-sized fish specialists and larger generalized predatory species that preyed on a variety of prey including other marine reptiles. Many Early Triassic marine reptiles had fish-dominated diets, while the Middle Triassic saw the rise of new ecological groups including aquatic invertebrate specialists and apex predators. These groups declined after the Middle Triassic, while fish eating marine reptiles persisted. Increasing adaptation toward pelagic food sources facilitated the survival of some marine reptile lineages during an interval when nearshore niches were contracting. A comparative scarcity of herbivorous or specialist squid-feeding taxa in the Triassic relative to modern aquatic tetrapods may indicate these food resources were not readily available to Triassic marine reptiles. Both taxonomic diversity and ecomorphological disparity peaked in the Middle Triassic, and then declined during much of the Late Triassic. The persistence of some specialist groups and the eventual appearance of new forms characteristic of Jurassic assemblages led to an increase in overall morphological disparity at the very end of the Triassic. This analysis suggests that Triassic marine reptiles were ecologically diverse and may have played an important role in the restructuring of marine ecosystems during the Mesozoic.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ON AN UNUSUAL TAPEJARID PTEROSAUR FROM THE EARLY CRETACEOUS OF BRAZIL AND COMMENTS ON THE PTEROSAUR PALATE

KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; RODRIGUES MARQUES DA SILVA, Taissa, , Alegre - ES,

Among the most important pterosaur deposits known to date is the Romualdo Formation (Aptian–Albian) of the Araripe Basin, north-eastern Brazil. Since the discovery of the first specimen in 1971, hundreds have been unearthed so far, some preserved in three dimensions. Most of them represent juveniles or sub-adults, and fully ontogenetically developed individuals are rare. Here we present a new unusual tapejarid pterosaur from this deposit (MN 4726-V) housed in the Museu Nacional/UFRJ, composed of skull, lower jaw and some postcranial elements. Scapula and coracoid are fused, as are all cranial elements, indicating that it represents an adult individual. MN 4726-V has the typical high nasoantorbital fenestra of the Thalassodrominae but lacks a palatal ridge observed in *Thalassodromeus* and *Tupuxuara*. It shows a down-turned rostral end, a typical feature of the Tapejarinae. Among other characters, the new species differs from all other tapejarids in having an anteriorly and posteriorly expanded premaxillary sagittal crest and the lacrimal process of the jugal strongly inclined posteriorly. The surface of the premaxillary crest presents grooves indicating the impressions of blood vessels and corroborates with the growing evidence that pterosaurs could have used their cranial crests in thermoregulation. The area corresponding to the jugal-quadratojugal-quadrate of the left side shows a pathology, likely the result of an infection. MN 4926-V also has an extremely well preserved palate that shows a slit-like postpalatine fenestra. The palatines are large, forming the anterior region of the choanae and the postpalatine fenestra and a secondary subtemporal fenestra, indicating that this is the regular condition within derived pterosaurs. The palatal configuration of the new specimen argues against the hypothesis that the presence of a secondary subtemporal fenestra is unique to non-pterodactyloids. If previous interpretations of the palatal configuration in non-pterodactyloid pterosaurs are correct, the evolution of palatal region in those flying reptiles is more complex than previously thought.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DIETS OF LATE EARLY MIOCENE LITOPTERNS FROM SANTA CRUZ, ARGENTINA, BASED ON MESOWEAR AND ENAMEL MICROWEAR

KELLOWAY, Tara L., Case Western Reserve University, Cleveland, OH, United States, 44106; CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States; PRYBYLA, Alix, Hawken School, Gates Mills, OH, United States; SEMPREBON, Gina M., Bay Path College, Longmeadow, MA, United States; TOWNSEND, K.E. Beth, Midwestern University, Glendale, AZ, United States

Paleodietary reconstruction of two South American litoptern families from the Miocene Santa Cruz Formation was undertaken using mesowear and stereomicrowear analyses. Taxa studied included *Anisolophus*, *Diadiaphorus*, *Tetramerorhinus*, and *Thoatherium* of the family Proterotheriidae and *Theosodon* of the family Macraucheniidae.

Mesowear analysis examines gross wear of molars by examining the shape of cusps in lateral view, which provides a measure of total dietary abrasion incurred in the lifetime of an individual animal. Mesowear scores were obtained using a standardized mesowear "ruler" that allows the teeth of fossil taxa to be compared to molar teeth of extant mammals ranging in shape from high and sharp (score of 0) to completely blunt with no relief (score of 3). Mesowear scores of individuals were averaged to obtain an average mesowear score for that taxon. Microscopic enamel scars were examined using stereomicrowear analysis. A standard 0.4x0.4 mm ocular reticle was employed at 35x magnification to quantify the number of pits and scratches and to score (presence or absence) three qualitative variables: large pits, gouges, and scratch texture.

All litoptern genera studied here have relatively low mesowear scores typical of attrition-dominated extant browsers and apparently encountered little dietary or non-dietary (i.e., grit) abrasive substances in their trophic regimes. Microwear average scratch/pit results are consistent with extant leaf-browsing ungulates. Raw scratch distributions are all unimodal and within the low-scratch range. This is typical of browsing ungulates and does not indicate seasonal or regional variations in diet (i.e., mixed feeding).

While both mesowear and microwear results point to the likely occupation of mainly closed habitats in these forms (e.g., low abrasion and little gouging), the macraucheniid *Theosodon* has coarser scratch textures and more large pitting than the proterotheriids and may have occupied somewhat more open habitats. *Theosodon* may have been a high-level browser as has been inferred previously based on its elongate neck.

Technical Session V (Wednesday, October 30, 2013, 2:30 PM)

SIZE-BIASED EXTINCTION EXHIBITED BY QUATERNARY CARIBBEAN LIZARDS

KEMP, Melissa, Stanford University, Stanford, CA, United States, 94305; HADLY, Elizabeth, Stanford University, Stanford, CA, United States

Body size is important to the ecology and evolution of vertebrates, including reptiles, which are highly diverse and globally distributed. We explore the link between body size and extinction in this ecologically and morphologically diverse group, using the Quaternary and modern Caribbean lizard fauna as a model system. We integrate body size data for over 380 species of lizards with conservation statuses from the International Union for Conservation of Nature (IUCN) Red List and species extinctions from the Quaternary fossil record. We use these data to evaluate whether body size predicts extinction risk in individual island classes (the Greater Antilles, Bahamas, Lesser Antilles, and isolated island banks) and throughout the archipelago as a whole. We find that extinction is size-biased, with a higher rate of extinction in large-bodied lizards than expected by chance. This phenomenon holds true even when we account for paleontological sampling bias against smaller species, island class, and phylogeny. Our findings are in accordance with studies in other taxonomic groups, suggesting that large body size diversification might be constrained in vertebrates and that attributes that scale with body size, such as abundance and metabolic rate, may predispose larger species to extinction. Ours is the first study to demonstrate a size bias in extinction of lizards in the Quaternary, but is important for extinction risks today. While the conservation status of many Caribbean lizards remains under-assessed, our results suggest that body size is a significant predictor of extinction risk in insular lizards.

Symposium 3 (Friday, November 1, 2013, 9:15 AM)

INTEGRATION OF MAGNETIC POLARITY STRATIGRAPHY AND ORBITAL CYCLOSTRATIGRAPHY TOWARDS A LATE TRIASSIC CHRONOLOGY

KENT, Dennis, Rutgers University, Piscataway, NJ, United States, 08854; OLSEN, Paul, Columbia University, Palisades, NY, United States; MUTTONI, Giovanni, University of Milan, Milan, Italy

Thousands of meters of Newark Basin Coring Project (NBCP) continuous core and partially overlapping outcrop section in the nearby Hartford Basin, where all but the lowermost part of the Newark basin sequence has cycle stratigraphic control, provide an astronomically-calibrated geomagnetic polarity time scale (APTS) for virtually the entire Late Triassic (Carnian, Norian, and Rhaetian) and the Hettangian of the Early Jurassic (235-200 Ma), with designation of standard stages according to magnetostratigraphic correlation to marine sections in the Tethyan realm. The relative chronology, mainly delineated using the 405 ky eccentricity climate modulation expressed as lake level facies variations, is tied to dating of volcanics and closely associated intrusions of the Central Atlantic Magmatic Province (CAMP) that started at 201.6 Ma, indistinguishable from the end-Triassic extinction level according to recently reported high-precision U-Pb zircon dating, which also confirms the relative astrochronology. Stochastically-distributed polarity reversals have a mean interval length of around 0.5 My. One of the shortest polarity intervals in the Newark-Hartford APTS - E23r with a duration of ~10 ky - occurs within an orbital precession cycle (~20 ky) prior to the ETE and CAMP, providing a useful marker horizon that has now been found just below CAMP lavas in the Fundy and Argana basins. The Newark-Hartford APTS provides a chronostratigraphic template for continuing efforts at correlation of Late Triassic and Early Jurassic continental (and marine) sections throughout the world, for example, the Los Colorados Formation of Argentina and the Chinle Formation of the western United States.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PRELIMINARY ANALYSES OF BRAIN GROSS MORPHOLOGY OF THE WOOLLY MAMMOTH, *MAMMUTHUS PRIMIGENIUS*, FROM YAKUTIA, RUSSIA

KHARLAMOVA, Anastasia , Institute of Human Morphology Russian Academy of Medical Sciences, Moscow, Russia; SAVELIEV, Sergey, Institute of Human Morphology Russian Academy of Medical Sciences, Moscow, Russia; BOESKOROV, Gennady, Diamond and Precious Metals Geology Institute, Siberian Branch of Russian Academy of Sciences, Yakutsk, Russia; USCHAKOV, Vadim, National Research Centre "Kurchatov Institute", Moscow, Russia; MASCHENKO, Evgeny, Paleontological Institute, Russian Academy of Sciences, Moscow, Russia

We analyzed a brain from the Yuka mammoth specimen that was discovered in 2009 on the coast of the Dmitry Laptev Strait (Eastern Siberia). Radiocarbon dating of the 6 to 9 year old mammoth yielded results of 39,440 - 38,850 cal BP. CT scanning of Yuka's brain was initiated by Dr. G. Boeskorov in Yakutsk in 2012. The brain was extracted after preservation through flowing formalin fixation in February 2013 in Yakutsk before it was flown to the Research Institute of Human Morphology, Russian Academy of Medical Sciences, Moscow, Russia for further study.

The initial gross anatomy examination of the Yuka specimen revealed similar brain morphology to that observed in modern elephants: disproportionally large and laterally expanded temporal lobes, a dorsally visible and relatively large cerebellum, and large olfactory bulbs. The frontal, parietal, and temporal lobes of the cerebrum and the folded hemispheres of cerebellum with the horizontal sulcus, quadrangular lobule, superior and inferior semilunar lobes, and relatively narrow vermis were enveloped by a thick dura mater. The cerebral falx, cerebellar tentorium, and some blood vessels of the dura mater were well preserved. Most of the brainstem was missing, but remnants of the trigeminal, optical, and olfactory nerves were identifiable. The brain appeared to be dehydrated due to the mummification process, with the cerebellum exhibiting less shrinkage in comparison to the cerebrum. Oxidation processes stained the brain to a brown color. The hemispheres of the cerebrum didn't provide clear morphology due to its state of preservation; the topography of the gyri and sulci remain obscure.

The CT scan and IMR performed at the National Research Centre "Kurchatov Institute", Moscow, revealed more morphological details: white and gray matter structures of the cerebrum and cerebellum (including the dentate nucleus and arbor vitae) with declive vermis and flocculus, corpus callosum, and anterior commissure.

The forebrain lateral ventricles with the anterior and inferior hornes, foramen Monro, third ventricle with part of the aquaeductus Silvii, and a small opening of the forth ventricle were identified.

The lateral and medial nuclei of thalamus, both lobes of the hypophysis, infundibulum, and pineal gland capsule were also visible. The coronal and sagittal scans revealed the olfactory tubercle, rostral part of the pons, and most rostral ascending somatosensory fibers of the brainstem.

This study is aimed at comparisons of the Yuka mammoth brain morphology with living Proboscidea.

Technical Session XV (Saturday, November 2, 2013, 8:45 AM)

PINNIPED SKULLDUGGERY: THE EVOLUTION OF FEEDING STRATEGIES IN PHOCIDS (PINNIPEDIA, PHOCIDAE)

KIENLE, Sarah, San Diego State University, San Diego, CA, United States, 92182; BERTA, Annalisa, San Diego State Univ, San Diego, CA, United States

*During their transition from land to water, phocids (seals) evolved specific adaptations that allowed them to efficiently obtain prey in an aquatic habitat. Phocids are the most diverse pinniped (seals, sea lions, and walruses) lineage with 18 extant species and a rich fossil record. Extant phocids use multiple feeding strategies (filter, generalist, grip and tear, and suction feeding) to capture and consume prey underwater. However, no quantitative study of feeding in extant and fossil phocid taxa has been conducted to date. The objectives of this study were to 1) determine feeding strategies used by fossil pinnipedimorphs using qualitative and quantitative data, 2) conduct a comparative phylogenetic analysis of the evolution of feeding strategies in Pinnipedimorpha, and 3) incorporate ecological data to investigate evolutionary hypotheses regarding the evolutionary drivers of each feeding strategy. Three-dimensional landmark data were collected from 28 fossil pinnipedimorphs and 220 extant phocids. A total of 56 cranial and 24 mandible landmarks were collected per specimen. Principal Component Analysis (PCA) was performed to describe the major axes of variation in the dataset. The OUCH method implemented in R was used to test different hypotheses on the evolution of pinnipedimorphs. Mesquite and BayesTraits were used to perform ancestral state reconstructions. Contrary to previous hypotheses, most fossil taxa are more closely aligned with specialist feeding strategies, specifically grip and tear feeding, than to generalist feeding strategies. For example, fossil taxa *Acrophoca longirostris* and *Allodesmus* spp. occupy similar regions of morphospace as the extant predator *Hydrurga leptonyx* (leopard seal), which uses grip and tear feeding to capture large prey items, such as penguins, marine mammals, and fish. Feeding strategy and prey type were both found to influence the evolution of cranial and mandibular shape in phocids. Knowledge of feeding strategies in phocids is fundamental to understanding the adaptations that allowed pinnipeds to reinvade the marine ecosystem.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CORRELATIVE MICROSCOPIC INVESTIGATIONS OF MICRO-STRUCTURES AND PHASES FROM DINOSAUR RIB BONES AND THE ASSOCIATED MUDSTONE

KIM, Jung-Kyun, Chungnam National University, Daejeon, Korea, Republic of (South); LEE, Eunji, Chungnam National University, Daejeon, Korea, Republic of (South); CHOI, Man Sik, Chungnam National University, Daejeon, Korea, Republic of (South); KIM, Youn-Joong, Korea Basic Science Institute, Dajeon, Korea, Republic of (South)

Postcranial skeletal fossils of the basal ornithopod *Koreanosaurus boseongensis* were uncovered from the rich dinosaur egg fossil sites located at the Upper Cretaceous (Santonian-Campanian) sediments in Boseong County, South Korea. Due to their particular locality and state of preservation, osteohistological and petrographical analyses were conducted from macro to nano-scale by applying correlative microscopy for microstructure and phase identification. A dorsal rib bone fragment was initially studied, and a portion of the 7th left dorsal rib bone and its associated mudstone were analyzed for further investigations. No specific cortical growth features from the bone were discernible through polarized light microscopy, but the vascularization patterns displayed a trend of increase in size and shape irregularity from the outer region towards the center. Calcite crystals of various orientations occupied the vascular channels. The mudstone contained detrital grains of quartz, various feldspars, and micritic calcite. According to X-ray diffraction analysis, the rib bone was mainly consisted with calcite, followed by quartz and apatite. Scanning electron microscopy with back-scattered electron imaging, energy dispersive spectroscopy, and electron probe microanalyzer analysis revealed the specific distribution of the major and minor phases. Universal distribution of Ca was revealed from the bone sample, while a relatively sparse distribution was observed in the mudstone. P, Al, Si, and K appeared nearly exclusively within the bone matrix. The mudstone also had very high contents of Al and Si, followed by K, Na, and Fe, but showed a limited distribution of P. Phase identification and chemical analysis of the bone matrix were carried out by transmission electron microscopy. Twin-related calcite crystals from the boundary region of the bone matrix and open space of the vascular channel were observed. While apatite crystals of 10 ~ 200 nm in size were commonly observed from the bone matrix, larger platy crystals consisted of Al-Si and smaller quartz crystals of rounder morphology were occasionally associated with the apatite crystals. Due to apatite crystals containing fluorine and their exclusive occurrence within the bone matrix, it was assumed that the crystals were originated diagenetically from bioapatite. The arrangement and identification of these crystalline phases are significant to

understand how the bone structure has been preserved at submicron levels and to evaluate the interaction between the bone and the surrounding mudstone.

Romer Prize Session (Thursday, October 31, 2013, 10:30 AM)

DENTAL ADAPTATIONS LINKED TO ISOTOPIC DIET AND EVOLUTIONARY PATTERN IN MURINE RODENTS FROM THE MIOCENE OF PAKISTAN

KIMURA, Yuri, Southern Methodist University, Dallas, TX, United States, 75275-0001

*Ungulates are often the subjects of paleoecological investigations because their large size facilitates isotopic analyses of tooth enamel. Due to abundant fossil samples and diverse tooth morphology, as well as spatially limited behavior of rodents, carbon isotope analysis in rodents can potentially provide a level of detail not yet possible in ungulates for studies of evolutionary dynamics in relation to diet.

In this study, I evaluated morphological evolution of tooth shape relative to isotopic dietary inference in two sympatric clades of murine rodents (here called *Karnimata* and *Progonomys* clades) from the Miocene (13.8 to 6.5 Ma) of northern Pakistan. Murine rodent samples from the region record the origin of the group and its diversification into the clades, beginning before and continuing through a transitional interval from C3- to C4-dominated vegetation. Carbon isotope values in enamel of the first lower molars were obtained by laser-ablation gas chromatography-isotope ratio mass spectrometry (GC-IRMS) to infer paleodiet. Tooth shape of upper first molars was defined by morphometric distance of ecomorphological characters, two-dimensional geometric morphometric analysis of tooth outline, and three-dimensional geographic information systems (GIS) models.

Carbon isotope data demonstrate that murine rodents experienced a remarkable C3-C4 dietary shift, with the *Karnimata* clade consuming a greater percentage of C4 grasses than the *Progonomys* clade at any given time. Pairwise progressive reduction in overlap of principal component fields through time quantifies the similarity of basal members of each clade and demonstrates divergence of derived members. Change of tooth outline in the *Karnimata* clade is more strongly associated with reduction in spacing between anteroposteriorly positioned cusps and transverse arrangement of cusps. However, in both clades, 3-D model analysis shows that more derived (and younger) species have average slopes of cusps directed more anteriorly than more basal (and older) species. The reduction in spacing and transverse alignment of cusps are related to increasing chewing efficiency in a shift to a more propalinal direction of mastication in murines. These results indicate that while both clades adapted to varying contributions of C4 grasses to their diets, selection pressure forcing dental adaptations was differentially greater in the *Karnimata* clade. Moreover, the morphological analysis and associated isotope data of these two clades of murine rodents present a fine-scale pattern of mammalian evolution that fits well with theoretical models of sympatric speciation and interspecific competition for the same food source.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CRANIAL PIT DEVELOPMENT IN EXTANT AND FOSSIL *ALLIGATOR*

KING, Leigha, Oklahoma State University, Tulsa, OK, United States, 74107; LYNCH, Eric, East Tennessee State University, Johnson City, TN, United States; SCHUBERT, Blaine, East Tennessee State Univ, Johnson City, TN, United States

While previous studies have noted that cranial pit depth in Alligator increases with age, none have quantified in detail the ontogenetic pattern of cranial pitting. We sought to describe and quantify this relationship because 1) it could allow estimation of size and age of fragmented skulls, 2) this method could be applied to the fossil record to better understand evolution within the group, and 3) the ontogenetic development of cranial pits may provide insight into their function. To address these possibilities, we measured pit depth for 14 craniomandibular bones on specimens of extant *Alligator mississippiensis* and *A. sinensis*, and *Alligator* from the Mio-Pliocene Gray Fossil Site of eastern Tennessee. Results from modern individuals indicate that each bone exhibits a unique pit development pattern. For example, maxillae and premaxillae display obvious pits in the youngest specimens, while quadratojugal pits do not appear until the young adult stage. Prefrontal pits elongate with age and the number of pit rows on the jugal increases. As expected, pit depth is positively correlated with skull and jaw length in extant *Alligator*, with the strongest correlation displayed by the maxilla and dentary. Observed patterns are similar between *A. mississippiensis* and *A. sinensis*, but with recognizable differences. The Gray fossil *Alligator* most closely matches *A. sinensis*, but likely because both display relatively small adult skulls. Modern individuals clustered according to age group in principal components analysis, indicating that pit depth is a strong predictor of age. Inclusion of fossils in these analyses revealed multiple ontogenetic stages among the sample. We conclude there is strong correlation between cranial pit depth and skull size in extant *Alligator* and that this relationship can be used to infer the ontogenetic stage of fragmented modern and fossil specimens. Recognition of cranial pit development in more complete fossil ontogenetic series of *Alligator* and other crocodilians may reveal useful relationships for inferring the ages of many fossil specimens across Crocodylia and potential evolutionary trajectories among the order defined by cranial pit development.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ISOTOPIC VARIABILITY IN EARLY MIOCENE C_3 DOMINATED ECOSYSTEMS IN UGANDA

KINGSTON, John, University of Michigan, Ann Arbor, MI, United States, 48109; MACLATCHY, Laura, University of Michigan, Ann Arbor, MI, United States; KIYEMBA, Jalia, Makerere University, Kampala, Uganda

Fossil enamel collected from sites at Moroto and Napak (eastern Uganda) have yielded isotopic signatures consistent with more open forested/wooded C_3 habitats in contrast to previous interpretations that suggest dense forests on the flanks of these extinct volcanoes. Carbon isotopic dietary signatures for a series of herbivore guilds average from -9 to -11‰, considerably more positive than any modern forest communities currently analyzed. In addition, a number of specimens have yielded values greater than -8‰, generally considered a relatively conservative upper boundary for the most enriched C_3 dietary signal. A number of suiform, rhinoceros, and proboscidean samples range from -6 to -8‰, suggesting that modern analogs for dietary patterns in C_3 environments require further characterization to interpret raw values from fossil enamel and partition the variability inherent in fossil assemblages. The variability may reflect differential intake of C_3 browse and C_3 graze, heterogeneity in the extent of canopy cover and canopy closure (i.e. more open/closed forests) or canopy effects due to vertical partitioning of isotopes within open forests. Isotopic analysis of intra- and inter-tooth variability of P_4-M_3 from a fossil specimen of *Brachypotherium heinzelini* from Napak yielded a systematic variation of up to 4.5‰ in carbon, potentially indicating variable juvenile/adult diets and/or seasonal shifts in dietary signals. To contextualize the fossil rhinoceros data, we analyzed intra- and inter-tooth isotopic signatures of modern white rhinos (*Ceratotherium simmum*) and black rhinos (*Diceros bicornis*). Relative to the extant forms, the fossil rhino teeth exhibit considerably more isotopic (dietary) variation through its lifetime as well as seasonally. Previously, differences in taxonomic representation in the fossil assemblages of Napak (e.g., localities that contain more primates and rodents suggest closed forests relative to those localities that include more larger herbivores) have been used to infer an altitudinal vegetation gradient on the slopes of the evolving volcano. The new isotopic data corroborate this finding.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

HIND LIMB MORPHOLOGY OF CARNIVOROUS BIRDS: A MORPHOMETRIC ANALYSIS OF PREY PREFERENCE AND PREDATORY TECHNIQUES

KIRCHNER-SMITH, Mackenzie, Indiana University Bloomington, Bloomington, IN, United States, 47401

Most predatory birds hunt a variety of prey animals, but some of them have a preference towards a specific prey item and have specialized to feed on this prey. Along with the bill, the feet are the primary hunting tools of raptors and so it is expected that foot morphology will vary with diet or prey handling techniques. The shape of the tarsometatarsus is strongly correlated with limb function and can be used to study the functional morphology of the foot in respect to different avian lifestyles (e.g., capture of prey, perching behavior, feeding behavior, etc.). This analysis used the shape of the distal end of the tarsometatarsus in 9 species of modern carnivorous birds to assess whether the shape of the bone indicates prey preference or hunting technique. A 3D Geometric Morphometric analysis was performed using 33 landmarks across the front, back and top curvatures of the trochlea. The overall shape of the distal end was then used to analyze eagles, falcons, owls, vultures, and two species of non-predatory perching birds, totaling 33 specimens. My results showed that there is a strong correlation in the hunting technique of the predatory birds across PC1, which represents a tarsometatarsus shape spectrum going from more planar to more curvature at the distal end. In this analysis, the higher the curvature the more specialized the hunting technique; the lower the curvature, the more opportunistic the bird. Hunting techniques are indicative of the environment in which both the predators and prey are living, and knowing how extinct bird species were hunting has the potential to give insight into the kinds of environments they were inhabiting.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW NODOSAURID ANKYLOSAUR (DINOSAURIA) FROM THE LOWER ALBIAN ESCUCHA FORMATION, TERUEL, SPAIN REVEALS THAT SINCE THEIR APTIAN ORIGIN, NODOSAURID SPECIES IN NORTH AMERICA AND EUROPE DEFINE PALEOBIOGEOGRAPHICALLY SEPARATE CLADES

KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, United States, 84114-6100; ALCALA, Luis, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; LOEWEN, Mark, Univ of Utah, Salt Lake City, UT, United States; ESPILEZ, Eduardo, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; MAMPEL, Luis, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain

Associated ankylosaur skeletons are a conspicuous part of an extensive bonebed discovered below the lowest minable coal seam in the Santa María coal mine near Ariño, Spain. The most completely documented ankylosaur taxon from Europe, they are found with skeletons of the iguanodontian grade ornithopod *Proa valdearinnoensis*, large theropods, goniopholidid crocodilians, two species of turtles, fishes, invertebrates, and abundant plant remains. Two of the specimens from the AR-1 locality (AR-1/10 & AR-1/31) that together lack only the premaxilla, distal forelimbs, and lower portion of the scapula, were the focus of an initial description and phylogenetic analysis. Autapomorphies include wide quadrates, fully fused ischial-pubes with a slot-shaped obturator foramen, a strongly arched sacrum, and the greatest tibia/femur ratio of any ankylosaur. Nodosaurid synapomorphies include an elongate skull with subdued ornamentation, visible lower temporal fenestra, a large frontoparietal scale, broad pterygoids flexed dorsally at the front of the braincase, relatively long distal limb elements, a long tapering tail, and few lateral spines and plates. Unique synapomorphies of European nodosaurids are a straight ischium, an acromium process centered at the middle of the scapula, and erect armor incorporated into the sacral armor.

Restricted to Europe and North America, polacanthid ankylosaurs characterize Lower Cretaceous faunas until the middle Aptian. In North America, nodosaurids first appear in the upper Aptian of Maryland based on the neonate nodosaurid *Propanoplosaurus marylandicus*. However, *Sauropelta edwardsi* from the lower Albian Cloverly Formation of Montana and Wyoming is the oldest well-represented species. The new lower Albian Spanish nodosaurid is Europe's oldest. There are no definitive nodosaurids known in Asia. The replacement of polacanthids by nodosaurids occurred

during a time of rapid global warming and the rapid diversification of angiosperms near the base of Cretaceous long normal paleomagnetic interval. Additionally, the separation of the Nodosauridae into North American and European clades at the end of the Aptian was nearly simultaneous with the family's origin and their subsequent isolation, as flooding by rising sea level isolated and fragmented Europe.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

TRACKS AND BODY FOSSILS PRESERVE DIFFERENT CAMELID POPULATIONS IN THE BARSTOW FORMATION (MIOCENE) OF SOUTHERN CALIFORNIA

KLOESS, Peter, California State University, Fullerton, CA, United States, 92834-6850; FARKE, Andrew, Raymond M. Alf Museum, Claremont, CA, United States

Taphonomic biases are well-known factors affecting fossil assemblages, but such biases are often difficult to verify. One way to establish bias is by comparing the abundance of body and trace fossils for the same taxa in the same strata. Miocene-aged (Barstovian) camelids from the Barstow Formation of San Bernardino County, California offer an excellent opportunity for study due to the abundance of their bones and tracks, as well as their taxonomic diversity. Here, we compare the size distributions of tracks and metapodials to see if there were differences in the characteristics of each assemblage. The widths of camel tracks (n=326) were compared to mediolateral widths at the proximal ends of metapodials (n=62). Manual and pedal tracks could not be distinguished reliably, so metacarpals and metatarsals were considered together. The widths of the proximal ends of metapodials were used as a skeletal proxy for foot width because these elements are easily identifiable and abundant in museum collections. We compared distributional shapes because track and metapodial widths were not directly comparable. The track sample exhibited a leptokurtic distribution, with skew towards smaller footprints, whereas the osteological sample was skewed toward larger individuals with a distribution nearing platykurtic. These differences could be due to taphonomic effects or collection bias; i.e., larger camels may have avoided substrates likely to leave footprints, or perhaps their bones are more durable and easily found. Ultimately, the data confirm major differences in the composition of track and bone assemblages, warranting caution when trying to base ecological inferences on one or the other alone.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

TAPHONOMIC ANALYSIS OF FOSSIL FRESHWATER TURTLES IN THE UPPER CRETACEOUS (CAMPANIAN) KAIPAROWITS FORMATION OF SOUTHERN UTAH

KNELL, Michael, Southern Connecticut State University, New Haven, CT, United States, 06515

A diverse assemblage of fossil freshwater turtles can be found in southern Utah within exposures of the Upper Cretaceous (Campanian) Kaiparowits Formation, which is comprised of primarily fluvial and floodplain deposits. Common taxa include a variety of baenids, adocids, and trionychids in addition to a kinosternid, chelydrid, *Compsemys*, and *Basilemys*. A taphonomic analysis of the Kaiparowits fossil turtles was conducted to identify links between the morphology of each turtle taxon, the depositional environment in which it was buried, and the quality of preservation of each specimen. Over 700 turtle specimens were examined in both museum collections and in the field to collect taphonomic data such as specimen completeness, degree of post-mortem bone modification, and, when possible, depositional environment as inferred by encasing sediments. The vast majority of Kaiparowits turtle specimens examined consist of only shells or shell fragments, but there are a few that have associated skull and/or appendicular skeletal elements including one remarkable specimen containing multiple preserved fossilized eggs.

The results of the taphonomic analysis showed a preservation preference towards turtles that were buried within channel deposits over floodplain deposits, but only for those with robust shells. Remains of the largest turtle taxa, such as *Neurankylus* and *Basilemys*, were common, but typically only as fragmentary remains. Specimens of *Denazinemys* and *Adocus* were more likely to be found in channel deposits as intact shells rather than fragments, likely due to their robust shell morphology. The smallest turtle taxa were found frequently as only fragmentary remains, primarily in overbank, floodplain, and pond deposits. In terms of preservation, the optimal combination of having a moderately sized, robust shell with burial in a fluvial channel produced the most complete, highest quality specimens. Based upon the abundance of taxa within each depositional environment, inferences were made regarding probable habitat preferences. Turtles found more commonly in channel deposits, such as *Adocus* and the baenids, are believed to have preferred riparian habitats when alive, while those found more commonly in floodplain and pond deposits, such as *Compsemys*, the kinosternid, and the chelydrid, probably preferred to inhabit those environments.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A NEW TITANOSAURIAN SAUROPOD NEUROCRANIUM FROM THE LATE CRETACEOUS OF SPAIN

KNOLL, Fabien, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain; WITMER, Lawrence, Ohio University, Athens, OH, United States; RIDGELY, Ryan, Ohio University, Athens, OH, United States; ORTEGA, Francisco, Universidad Nacional de Educación a Distancia, Madrid, Spain; SANZ, Jose Luis, Universidad Autónoma de Madrid, Madrid, Spain

The Spanish Late Cretaceous (Campanian or Maastrichtian) site of "Lo Hueco" has yielded a wealth of sauropod bones. However, only two braincases are represented among these specimens. The first presents certain similarities (but also differences) with the braincase of *Ampelosaurus atacis* from the Campanian of France. It has been recently described in detail as *Ampelosaurus* sp.

The second new specimen enhances our knowledge of the cranial anatomy of European titanosaurs, which remains poor despite recent improvements. It is short and deep in overall morphology. The frontal is rostrocaudally short. A ventrally curved process (? prefrontal) projects from its rostrolateral corner. The parietal is characterized by two crescentic crests on both sides of the median plan. The supraoccipital is a small, rounded bone. The caudal surface of the otoccipital is fairly flat. The paroccipital process is aliform and strongly arches ventrally. The basioccipital is a relatively high but short bone. In caudal view of the braincase, the parabasispenoid makes up the very ventral extremity of the basicranium, just beneath the basal tubera. Both basipterygoid processes are broken near their base. However, it can be inferred from what remains that they probably diverged from one another in a widening U-shaped fashion. The adductor chamber is partially filled with matrix on both sides, largely concealing the prootic. The chamber is very short rostrocaudally and the prootic is even shorter. As in other dinosaurs, a conspicuous trigeminal foramen pierces the lateral wall of the braincase. The laterosphenoid is characterized by a thin capitate process. The orbitosphenoid is carinate.

A flat occiput is a phylogenetically restricted character within titanosaurs. The same condition is found in both *Ampelosaurus* and *Jainosaurus septentrionalis* from the Maastrichtian of India. Nevertheless, the new specimen presents several features (such as a dorsoventrally elliptical foramen magnum) suggesting that it did not pertain to the same species as the other titanosaur braincase from "Lo Hueco". It appears so close to the "*Jainosaurus* morph" braincase that a phylogenetic proximity with *Jainosaurus* is likely.

Technical Session IX (Friday, November 1, 2013, 10:15 AM)

FIRST RECORD OF A DINOSAUR NESTING COLONY FROM MONGOLIA REVEALS NESTING BEHAVIOR OF THERIZINOSAUROIDS

KOBAYASHI, Yoshitsugu, Hokkaido University, Hokkaido, Japan; LEE, Yuong-Nam, Korea Institute of Geoscience & Mineral Resources, Daejeon, Korea, Republic of (South); BARSBOLD, Rinchen, Paleontological Center, Ulaanbaatar, Mongolia; ZELENITSKY, Darla, University Of Calgary, Calgary, AB, Canada; TANAKA, Kohei, University Of Calgary, Calgary, AB, Canada

In the western Gobi Desert of Mongolia, dinosaur eggs are commonly discovered from the Upper Cretaceous beds and shed light on nesting behaviors. However, dinosaur eggs from the eastern Gobi Desert are relatively rare. In 2012, a colonial nesting ground of a theropod dinosaur, containing at least seventeen clutches of eggs in a single stratigraphic horizon within an area of 22 m by 52 m, was discovered from the middle part of the Javkhlant Formation in the eastern Gobi. The egg-bearing horizon consists of a red-brown mudstone with caliche nodules and is interpreted as a paleosol of overbank deposits in a proximal alluvial plain in a seasonally-arid setting. Each clutch contains up to eight spherical eggs (13 cm in a diameter) in a single layer. Eggs in each clutch are in contact and form a circular structure without a central opening. The size of one clutch, containing eight eggs, is 51 cm by 43 cm, and clutches are laid in close proximity (shortest distance 1.4 m apart, and four clutches within a 4 m by 4 m area). Eggshell is approximately 1.5 mm thick and has a rough outer surface without distinct ornamentation. Microscopic analyses of eggshells show the dendrospherulithic morphotype with a prolatocanaliculate pore system. All these features suggest that the Javkhlant eggs belong to the Dendroolithidae, an egg type that was previously unreported from the eastern Gobi. Dendroolithids have previously been ascribed to therizinosauroids based on *in ovo* embryonic remains from China. Although there is no record of therizinosauroids from the Javkhlant Formation, remains of large therizinosaurs (*Enigmosaurus*, *Erlikosaurus*, and *Segnosaurus*) are common from the underlying Bayanshiree Formation. This discovery represents the first nesting colony of a non-avian theropod dinosaur in Asia and the largest known non-avian theropod colony. Multiple egg clutches indicate that some therizinosauroids were colonial nesters, behaviors also described for hadrosaurids, prosauropods, titanosaurs, and birds. Egg clutches within a single stratigraphic layer at the outcrop suggests these dinosaurs nested at this site on a single occasion, indicating no site fidelity.

Technical Session IV (Wednesday, October 30, 2013, 4:00 PM)

THE ROLE OF NETWORK STRUCTURE IN PLEISTOCENE MEGAFAUNA EXTINCTIONS

KOCH, Paul, University of California, Santa Cruz, CA, United States, 95064-1077; PIRES, Mathias, Universidade de Sao Paulo, Sao Paulo, Brazil; GUIMARAES, Paulo, Universidade de Sao Paulo, Sao Paulo, Brazil

The end of the Pleistocene was marked by the extinction of most large land mammals (the megafauna). Debate about the megafaunal extinction has focused on possible external triggers for the event, such as climate change, floral change, and the direct and indirect impacts of humans. Extinction events are not only the result of external factors, however; they also depend critically on how species interactions modulate the propagation of perturbations. We combined paleontological data and approaches from ecological network theory to explore the role of species interactions in shaping the fragility of past and present assemblages of large mammals. First, we investigated whether there were intrinsic characteristics of Pleistocene communities that made them more vulnerable to collapse than surviving African communities. Then we evaluated if the basic characteristics of large-mammal communities could explain extinction patterns in the Late Pleistocene. Finally, to understand possible effects of human arrival in the Americas, we tested how the invasion by a new predator would impact dynamics by altering community organization.

We compiled data on the composition and body mass of Pleistocene large mammal faunas from five North American and four South American sites, as well as three modern African communities. To account for the uncertainty inherent to any characterization of

ecological networks, we used a probabilistic model (parameterized using the body mass of herbivores and predators) to generate ensembles of realistic potential Pleistocene networks. We constructed community matrices from these networks, and then used eigenvalue analysis to explore the dynamical behavior of these potential networks when subjected to a perturbation, and whether basic community characteristics (i.e., species richness, the average mass of predator and prey) affect their stability. We found that Pleistocene communities were not more responsive to perturbations than extant African communities, but were remarkably more vulnerable to the arrival of new predators such as humans. In addition, our analyses suggest that high predator richness has destabilizing effects, whereas high richness of large herbivores favors the stability of large mammal predator-prey systems. Our findings may explain why the extinction in North America preceded the demise of South American megafauna. More generally, they emphasize how information on the network organization of species assemblages can contribute to our understanding of past and future extinction events.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE FIRST NEARLY COMPLETE SKULL OF *STEGOLOPHODON* (STEGODONTIDAE, PROBOSCIDEA) FROM THE LOWER MIOCENE OF JAPAN

KODA, Yoshiki, Ibaraki Nature Museum, Bando, Japan; SAEGUSA, Haruo, University of Hyogo, Sanda Hyogo, Japan; ANDO, Hisao, Ibaraki University, Mito, Japan; IIZUMI, Katsunori, Ushiku City, Ibaraki, Japan

Stegolophodon is an extinct elephant-like proboscidean that flourished in Asia from the late early Miocene to Pliocene. Three stegolophodont species have been described from the Miocene of Japan. However, these species are defined on the basis of limited specimens of a few disarticulated teeth, an incomplete skull and a mandible. The first nearly complete skull specimen of *Stegolophodon* (INM-4-013853) was recovered from a sandstone unit in the upper lower Miocene Tamagawa Formation, Ibaraki Prefecture, eastern Japan; this unit represents estuary deltaic paleoenvironments. Trace fossil assemblages and plant fossils, which suggest warm and humid paleoclimate, were also observed in this unit. The nearly complete skull includes a rostrum that preserves parts of the zygomatic arches, maxillae, palate, and M1–M3 molars. The braincase, basicranium, and petrosal morphology are also preserved, although some aspects of the skull are badly crushed, and not all parts are preserved on both the left and right sides. The specimen exhibits the following features:1) eruption angle of M3 steep; 2) post-glenoid fossa deep; 3) lingual and buccal sides of the molars worn almost equally; 4) molars with weakly developed single trefoiling; 5) M2 with 4 lophs; M3 with 5 lophs; 6) upper tusk with oval cross section, enamel band and prominent ventral concavity; 7) maxillary with two infraorbital foramina; 8) the rostrum is very narrow, and the palate is convex and narrow. The dentition indicates that the individual was a small young adult. The first three features suggest the derived propalinal jaw movement was already developed in this animal, while sixth and seventh features represent the primitive features for Elephantoidea. The eighth character is shared with *Stegodon*, and considered to be a synapomorphic character of the Stegodontidae (*Stegolophodon* and *Stegodon*).

Technical Session V (Wednesday, October 30, 2013, 3:30 PM)

WHO GETS TO EAT WHAT: NICHE PARTITIONING BETWEEN PHYLOGENETICALLY CLOSELY RELATED BUT MORPHOLOGICALLY DISPARATE MOSASAURS (MOSASAURIDAE: MOSASAURINAE), *MOSASAURUS MISSOURIENSIS* AND *PROGNATHODON OVERTONI*, BASED ON NEW MATERIAL FROM THE UPPER CAMPANIAN BEARPAW FORMATION, ALBERTA, CANADA

KONISHI, Takuya, University of Alberta, Edmonton, AB, Canada, T6G2E9; NEWBREY, Michael, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada

A new, exquisitely preserved specimen of a small individual of a mosasaurine mosasaur, *Mosasaurus missouriensis*, is reported from the Bearpaw Formation (ca. 75 Ma, upper Campanian) of southern Alberta, Canada. The material comprises an articulated partial skeleton with a skull and many calcified cartilaginous elements, among which are tracheal rings and the sternum; this is the first-known co-occurrence of these cartilaginous structures in the genus and the second in the family Mosasauridae. Moreover, inside the ribcage and around the specimen are well-preserved aulopiform fish bones including a skull, representing a meter-long fish. The fish remains constitute the very first stomach contents to be reported for the genus *Mosasaurus* and provide new paleoecological insights. The fish skull is punctured and its centra are truncated, suggesting that macrophagy was employed in *M. missouriensis* despite the dentition of gracile nature and the apparent lack of tooth wear. Known from the identical horizon in the same Bearpaw quarry is a specimen of another mosasaurine mosasaur *Prognathodon overtoni*. This specimen is confirmed to have consumed a sea turtle as well as fishes, and consistently exhibits apical wear across bulbous marginal teeth. The two mosasaurines also exhibit a clear disparity in jaw morphology, where in *P. overtoni* the dentary is short and bowed, and the opposite conditions are present in *M. missouriensis*. Consequently, we hypothesize that coexistence of these apex predators, *M. missouriensis* and *P. overtoni*, in the Bearpaw Sea was possible because of niche partitioning, where the latter preferentially consumed harder prey items and the former predominantly or, even exclusively, preyed upon fish. At this time, we lack direct evidence for intra-familial predation including cannibalism among mosasaurs from this mosasaur-rich Bearpaw quarry in southern Alberta.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DISTINGUISHING DISASSOCIATED ELEMENTS OF *CANIS DIRUS* FROM *CANIS LUPUS* AT RANCHO LA BREA: LINEAR TRENDS OFFER A NEW INSIGHT INTO SPECIES IDENTIFICATION WHEN CRANIAL AND DENTAL INFORMATION IS UNAVAILABLE

KOPER, Lindsey, Northern Illinois University, DeKalb, IL, United States, 60115

The preservation process at Rancho La Brea makes it difficult to identify postcranial material accurately, especially to discern the difference between *Canis lupus* and *Canis dirus*. The tar pits actively 'mix' and disarticulate the remains of organisms, preventing any one element from being associated with another. According to the original description of *C. dirus* from Rancho La Brea, distinguishing a *C. dirus* from a *C. lupus* is primarily achieved by the use of the dentition and cranial features. The description of postcranial material is not as complete; therefore, overall size of each bony element is the determining factor. There is no known numerical measurement range for individual postcranial elements that can be used to separate *C. dirus* and *C. lupus*.

Because of the lack of completeness of the fossil data, I compiled digital caliper measurements of the scapulae, humeri, and ulnae of *C. dirus* from Rancho La Brea (pit 3) to compare against similar measurements of modern *C. lupus*. Most of the *C. lupus* specimens used in this study represent wild populations that included sex and age information. These animals were collected from Minnesota, Michigan, Wisconsin, Alaska, and the Canadian provinces of Ontario and Alberta.

By comparing linear measurements of both taxa, I was able to determine statistically relevant differences in the forelimb bones between *C. dirus* and *C. lupus*. For example, when comparing humeral length versus humeral depth at the deltoid tuberosity, *C. dirus* separates out from modern *C. lupus* and Pleistocene age *C. lupus*.

Being able to provide numerical size ranges for individual bony elements, these disarticulated canid species can be more accurately identified based only upon postcranial material. Establishing overall size minima and maxima will make it easier to determine size overlap between *C. dirus* and *C. lupus* specimens. Also, these size ranges can be applied as a reference tool to other fossil sites where cranial material that can be used for identification for canids is lacking.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ORIGINS, EVOLUTION, AND CLASSIFICATION OF TRUE SEALS AND THEIR PALEOBIOGEOGRAPHICAL IMPLICATIONS

KORETSKY, Irina, Howard University, Washington, DC, United States, 20059; RAHMAT, Sulman, Howard University, Washington, DC, United States; GILLAND, Edwin, Howard University, Washington, DC, United States

The family Phocidae originated from primitive Carnivora in the late Early Oligocene on the Paratethyan Sea coast, dispersed during the Middle–Late Miocene, and disappeared from the Eastern-Central Paratethys by the Early Pliocene. Originally, Paratethyan seals lived in warm waters, but global cooling caused cold-water adaptations, followed by dispersal. The eastern limit of the Paratethys was the Caspian Basin in the Miocene, but in the Late Pliocene, it extended farther east. Ancestors of *Pusa sibirica* dispersed westward (12.5 Ma) to the Atlantic Ocean via the Western Paratethys and north to the Arctic Ocean. From there, *Pusa* could have migrated south to Lake Baikal via the Yenisey River (3.0 Ma). Fossil *Leptophoca* share characteristics with representatives of other subfamilies and originated on the coast of Western Europe (15.8-16.4 Ma). This genus dispersed across the Atlantic to the western shore of the North Atlantic in Calvert time (14.2-15.0 Ma) and spread south in St. Mary's time (8.5-10.5 Ma). The first discovery of two new cystophorine species from the Middle Miocene of southern Ukraine provides a unique opportunity to study sexual dimorphism in fossil and modern seals. These new species show a mosaic of primitive characters and were more adapted to terrestrial locomotion than any living representative of this subfamily. Phylogenetic analyses show that seals with 10 incisors (Phocinae) are more primitive than those with 8 (Monachinae), which are more primitive than those with 6 (Cystophorinae). The subfamily Cystophorinae, includes not only two Recent taxa, but also the two new extinct seals. *Devinophoca claytoni*, from the early Middle Miocene of the Central Paratethys, is the sister taxon to the three extant subfamilies, is morphologically the closest common ancestor of all true seals, and presents a mixture of subfamilial characters. The family Phocidae should be regarded as monophyletic, including four subfamilies: Devinophocinae, Phocinae, Monachinae, and Cystophorinae. Critical examination of certain questionable characters demonstrated that many morphological differences strongly support a diphyletic origin of pinnipeds. The paleontological record confirms biogeographical, phylogenetic, and morphological arguments of separate ancestries, with phocids originating in the North Atlantic and otarioids in the North Pacific. Recent Libyan finds, the oldest in the Eastern Hemisphere, also support the hypothesis that Phocidae originated in the Paratethyan and/or Mediterranean Basins no later than the late Oligocene.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FIRST ASSOCIATED UPPER DENTITION OF A GONDWANATHERIAN MAMMAL

KRAUSE, David, Stony Brook Univ, Stony Brook, NY, United States, 11794-8081; HOFFMANN, Simone, Stony Brook Univ, Stony Brook, NY, United States; NESTLER, Jennifer, Stony Brook Univ, Stony Brook, NY, United States

A recently discovered, virtually complete, and well-preserved cranium from the Late Cretaceous of Madagascar preserves the first associated upper dentition of a gondwanatherian mammal. Gondwanatherians are known almost exclusively from isolated teeth, particularly molariforms. As such, referral of the cranium to the Gondwanatheria, differentiation of the new genus and species it represents, and determining the relationships of the new taxon relative to the eight other known

gondwanatherian monotypic genera must rely heavily on molariform cheek tooth morphology. The hypsodont nature, morphology, and wear pattern of its molariform teeth serve to unequivocally identify the cranium as that of a sudamericid gondwanatherian. The size, shape, and number of alveoli of the missing teeth and the internal morphology of the molariform teeth, particularly the conformation of the infundibula and the pulp cavities, are revealed from microCT scans.

Based on available morphology, the new taxon appears to have had an upper dental formula of 2.0.1.4, therefore complementing the lower dental formula of 1.0.0.4–5 inferred for two other gondwanatherian taxa. The cranium of the new Malagasy taxon has two long, curved alveoli in each premaxilla for enlarged, procumbent incisors that were well separated from the cheek teeth by a diastema; there is no evidence of a canine. Also judging from alveoli, the single premolar on each side appears to have been small and peg-like; neither the left nor the right crowns are preserved. Four upper molariform teeth are retained in the cranium, three in the left maxilla (antepenultimate, penultimate, and ultimate) and one in the right (penultimate). These teeth and alveoli for those that are missing demonstrate that the new taxon had four molariforms (MF1–MF4) in each upper jaw quadrant, the first and last of which were smaller than MF2 and MF3. The molariform cheek teeth have several salient characteristics: large size, hypsodont crowns, roughly quadrangular occlusal outlines, occlusal surfaces worn essentially flat, presence of numerous cementum-filled infundibula, presence of cementum-filled furrows that invaginate from the labial side but do not extend to the base of the crown, and multiple short roots.

The heavily worn teeth indicate that the cranium is that of a senescent individual. Comparisons to the cheek teeth of other gondwanatherians and inferences drawn from the least worn molariform tooth (MF4) in the new taxon allow reconstruction of the occlusal morphology in the molariform teeth of younger individuals.

Technical Session VIII (Thursday, October 31, 2013, 2:45 PM)

HIGH RESOLUTION X-RAY COMPUTED TOMOGRAPHY RECONSTRUCTION OF A NEW, WELL PRESERVED THEROCEPHALIAN SKULL, WITH INSIGHTS ON THEROCEPHALIAN PHYLOGENETICS AND CHARACTER EVOLUTION

KRENTZEL, Dallas, University of Chicago, Chicago, IL, United States, 60615; FLYNN, John, American Museum of Natural History, New York, NY, United States; KAMMERER, Christian, Museum für Naturkunde, Berlin, Germany

Therocephalians were a diverse group of therapsids known from the Middle Permian to Middle Triassic. They exhibited a wide range of ecomorphologies, including large, saber-toothed carnivores, small weasel-like predators, and herbivorous forms with transversely expanded post-canine dentitions. The diversity of morphologies and the propensity for homoplasy have made phylogenetic reconstructions at higher taxonomic levels challenging, and thus the pattern of character evolution for the many distinct apomorphies that evolved across the clade has remained elusive. Here we describe, based on high resolution computed tomography (CT) scans acquired in the American Museum of Natural History's Microscopy and Imaging Facility, a new, well preserved therocephalian skull from the Upper Permian *Tropidostoma* Assemblage Zone in the Karoo Basin, South Africa. The presence of a large septomaxilla, narrow rostrum, and posterior processes of the nasals tentatively ally the new specimen with *Ictidostoma hemburyi* in the family Hofmeyriidae. CT data from the fragmentary holotype of *I. hemburyi* reveal that this species has a full lower postcanine arcade, resembling the primitive therocephalian condition; however, the new specimen shares with *Hofmeyria* and *Mirotenthes* a more derived lower tooth row, in which the few lower postcanines are restricted to a raised shelf anteriorly. A phylogenetic analysis was conducted using 23 therocephalians across a broad range of recognized families and representatives from four therapsid outgroups. Both *I. hemburyi* and the new specimen were placed at the base of a clade containing Hofmeyriidae and Whaitsiidae (Whaitsioidea). This analysis suggests that the characteristic banana-shaped dentary seen in all whaitsioids appeared first, followed by a restriction of lower postcanine teeth to an anterior shelf (as seen in the new specimen and hofmeyriids). An enlargement of the temporal fenestra occurred in hofmeyriids and whaitsiids, along with continued reduction of postcanine teeth, with total loss of postcanines in the whaitsiid *Theriognathus*. Finally, a more detailed analysis of character evolution in this group highlights extensive parallelism between various eutherocephalians and cynodonts, with mammal-like characters (enlarged temporal fenestrae, secondary palate, etc.) evolving multiple times independently in therocephalian history.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

EVOLUTION OF BASAL GNATHOSTOME EGG CAPSULE MORPHOTYPES

KRIWET, Jürgen, University of Vienna, Vienna, Austria; FISCHER, Jan, TU Bergakademie Freiberg, Freiberg, Germany; LICHT, Martin, Museum fuer Naturkunde Berlin, Berlin, Germany; BUCHWITZ, Michael, Museum fuer Naturkunde Magdeburg, Magdeburg, Germany; BARTSCH, Peter, Museum für Naturkunde Berlin, Berlin, Germany

Chondrichthyan fishes are characterized by internal fertilization with either oviparous (egg-laying) or viviparous (life-bearing) reproductive modes. Although viviparity represents the dominant type of reproduction in all extant species, oviparity is generally considered to be the ancestral reproductive mode, which also is confirmed by fossil finds. Chondrichthyan egg capsules have been well-known since the 19th century, although their systematic affinities have long been a source of conjecture and controversy. To date, ten distinct morphotypes of chondrichthyan egg capsules are distinguished representing a range of species-specific morphological traits. Eight egg capsule morphotypes are known from the fossil record with five types being exclusively represented by fossil finds. Their phylogenetic signal and evolutionary traits have not been analyzed until now. Here, we present an analysis of all extant and currently known fossil chondrichthyan egg capsule types, and use a putative placoderm egg capsule as outgroup for character polarity. The phylogenetic hypothesis based on discrete morphological characters indicates that the enigmatic Carboniferous egg capsule morphotypes *Vetacapsula* and *Crookallia* form a monophyletic group together with the egg capsule morphotype of chimaerid holocephalans. The elasmobranch egg capsule morphotypes are more derived and sister to the holocephalan types since the Late Paleozoic. Based on our results, we conclude that the ancestral chondrichthyan egg capsule morphotype closely resembles the callorhinchid holocephalan and placoderm morphotypes with a broad, lateral, ribbed collarette. From this ancestral type, two lineages of basal gnathostome egg capsule morphotypes diverged leading towards the major modern holocephalan and elasmobranchian egg capsule morphotypes. The conservative and similar egg capsule morphology of placoderms and holocephalans confirm the latest results, that holocephalan and placoderm fishes might be more closely related than holocephalans and elasmobranchs.

Symposium 1 (Wednesday, October 30, 2013, 9:45 AM)

HISTOLOGICAL STUDY OF CRANIAL ELABORATION IN CERATOPSIAN DINOSAURS: FUNCTIONAL & DEVELOPMENTAL IMPLICATIONS

KRUK, Betsy, University of Alberta, Edmonton, AB, Canada, T6H 2P9; BURNS, Michael, University of Alberta, Edmonton, AB, Canada; CURRIE, Philip, , Edmonton, AB, Canada

Hypotheses for the developmental processes of cranial elaborations in ceratopsians have relied upon gross morphology and studies of morphological changes in taxa with relatively complete growth series. To date, these hypotheses have not been tested using histology. A study on the cranial epidermal coverings of centrosaurine skulls, however, did investigate the nasal boss histology of *Pachyrhinosaurus* as a correlate for the keratinized covering of that unique structure. Here the histological data available is expanded for the cranium of *Pachyrhinosaurus*, a centrosaurine ceratopsian dinosaur that has cranial bosses in place of bony horn cores. In addition, other cranial material from Late Cretaceous Albertan ceratopsians of various ontogenetic stages is examined. The focus of this study is to test whether morphologically diverse cranial elaborations in ceratopsians demonstrate similarly diverse developmental processes via paleohistological analysis. Overall, cranial elaborations in ceratopsians are observed to be intramembranous in origin, not metaplastic. This is in contrast to some other dinosaurs, such as the ankylosaurs, whose cranial elaborations form via combinations of metaplastic mineralization of the dermis and intramembranous outgrowth of the cranial vault bones. In the specimens examined, these structures generally contain trabecular bone at maturity, but the nasal bosses show thinner trabeculae than the other cranial material sectioned. Secondarily remodeled bone is common among all elements examined, with occasional interstitial primary fibrolamellar bone preserved. Periosteal bone was observed in only two horn core specimens. Trabecular bone in the examined specimens is mostly associated with mature structures, commonly found with resorption pits and spicules. An immature horn core examined exhibited radial fibrolamellar bone, which suggests that the bone was growing quickly at the time of the animal's death. Secondary remodeling in this specimen is restricted to the core and retains a high proportion of the primary fibrolamellar bone. This study proposes that all ceratopsian cranial elaborations grow rapidly as primary, fibrolamellar outgrowths of the dermatocranium and remodel, later in ontogeny, into mature, largely trabecular structures.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

OSTEOLOGICAL OBSERVATIONS ON NEW SPECIMENS OF *ORYCTODROMEUS* SP. FROM THE BLACKLEAF FORMATION OF MONTANA AND THE WAYAN FORMATION OF IDAHO

KRUMENACKER, L.J., Montana State University, Bozeman, MT, United States, 59715; BRITT, Brooks, Brigham Young Univ, Provo, UT, United States; VARRICCHIO, David, Montana State Univ, Bozeman, MT, United States; SCHEETZ, Rodney, Brigham Young Univ, Provo, UT, United States; FEARON, Jamie, Montana State University, Bozeman, MT, United States

Oryctodromeus, a basal euornithopodan, is the most common and most complete dinosaur in the Cenomanian foredeep assemblages of Idaho (Wayan Formation) and Montana (Blackleaf Formation). The taxon was first described from the Blackleaf Formation of Montana. While the Idaho specimens lack the specific cranial material to allow assignment to the species level, postcranial characters indicate the specimens are congeneric. Here, we present newly observed osteological characters shared by specimens from both formations, and note their distribution in related genera.

Salient features of the axial column include elongate centra throughout the vertebral column. The length to height ratio of the cervical centra is 1.6 while in the dorsal centra the ratio is 1.4. Similarly elongate centra are present in *Koreanosaurus*. The function of this elongation remains unknown. The caudal series contains more than 55 vertebrae, with the centra quickly becoming elongate and hexagonal in cross section, as in *Zephyrosaurus*. While the holotype of *Oryctodromeus* lacks ossified tendons, additional specimens from both formations possess epaxial tendons beginning in the anterior dorsal vertebrae while the caudal vertebrae are encased in sheaths of epaxial and hypaxial tendons. The presence/absence of ossified tendons may relate to sexual dimorphism or ontogeny.

Notable appendicular features include an exceptionally elongate preacetabular process of the ilium. The paratype specimen was described as possessing an ilium with a short preacetabular process but the process was incomplete. In specimens where pelvic elements are articulated with the sacrum the ilia are aligned with the ventral portions flaring away from the sacrum at an approximate angle of 30° below the horizontal, with the dorsal blade of the ilium nestling against the transverse processes and neural spines of the sacral vertebrae – a character shared with *Orodromeus* and *Koreanosaurus*. Similar to the condition reported in *Koreanosaurus* the femur has a hemispherical head projecting from the shaft at an angle of 38° above the horizontal on an elongate neck that angles above and away from the greater trochanter. In *Koreanosaurus* these femoral characters were interpreted as evidence that the hind limbs were used as a brace to counteract

forelimb digging. We note the configuration permitted a greater range of motion, suggesting a shift in locomotion habits and perhaps the use of hind limbs in earthmoving, such as the relocation of excavation debris.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PRELIMINARY PHYLOGENETIC AND HISTOLOGICAL ANALYSIS OF A LATE TRIASSIC SAUROPODOMORPH FROM THE LOWER ELLIOT FORMATION OF LESOTHO

KRUPANDAN, Emil, University of Cape Town, Cape Town, 7700 , South Africa; OTERO, Alejandro, Museo de La Plata, La Plata, Argentina; CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, 7700 , South Africa

One of the richest known Late Triassic – Early Jurassic sauropodomorph faunal assemblages is the Elliot Formation of South Africa. It is dominated by sauropodomorph dinosaur remains consisting of *Antetonitrus ingenipes*, *Blikanasaurus cromptoni*, *Melanorosaurus readi*, *Massospondylus carinatus*, *Plateosaurus cullingworthi*, *Eucnemesaurus fortis* and *Aardonyx celestae*. In the current study, we assessed the remains of undescribed sauropodomorph material that was excavated during the 1950s from the Late Triassic Lower Elliot Formation in Lesotho. The material is represented by at least 5 individuals of varying ontogenetic sizes, excludes crania, but comprising of more than 250 postcranial elements. Previous researchers suggested that the material belonged to either a "prosauropod" similar to either *Plateosaurus* or *Melanosaurus*, or to *Euskelosaurus browni* (nomen dubium). In the current study, we performed a detailed character analysis to assess the taxonomic affinity of this dinosaur material. In addition, we conducted histological studies of three femora to deduce aspects of its biology and growth dynamics.

Our phylogenetic analysis recovers the postcranial material as a basal non-eusauropod sauropod, in a polytomy with *Antetonitrus*, *Lessemsaurus*, *Gonxianosaurus* and an as yet unnamed taxon from Argentina (Universidad Nacional de La Rioja specimen PULR 136). Based on the sharing of three of the five apomorphies of *Antetonitrus* it appears that these remains represent multiple individuals of *Antetonitrus* or a very closely allied taxon.

The femoral bone histology shows highly vascularised fibrolamellar bone tissue, suggesting rapid rates of bone deposition. Towards the outer 8% there appears to be a slowdown in the rate of bone formation, with several lines of arrested growth evident. This growth pattern differs from that of basal sauropodomorphs and is generally consistent with that observed in sauropods.

Our cladistic and histological findings suggest that the material from Lesotho represents a basal sauropod, possibly *Antetonitrus* or otherwise a close relative.

Technical Session XIV (Saturday, November 2, 2013, 11:30 AM)

NEW OLIGOCENE WATERBIRDS: PHYLOGENETIC ANALYSES AND IMPLICATIONS FOR TRANSITIONS IN THE WESTERN ATLANTIC AVIFAUNA

KSEPKA, Daniel, National Evolutionary Synthesis Center, Druham, NC, United States, 27705

Paleogene birds from the Atlantic coast of North America remain vanishingly rare, hindering our understanding of past marine avian communities and their response to re-organization of ocean systems. Fossils from South Carolina open a window into a remarkable Oligocene avifauna, revealing wholesale differences from better-known Neogene regional avifaunas. A total of 75 specimens, including two well-preserved skulls, are reported from the Chandler Bridge and Ashley Formations. Nine distinct species are represented in the avifauna, and the majority range across both formations. Plunge-diving sulids dominate in abundance and diversity. Four species with body sizes spanning the entire size range of extant Sulidae occur in the avifauna. Two species of the giant pseudotoothed bird *Pelagornis* (Pelagornithidae), one species of the small albatross *Plotornis*, and two petrels are also represented.

Phylogenetic relationships of the new sulid species were tested using a large morphological matrix modified from previous studies. In the primary analysis, the new species were recovered as the sister clade of the extant taxon *Sula*, nested well within the crown clade Sulidae. However, the analysis is highly sensitive to the signal from skeletal pneumaticity. In a subsequent analysis excluding all characters pertaining to pneumatic features, the position of the fossil species shifted outside of the crown clade Sulidae. Because discrete skeletal characters not pertaining to pneumaticity and the stratigraphic distribution of sulid fossils are both more consistent this basal position, the potential for multiple independent increases in skeletal pneumaticity in Sulidae is raised. In a separate analysis using a new matrix designed to more extensively sample Procellariiformes, *Plotornis* was recovered as a stem representative of the albatross clade (Pan-Diomedea).

Overall, the South Carolina avifaunas show an unexpected prevalence of surface-feeding and shallow-diving birds, with a complete lack of evidence for deeper diving taxa that are well-represented in Miocene avifaunas, including the wing-propelled diving Alcidae and foot-propelled Gaviiformes.

Preparators' Session (Thursday, October 31, 2013, 8:00 AM)

THE YUKA WOOLLY MAMMOTH (*MAMMUTHUS PRIMIGENIUS* BLUM) BRAIN EXTRACTION AND PRESERVATION: THE METHODS AND RESULTS

KURTOVA, Anastasia, Research Institute of Human Morphology, Moscow, Russia; KHARLAMOVA, Anastasia, Research Institute of Human Morphology, Moscow, Russia; PROTOPOPOV, Albert, Sakha (Yakutia) Republic Academy Sciences, Yakutsk, Russia; PLOTNIKOV, Valery, Sakha (Yakutia) Republic Academy Sciences, Yakutsk, Russia; POTAPOVA, Olga, Mammoth Site of Hot Springs, Inc., Hot Springs, SD, United States

The Yuka Woolly Mammoth was found in 2009 on the coast of the Dmitry Laptev Strait (Siberia, northern Yakutia). The radiocarbon dating of the of the 6 to 9 year old mammoth yielded results of 39,440 - 38,850 cal BP (GrA-53289). The carcass was transported to Yakutsk for studies in January 2012, and since then it has been stored below freezing temperature in stable conditions. The first CT scan of the cranium was performed at the Sakha (Yakutia) Republic Academy of Sciences, Yakutsk in May 2012 to access morphology of the unerupted molars. It unexpectedly revealed the preserved brain with well-defined major gross anatomy features, including frontal, temporal, and parietal lobes with gyri, and cerebellum with internal structures, which yielded the first chance to examine Woolly mammoth brain morphology. Brain extraction was performed based on our own experience combined with the generally used treatment for large mammals, including modern elephants. In February 2013 the brain was preserved by the method of flowing fixation developed by Prof. Saveliev (Research Institute of Human Morphology, Russian Academy of Medical Sciences (RIHM RAMS), Moscow, Russia), which included three weeks of continuously on-going preservation of the braincase content only using formalin (performed by I. Pavlov, Museum of History and Culture of People of the North). Skull trepanation was performed on February 25th in Yakutsk. An angle grinder was used for the initial cut and a dental drill for the sphenoid, frontal, and nasal areas. The inner mantle of the neurocranium was opened by chisels. The cutting line went through the lower part of occipital bones, the lateral parts of parietal bones, and across the temporal and cranial parts of frontal bones. After removal of the fornix cranii, the dura mater was dissected along three lines near the cerebral falx and cerebellar temtorium. The brain, which appeared to be dehydrated and very brittle, was lifted off the cranial base and removed manually, together with the dura mater. After the extraction the brain was wrapped with fabric for support and placed into formalin solution overnight before being flown to Moscow. It is currently stored in formalin solution at the RIHM RAMS, Moscow, Russia. The results of the Yuka brain's conservation proved the methods of preservation and extraction were very successful and could be applied to mummified carcasses of paleontological objects found in permafrost.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

GAIT RECONSTRUCTION FROM SAUROPOD TRACKWAYS USING PHOTOGRAMMETRY AND SOIL MECHANICAL FINITE ELEMENT ANALYSIS: A CASE STUDY FROM THE MIDDLE KIMMERIDGIAN BARKHAUSEN TRACKSITE, GERMANY

LÄBE, Sashima, Universität Bonn, Bonn, Germany; SANDER, P. Martin, Universität Bonn, Bonn, Germany; SCHANZ, Tom, Ruhr-Universität Bochum, Bochum, Germany; PREUSCHOFT, Holger, Ruhr-Universität Bochum, Bochum, Germany; WITZEL, Ulrich, Ruhr-Universität Bochum, Bochum, Germany

Dinosaur tracks occur in a variety of Mesozoic sediments and provide important information about locomotion and behavior of the trackmaker. The Upper Jurassic (middle Kimmeridgian) track locality of Barkhausen, northern Germany, exposes trackways of both sauropod and theropod dinosaurs. Several studies had been carried out to describe and name these tracks, with the sauropod tracks being of the narrow-gauge type and having been named *Elephantopoides barkhausensis* and the theropod tracks *Megalosauropus teutonicus*. However, a combined study on the track geometry for inferring locomotion patterns of the trackmakers and substrate analysis of the track-bearing sediments has not been done for the Barkhausen locality before.

The tracks were documented using photogrammetry, an effective and nondestructive method for 3D documentation that is scale-independent and especially suited for field conditions. Around 100 photographs taken with a consumer camera were processed into a textured (i.e., colored) 3D model of the trackways with the software Agisoft PhotoScan v. 0.9.0. From these models accurate measurements could be taken, and the footfall pattern of fore and hind feet of the trackmaker could be assessed, suggesting walk as gait. In addition, a historic partial cast of the tracksite, which is on display at the Osnabrück natural history museum in Germany, was documented with photogrammetry and compared with the original tracks to assess the effect of weathering on the original tracksite.

In order to reconstruct the gait of the sauropod trackmakers, an approach from soil mechanics was employed. The original track-bearing sediments were characterized by sediment petrography, including thin section analysis, to determine grain size and grain size distribution. Also, micro-CT analyses provided important information about porosity and stiffness of the sediment. Finite element models were built based on these parameters to reconstruct the forces producing observed sediment deformation. This data was then used to test hypotheses about gait.

Technical Session XV (Saturday, November 2, 2013, 11:30 AM)

A NEW ARCHAIC SHARK-TOOTHED DOLPHIN FROM THE LATE OLIGOCENE-EARLY MIOCENE OF PERU

LAMBERT, Olivier, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; BIANUCCI, Giovanni, Università di Pisa, Pisa, Italy; DE MUIZON, Christian, Muséum national d'Histoire naturelle, Paris, France; URBINA, Mario, Museo de Historia Natural, Universidad San Marcos, Lima, Peru

In past studies, fragmentary Oligo-Miocene heterodont cetacean remains were often referred to the shark-toothed dolphin family Squalodontidae, mostly based on plesiomorphic dental features: double-rooted cheek teeth with accessory crown denticles. For the last 20 years, the content of the family was reassessed and several of the heterodont cetaceans were attributed to other families, in the suborder Odontoceti (e.g. Simocetidae, Waipatiidae) or even within toothed-mysticetes and archaeocetes. However, the affinities of several species remain controversial, especially for the ones represented by isolated teeth. Recently, the articulated, almost complete, skeleton of a medium size heterodont cetacean was discovered in the Pisco-Ica desert, Peru, in late Oligocene to

early Miocene beds of the Chilcatay Formation. The robust and long-snouted skull is preserved with associated ear bones, mandible, upper and lower teeth. Together with ear bones and basicranium characters, the presence of deep antorbital notches, premaxillary sac fossae, and the maxillary covering of the frontal in the facial area point to an odontocete. Differing from squalodontids, the incisors are not procumbent and their crown is not fluted. Furthermore, the double-rooted cheek teeth lack marked cingula and papillae on the smooth labial and lingual surfaces of the crown. The accessory denticles of posterior cheek teeth are larger and more numerous than in squalodontids. As a whole, the crown is diamond-shaped rather than triangular as in *Squalodon*. Interestingly, these teeth are more similar to basilosaurid archaeocetes, and even closer to isolated teeth with uncertain relationships, for example the holotype of *Phococetus vasconum*, ?early Miocene of France, previously tentatively identified as a kekenodontid archaeocete. The large accessory ossicle of the tympanic bulla, the correspondingly wide fovea epitubaria on the periotic, the short tuberculum of the malleus, and the strikingly robust antorbital portion of the jugal are features also observed in physeteroids, the earliest diverging extant odontocete lineage. Differing from basilosaurids, the centrum of intermediate caudal vertebrae is higher than wide, a clue for the presence of a peduncle on the tail, ahead of the fluke. This new Peruvian find, not matching any of the known families, further evidences the Oligocene-early Miocene odontocete radiation(s). It may also help solving the systematic affinities of isolated double-rooted teeth, including some of the presumably post-Eocene archaeocetes.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DISPARITY DYNAMICS OF SMALL THEROPOD (COELUROSAURIA: DINOSAURIA) TOOTH ASSEMBLAGES FROM THE LATE CRETACEOUS OF NORTH AMERICA

LARSON, Derek, University of Toronto, Toronto, ON, Canada, M5S 2C6; BROWN, Caleb, University of Toronto, Toronto, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

Dinosaur diversity dynamics in the Late Cretaceous and their bearing on hypotheses of dinosaur extinction continue to be hotly debated. Patterns of species richness through the Campanian and Maastrichtian, as a proxy for ecological breadth and stability, have been used to argue for either gradual decline or long-term stability in dinosaurs leading up to the end-Cretaceous mass extinction. These analyses are hampered by disagreement among taxonomists about dinosaur synonymy and diversity, particularly in the latest Cretaceous. Morphological disparity and morphospace occupation are alternative measures of diversity that are free of the subjectivity of taxonomic opinion. Small-bodied theropod dinosaurs are an ecologically important carnivorous dinosaur guild. Although understanding of their alpha diversity patterns is severely limited by a lack of complete specimens, their fossil record preserves a massive sample of isolated teeth, which can convey information on their feeding ecology.

In order to assess patterns of diversity in this small theropod guild and test hypotheses of community stability leading up to the end-Cretaceous mass extinction, we amassed linear measurement data (using five standard variables) for over 3000 small theropod teeth from 18 lithostratigraphic units in the Western Interior Basin of North America. Results indicate that different groups (Troodontidae, Dromaeosauridae, *Richardoestesia*, *Paronychodon*) within this guild occupy distinct non-overlapping morphospaces that shift in position through time, but that morphological disparity (within groups and overall between different lithostratigraphic units, measured by both centroid size and Foote's disparity) show no significant shifts through the last 18 million years of the Cretaceous. These metrics of disparity do tend to be highest in Late Campanian Judithian-aged units, but they are not significantly different from other samples. Therefore, the results show that ecological breadth and stability of small theropod dinosaurs remained relatively stable in North America throughout the last 18 million years of the Mesozoic, despite morphological shifts in these groups through time. This suggests that this dinosaur guild did not experience significant declines prior to the bolide impact that precipitated the end-Cretaceous mass extinction.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE VALIDITY OF *NANOTYRANNUS LANCENSIS* (THEROPODA, LANCIAN – UPPER MAASTRICHTIAN OF NORTH AMERICA)

LARSON, Peter, Black Hills Instituteof Paleontology, Hill City, SD, United States, 57745

Several specimens of the enigmatic tyrannosaurid dinosaur *Nanotyrannus lancensis* have recently come to light. These new specimens, derived from the upper Maastrichtian-aged sediments of the Lance and Hell Creek Formations of Wyoming, South Dakota, and Montana, along with a recently described juvenile specimen of *Tarbosaurus bataar* from the Nemegt Formation of Bugin Tsav, Mongolia, provide new information that unequivocally demonstrates that this dinosaur is unique and clearly not a juvenile *Tyrannosaurus rex*, as proposed by some other researchers. Comparisons with known and new specimens of *Tyrannosaurus rex* show a host of characters that support the taxon, *Nanotyrannus lancensis*. These characters include: consistent substantially greater maxillary and dentary tooth counts, unique general tooth morphology (especially for the first maxillary and dentary tooth positions), a unique exit for the V-2 cranial nerve, unique pneumatopores in cranial elements, a shallow (as opposed to a deep) antorbital fossa, the presence of a long linear groove on the lateral aspect of the dentary, a morphologically unique furcula, an outward facing scapular glenoid, a proportionally and absolutely larger manus, the presence of third digit manus phalanges, and the presence of an anterior iliac hook.

Symposium 1 (Wednesday, October 30, 2013, 8:00 AM)

INTERPRETING DINOSAUR ONTOGENY AT SCALES FROM EMBRYOS TO BONE MICROSTRUCTURE TO PHENOTYPIC COVARIANCE

LARSSON, Hans, McGill Univ, Montreal, QC, Canada, H3A 0C4; DU, Trina, McGill Univ, Montreal, QC, Canada

Development provides the primary phenotypic variation on which natural selection can act. However, in the context of vertebrate paleontology, processes of natural selection are intractable, population-level variation is very rare, and developmental variation within these populations is all but absent. In spite of these obstacles, we will review how some aspects of developmental variation can be garnered from less obvious sources. Growth trajectories offer seemingly straightforward insights into growth patterns to assess relative developmental sequence differences, such as continuous and sequential heterochrony. These methods require adequate phylogenetic sampling to make robust hypotheses and opportunities are rare in the dinosaur fossil record. In some cases, dinosaur bone histology offers very good inter- and intraspecific sampling of relative and absolute growth rates. Bone histology may also be used to assess the relative interactions of physiology, environment, and phylogeny during the development of bone microstructure. Phenotypic covariance offers perhaps the strongest insight into developmental mechanisms of dinosaur evolution. We present this model using theropod cranial anatomy as a case study. A well sampled series of non-avian and early avian theropod skulls was used to identify regions of phenotypic covariance and modularity during 150 Ma of evolution. Extant chicken embryos were used to generate a high resolution data set of cranial embryonic development. Developmental covariance and fluctuating asymmetry within this data set were used to estimate developmental modules. A significant match of a premaxilla-maxilla-jugal module was recovered between the evolutionary and developmental trajectories. Other theropod evolutionary modules did not match chicken developmental modules, suggesting either divergent developmental mechanisms were at play or that other physiological processes, such as biomechanical integration, were acting to shape the covariance patterns in non-avian theropods. We present a generalized outline of this methodology to extend to other skeletal and taxonomic realms of dinosaurs.

Preparators' Session (Thursday, October 31, 2013, 11:45 AM)

A TALE OF TWO EXHIBITS: THE FOSSIL PREPARATOR AS AN INTEGRAL PART OF MUSEUM OUTREACH

LASH, Catherine, Petrified Forest National Park, Holbrook, AZ, United States, 86025; Smith, Matthew, Petrified Forest National Park, Holbrook, AZ, United States; Parker, William, Petrified Forest National Park, Petrified Forest National Park, AZ, United States

Within the last decade, Petrified Forest National Park (PEFO) has constructed two separate exhibits in its Rainbow Forest Museum. Initially, a division of park staff whose major responsibility was to conceptualize and write the exhibits lacked the requisite knowledge needed to synthesize and relate the complex topic of geology, deep time, and paleontology to the public. Also, both of these exhibits began with casework and other design elements being constructed by contractors which, whereas they were certainly of high quality, used most of the budget set aside for the project and added layers of complexity that sometimes slowed and confused progress. In both cases, as deadlines passed, professional exhibits were ultimately designed, written, constructed, and installed by a very small crew of in-house staff led by fossil preparators and other paleontologists, who possessed the broad skill sets necessary to successfully complete the exhibits. Ultimately, by utilizing the in-house talent of its preparators to complete all aspects of the exhibit, PEFO minimized costs of materials and labor. For example, by modifying preexisting furniture, constructing armatures, writing text, casting specimens, and creating fossil reconstructions, all of which minimized personnel and time involved and reduced the need for most contracting. If further contracting was required, the preparators possessed the expertise to provide the necessary quality control, ensure accuracy, and continuity between exhibits. In times of financial crisis, preparators and other museum support staff are either hired on a short term basis or are potentially cut because of a perceived narrow breadth of expertise associated with the job title "preparator". Contrary to that perception, this case study concludes that because it is necessary for the professional preparator to be conversant with every aspect of the museum experience from conservation and research to public outreach, preparators are central to a functional paleontology outreach program. This is especially true for smaller institutions where there are a limited number of positions and available funds.

Technical Session XI (Friday, November 1, 2013, 3:45 PM)

IS RAPOPORT'S RULE A RECENT PHENOMENON? A DEEP TIME PERSPECTIVE ON POTENTIAL CAUSAL MECHANISMS

LASHINSKY, Nick, Vanderbilt University, Nashville, TN, United States, 37235-1805; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States; YANN, Lindsey, Vanderbilt University, Nashville, TN, United States; DONOHUE, Shelly, Vanderbilt University, Nashville, TN, United States; HAUPT, Ryan, Vanderbilt University, Nashville, TN, United States

Macroecology strives to identify ecological patterns on broad spatial and temporal scales. One such pattern, Rapoport's rule, describes the tendency of species' latitudinal ranges to increase with increasing latitude. Several mechanisms have been proposed to explain this rule. Some invoke climate, either through Pleistocene glaciation driving differential extinction of narrow-ranging northern species, or through increased seasonal variability at higher latitudes causing higher thermal tolerances and subsequently larger ranges. Alternatively, continental tapering or high interspecific competition at lower latitudes may be responsible. These mechanisms are not mutually exclusive, and several may apply simultaneously in different ecological settings. However, causal dominance by different mechanisms predicts different patterns of adherence to Rapoport's rule through

time. Assessing the incidence of Rapoport's rule throughout the Cenozoic can help to distinguish between competing explanations. Using data from ~35,000 mammalian fossil occurrences recorded in the Paleobiology Database, we test these hypotheses by evaluating compliance with the rule during each epoch and North American Land Mammal Age (NALMA) of the Cenozoic of North America. Here, we quantify latitudinal midpoints and latitudinal ranges of mammalian species (excluding volant and marine taxa) to assess adherence to Rapoport's rule throughout the Cenozoic. The Pleistocene is the only epoch to demonstrate a significant ($p<0.0001$) positive relationship, thereby corroborating the differential extinction hypothesis. Examining NALMAs, which permit increased temporal resolution, reveals significant positive relationships between species midpoints and ranges during the Rancholabrean (0.012 to 0.3Ma; $p<0.0001$), Irvingtonian (0.3 to 1.8 Ma; $p=0.01$), Blancan (1.8 to 4.9 Ma; $p=0.04$), Whitneyan (30.8 to 33.3 Ma; $p<0.01$), Orellan (33.3 to 33.9 Ma; $p<0.02$), and Uintain (40.4 to 46.2 Ma; $p<0.0001$). Five of these six ages are marked by rapid cooling and high thermal seasonality (i.e., the Rancholabrean, Irvingtonian, and Blancan correspond to Plio-Pleistocene cooling and Pleistocene glaciation events, while the Whitneyan and Orellan occur in conjunction with dramatic cooling at the Eocene-Oligocene boundary), suggesting that extinctions caused by changing climate may have played an important role in erecting the latitudinal gradients in range sizes seen today.

Romer Prize Session (Thursday, October 31, 2013, 10:45 AM)

UNRAVELING THERIZINOSAUR PALEOBIOLOGY – A MULTI-ANGLE APPROACH

LAUTENSCHLAGER, Stephan, University of Bristol, Bristol, United Kingdom

Recent fossil findings have resolved a long-standing debate about the phylogenetic position of therizinosaurs, a group of large, feathered, theropod dinosaurs. Their paleobiology, however, still remains elusive. Their unique anatomy, with small, lanceolate teeth, a rostral rhamphotheca and long manual claws, not only distinguishes therizinosaurs from other theropods, but has also triggered many speculations on the functional and biological role of this peculiar morphology, particularly in light of a postulated dietary shift from carnivory to herbivory. Based on CT scans of the skull of *Erlikosaurus andrewsi*, the only therizinosaur with nearly complete cranial remains, the paleobiology of therizinosaurs has been investigated from different angles, utilizing a range of computational techniques. Applying successive reconstructive steps, *Erlikosaurus* skull morphology was digitally restored and subsequently served as a basis for different soft tissue reconstructions: the endocranial anatomy, the jaw musculature, and different reconstructions of the keratinous rhamphotheca. Based on the reconstructed anatomy (olfactory apparatus, endosseous labyrinth), evaluation of *Erlikosaurus* sensory function reveals that olfaction, hearing and equilibrium were well-developed in therizinosaurs and might have benefited from an enlarged forebrain. Reconstruction of the adductor myology further shows that muscle and calculated bite forces were comparably low in *Erlikosaurus*, suggesting that foraging was mainly restricted to leaf-stripping and plant cropping, rather than active mastication. These hard- and soft-tissue reconstructions were integrated into a biomechanical model to test the functional performance of the skull using Finite Element Analysis (FEA). Different bite scenarios and hypothetical morphologies (e.g., with and without rhamphotheca) were tested. Considered with other evidence (lack of tooth occlusion, absence of wear facets), biomechanical analysis confirms elevated bone stress for biting scenarios involving teeth, indicating that food procurement and processing preferentially occurred at the edentulous tip of the snout. Rhamphotheca-bearing FE-models showed reduced stress, suggesting that the development of a keratinous beak was advantageous for foraging and as an effective mechanism to increase cranial stability.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A FRESH LOOK AT THE GENUS *ICHTHYOSAURUS*: SPECIES CHARACTERISTICS, PHYLOGENY AND EVOLUTIONARY DRIVERS

LAWRENCE, Jessica, University of Southampton, Southampton, United Kingdom; NAISH, Darren, University of Southampton, Southampton, United Kingdom; DYKE, Gareth, University of Southampton, Southampton, United Kingdom

The classic Lower Jurassic parvipelvian ichthyosaur genus *Ichthyosaurus* is known from hundreds of specimens, the vast majority from the Lower Lias (Blue Lias) of southern England. Recent non-phylogenetic taxonomic reviews have recognized either three or four *Ichthyosaurus* species, but diagnoses have relied on variable and overlapping, thus problematic, characters: vertebral counts, skeletal proportions, and body lengths. Other recent studies have shown specimens assigned to *Ichthyosaurus* to be highly variable and to possess character combinations that link them to parvipelvians elsewhere in phylogeny. Despite the removal of these specimens from *Ichthyosaurus*, considerable variation persists and the monophyly of this genus needs to be tested: characters regarded as diagnostic for this taxon (such as an ulnare larger than the intermedium) are frequently ambiguous or not present in referred specimens, and our revised dataset failed to recover *Ichthyosaurus* as a clade. Two species traditionally placed within *Ichthyosaurus* group together in our new species-based analysis of thunnosaur ichthyosaurs, alongside *Leptonectes tenuirostris, Leptonectes moorei* and *Stenopterygius megacephalus*, demonstrating that the genus needs redefinition and reanalysis. Our work is aimed at: (1) resolving species-level phylogeny of *Ichthyosaurus*; (2) reinterpreting the phylogenetic relationships of traditional *Ichthyosaurus* "species" relative to other parvipelvians; (3) better understanding the stratigraphic distribution of known specimens, and; (4) linking specimen distribution in time and space to changes in sea level, temperature and sedimentation rates in the Lias. Initial specimen-based analyses show no significant clustering of specimens with other members of putative species and that some clades do not correspond with any presently recognized species of *Ichthyosaurus*. Our overall aim is to understand the systematics and evolution of *Ichthyosaurus* and thus elucidate tempo, mode and drivers of ichthyosaur evolution in Early Jurassic seas.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE FIRST OCCURRENCE OF FOSSIL EGGS FROM THE UPPER CRETACEOUS (CAMPANIAN) MORONDAVA BASIN, MADAGASCAR

LAWVER, Daniel, Montana State University, Bozeman, MT, United States, 59717

*Malagasy fossil eggs are previously known from Cenozoic deposits, with perhaps the most famous specimens being those of the extinct Elephant bird (*Aepyornis*); however, no Mesozoic specimens have been previously described. Three spherical eggs were discovered in Upper Cretaceous marine rocks of the Morondava basin in the Belo Region of western Madagascar. These specimens are significant because the Mesozoic fauna of this basin is poorly documented and warrants reevaluation. Two of the eggs lack eggshell and their morphology results from infilling of the eggs by sediment prior to surface erosion. The third egg measures approximately 33.50 mm in diameter and preserves eggshell on half of the specimen. Eggshell thickness averages 0.44 mm and shell units are tightly interlocking, with a height to width ratio of 2:1. The lower two-thirds of the eggshell exhibits tight, interlocking acicular crystalline structures that radiate from a nucleation site, allowing definitive assignment to Testudines. However, the eggshell show significant diagenetic alteration and a blocky extinction pattern under crossed polars. This differs from the sweeping extinction pattern characteristic of modern and unaltered fossil turtle eggs. Cathodoluminescence reveals bright orange fluorescence suggesting calcite replacement of the original aragonite, which prohibits assessment of pore density and gas conductance. The eggshell microstructure differs from all previously described turtle oospecies; however the specimens are referred to *Testudoolithus* oosp. rather than assigned to a new oospecies because of extensive alteration. Although these specimens occurred in marine rocks, they should not be interpreted as sea turtles eggs (Chelonioidea) because the poorly mineralized eggshell of this taxon consists of loosely organized shell units that differ significantly from the rigid eggshell of the Malagasy eggs. This also suggests that the eggs were transported from the paleo-nesting environment during taphonomy. These specimens are important because they are the first fossil eggs from the Mesozoic of Madagascar and illustrate the importance of the Morondava basin to the paleontological history of Madagascar.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE POSTCRANIAL ANATOMY OF *YACARERANI BOLIVIENSIS* AND THE EVOLUTION OF THE NOTOSUCHIAN POSTCRANIAL SKELETON

LEARDI, Juan, Instituto de Estudios Andinos Don Pablo Groeber, UBA, Buenos Aires, Argentina; POL, Diego, Museo Paleontologico Egidio Feruglio, Trelew, Argentina; NOVAS, Fernando, Mus Argentiono de Cs NaturalesComparative Anatomy, Capital Federal, Argentina; SUÁREZ RIGLOS, Mario, Museo de Historia Natural Noel Kempff Mercado, Santa Cruz, Bolivia

Yacarerani boliviensis is a bizarre notosuchian whose remains were recovered from the Upper Cretaceous of Bolivia. This taxon is diagnosed by its peculiar cranial and, in particular, dental morphology. The block containing the holotype material also included several other individuals. The material studied belongs to at least three different individuals. This record is the first well-preserved and represented postcranial skeleton of any sphageasaurid notosuchian known. Few differences in the size of the elements recovered suggest a similar ontogenetic state of these individuals. The objective of this contribution is to study the postcranial skeleton of *Yacarerani boliviensis* and to evaluate the distribution of several postcranial characters among basal mesoeucrocodylians. The abundance of specimens allows a deep knowledge of the postcranial skeleton of *Yacarerani*, as a great number of elements are known.

The axis is short and bears an anteroposteriorly short neural spine, as in most notosuchians. All cervical centra bear hypapophyses. As in other notosuchians, there is an abrupt migration of the parapophyses almost at the level of the diapophyses on the fifth dorsal vertebra. Knob-like hypapophyses are observed up to the seventh dorsal vertebra. There are forelimb characters shared with other notosuchians such as a greatly expanded scapular blade, the medially displaced deltopectoral crest of the humerus, the structure of the proximal end of the ulna, and the presence of an additional articular surface in the ulnare. Additionally, the hind limb also bears relevant characters like a reduced fourth femoral trochanter on the femur that lacks an anterior flange, two additional depressions on the anterior hollow of the astragalus, and a posteroventral tuber on the calcaneum.

Many postcranial characters have been previously identified as notosuchian synapomorphies, and new ones have been recovered as such in this contribution. This situation highlights the relevance of incorporating postcranial characters to the study of fossil crocodyliforms, as they can be phylogenetically informative.

Technical Session I (Wednesday, October 30, 2013, 8:45 AM)

TWO IF BY LAND, ONE IF BY SEA? EVIDENCE FOR MAJOR TRANSITIONS IN DIGIT MODULARITY OVER TETRAPOD EVOLUTION

LEARY, Brian, University of Massachusetts Dartmouth, North Dartmouth, MA, United States, 02747; KAVANAGH, Kathryn, University of Massachusetts Dartmouth, North Dartmouth, MA, United States

Adaptations to the autopod of the vertebrate limb were crucial in facilitating the occupation of land habitats previously off-limits to tetrapod ancestors. However, the developmental basis for these evolutionary changes has been unclear. Here we examine developmental changes in modularity that facilitated terrestrial adaptations. In tetrapods, the relative sizes of phalanges elements covary in a predictable way. Previously, we have established that this covariation is the result of modular integration of the phalanges,

where the sizes of individual phalanges are influenced by each other during development, yet exclude neighboring skeletal elements (metacarpals/metatarsals/ungual phalanges). Using morphometrics on fossil and extant taxa, as well as embryological and cell fate-mapping techniques, we investigated the evolutionary history and development of modules in the autopod. In derived tetrapods, a strong functional and morphological distinction between metacarpals/metatarsals and phalanges is observed. This distinction is missing in early tetrapods and some secondarily aquatic tetrapods (whales and marine reptiles), leading us to question how the developmental modularity of the digit ray may have evolved. Fate-mapping has revealed discrete cell populations of pre-chondrogenic mesenchyme separating metatarsals from phalanges. These cell populations are established just before digit development commences, but the phalanges-fated cells remain developmentally plastic long into digit development. When distal limb cells are labeled earlier in development, they map to the entire digit, suggesting that metatarsal and phalanges cell populations split from a single cell population around the time of zeugopod differentiation (HH stage 24-25). If ontogeny is informative of evolutionary history, it is plausible that a single digit module is the ancestral condition of the autopod. We propose that this single digit module split during early tetrapod evolution, freeing up the metacarpals/metatarsals and phalanges to diverge in function and morphology. Additionally, we propose that secondarily aquatic tetrapods either: 1) re-acquired the ancestral condition of a single digit module or 2) retained the derived, two-module condition, but converged on early tetrapod digit patterns.

Technical Session I (Wednesday, October 30, 2013, 11:15 AM)

PHYLOGENETIC PATTERNS AND FUNCTIONAL INTERPRETATIONS OF AMNIOTE PLICIDENTINE

LEBLANC, Aaron, University of Toronto Mississauga, Mississauga, ON, Canada, L5L 1C6; BRINK, Kirstin, University of Toronto Mississauga, Mississauga, ON, Canada; MACDOUGALL, Mark, University of Toronto Mississauga, Mississauga, ON, Canada; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada

Tooth shape has often been used for interpreting the dietary preferences of extinct vertebrates and their evolutionary relationships. Most of these studies have focused on the shape of tooth crowns, whereas few studies have examined the shape of the tooth roots. One exception is the use of plicidentine in the phylogenetic reconstructions of extinct tetrapods. Plicidentine refers to centripetal folding of the dentine wall of a tooth root towards the pulp cavity. Plicidentine has typically been associated with labyrinthodont amphibians, and the degree of complexity of this infolding pattern of the tooth has been used as a taxonomic or phylogenetic tool. Furthermore, the absence of plicidentine has historically been considered a synapomorphy of Amniota. Until recently, only a few histological studies had reported plicidentine in amniotes, and its presence was apparently restricted to Mesozoic aquatic reptiles, modern varanoid squamates, derived captorhinids, and a single occurrence within Parareptilia. To date, no study has been able to address whether or not plicidentine is plesiomorphic for the major amniote clades, or if plicidentine had secondarily evolved in these groups. Here, we provide the first comprehensive, comparative histological examination of plicidentine in Paleozoic amniotes. In order to assess the adaptive or taxonomic significance of different types of plicidentine in amniotes, we describe the relationships of the dentine folds to the adjacent tooth tissues, and examine the occurrence of plicidentine in a phylogenetic context. The presence of plicidentine in diadectomorphs, non-mammalian synapsids, basal eureptiles, and several parareptiles indicates that plicidentine was much more widespread within Amniota than previously thought. Moreover, plicidentine in Paleozoic amniotes was structurally diverse, suggesting that the degree of folding of the dentine may have served different purposes, depending on the taxon and the function of the dentition. Some taxa possessed highly convoluted tooth bases, which may have served to increase the surface area for the attachment of the dentine to the surrounding periodontal tissues. Other taxa exhibit highly folded dentine, but the roots are closed at their apices, similar to mammals, suggesting they could not have increased the surface area for tooth attachment. These results suggest that the occurrence of plicidentine is plesiomorphic for Amniota, and within-clade morphological variation is likely due to functional constraints of the dentition.

Technical Session IX (Friday, November 1, 2013, 9:30 AM)

NEW SPECIMENS OF *DEINOCHEIRUS MIRIFICUS* FROM THE LATE CRETACEOUS OF MONGOLIA

LEE, Yuong-Nam, Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea, Republic of (South); BARSBOLD, Rinchen, Paleontological Center, Ulaanbaatar, Mongolia; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan; LEE, Hang-Jae, Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea, Republic of (South)

The holotype of *Deinocheirus mirificus* was collected by the Polish-Mongolian Palaeontological Expedition at Altan Uul III in 1965. Because the holotype was known mainly on the basis of giant forelimbs with scapulocoracoids, *Deinocheirus* has remained one of the most mysterious dinosaurs. Two new specimens of *Deinocheirus* were discovered in the Nemegt Formation of Altan Uul IV in 2006 and Bugin Tsav in 2009 by members of the Korea-Mongolia International Dinosaur Expedition (KID). Except for the skull, middle dorsal and most of the distal caudal vertebrae, the right forelimb, left manus, and both pedes, the remaining parts of the skeleton (Mongolian Paleontological Center [MPC]-D 100/127) including a left forelimb clearly identifiable as *Deinocheirus* were collected. The humerus (993 mm in length) is longer than the 938 mm humerus of the holotype. The Altan Uul IV specimen (MPC-D 100/128) is a subadult *Deinocheirus* (approximately 72% of MPC-D 100/127), which consists of post-cervical vertebrae, ilia, ischia, and hind limbs. Both specimens provide important paleontological evidence for exact postcranial reconstruction of *Deinocheirus mirificus*. Cladistic analysis indicates that *Deinocheirus* is a basal member of Ornithomimosauria, but many new unique skeletal features appear to be quite different from other ornithomimosaurs. These include extreme pneumaticity of tall, anterodorsally oriented distal dorsal neural spines (7~8 times taller than centrum height) with basal webbing, fused sacral neural spines forming a midline plate of bone that extends dorsally up to 170% of the height of the ilium, ventrally keeled sacral centra, a well-developed iliotibialis flange, a posterodorsally projecting posterior iliac blade with a concave dorsal margin, a steeply raised anterior dorsal margin of the ilium, an anteriorly inclined brevis shelf, vertically well-separated iliac blades above the sacrum, an completely enclosed pubic obturator foramen, triangular pubic boot in distal view, vertical ridges on anterior and posterior edges of medial surface of the femoral head, and a robust femur that is longer than tibiotarsus. These features suggest that *Deinocheirus* (unlike other ornithomimosaurs) was not a fast-running animal, but a bulky animal with a heavily built pelvis and hind limbs. However, the dorsal ribs are tall and relatively straight, suggesting that the animal was narrow-bodied. A large number of gastroliths (>1100 ranging from 8 to 87 mm) were collected from the abdominal region of MPC-D 100/127, suggesting *Deinocheirus* was an herbivore.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

REGIONAL AND LANDSCAPE-SCALE PLEISTOCENE PALEOECOLOGY USING CARBON AND OXYGEN ISOTOPES FROM *IN SITU* MACRO- AND MICROMAMMAL TOOTH ENAMEL AT ELANDSFONTEIN, WESTERN CAPE, SOUTH AFRICA.

LEHMANN, Sophie, Johns Hopkins University, Baltimore, MD, United States, 21218; Patterson, David, , Washington, DC, United States; MATTHEWS, Thalassa, West Coast Fossil Park, Iziko Museum, Langebaan, South Africa; LEVIN, Naomi, Johns Hopkins University, Baltimore, MD, United States

The fynbos biome of the Western Cape of South Africa (WC) is renown for having the highest intra-habitat diversity of any biome in the world, however we know little about this variability in the past. More records of vegetation heterogeneity are needed in order to understand the history of the fynbos. The Pleistocene deposits of Elandsfontein (EFT, 0.7 – 1.0 Ma), WC, preserves macromammal (> 1 kg) and micromammal (< 1 kg) fossils and provides an opportunity to further understand the regional and landscape-scale nature of the fynbos biome. Here we report the carbon and oxygen isotopic data of tooth enamel from two herbivorous micromammal genera (Bathyergus and Otomys). We compare these data to isotopic results from tooth enamel from 11 fossil macromammal taxa (e.g., hippopotamids, giraffids, bovids, rhinocerotids, suids, and equids). Isotopic ratios of micromammal teeth were obtained using laser ablation GC/IRMS, whereas macromammal results were generated using conventional acid digestion methodology. The $\delta^{13}C$ values of all teeth suggest diets dominated by C_3 plants, typical of mammals living in the fynbos biome. $\delta^{13}C$ values of the two micromammal genera varied by locality at EFT, whereas $\delta^{18}O$ values were invariant. When teeth from all localities are considered together, $\delta^{13}C$ values of teeth from the eurybiomic Bathyergus (-13.8 ± 2.4‰ PDB, n = 43) are more positive and have a wider range than $\delta^{13}C$ values of teeth from the relatively stenobiomic Otomys (-16.6 ± 1.6‰ PDB, n = 11). In contrast, $\delta^{18}O$ values of Bathyergus and Otomys are similar to one another, averaging -6.9 ± 1.6‰ and -7.3 ± 1.5‰ PDB, respectively. When $\delta^{13}C$ data of Bathyergus from different localities are compared, we observe distinct isotope distributions; for example $\delta^{13}C$ values of Bathyergus teeth from localities 0609 and 0110 cluster together, averaging -12.1 ± 1.9‰ (n = 9), and -10.9 ± 3.1‰ (n = 3), whereas Bathyergus $\delta^{13}C$ values from locality 0209 average -16.2 ± 1.4‰ (n = 12). Locality 0209 is 330m away from locality 0110 and 195m away from locality 0609. In general, the macromammal teeth exhibit a 5.1‰ range. Otomys teeth $\delta^{13}C$ exhibits a similar range to macromammals with a 4.6‰ range, whereas Bathyergus exhibits an 8.4‰ range in $\delta^{13}C$. We interpret the heterogeneity in micromammal $\delta^{13}C$ values to indicate 102 m scale variation in vegetation in the WC during the Pleistocene that we would not be able to detect with the macromammal isotope results alone. These results are consistent with our understanding of the heterogeneity of the fynbos biome. Our data suggest this pattern extends into the Pleistocene.

Technical Session XVIII (Saturday, November 2, 2013, 2:30 PM)

OF MULTITUBERCULATES AND MASS EXTINCTION: EVIDENCE OF SELECTION FOR SMALL BODY SIZE WITHIN THE CIMOLODONTA (MULTITUBERCULATA) ACROSS THE CRETACEOUS-PALEOGENE EXTINCTION BOUNDARY, FOLLOWED BY MORPHOSPACE RECOVERY AND EXPANSION IN THE EARLIEST PALEOGENE

LEVERING, David, Oklahoma State University, Stillwater, OK, United States, 74078; LUTTBEG, Barney, Oklahoma State University, Stillwater, OK, United States

In this study, we focus on the loss of species diversity – and therefore morphological diversity - within the Cimolodonta (Multituberculata) during the Cretaceous-Paleogene (K-Pg) extinction, followed by their recovery in the Puercan (earliest Paleogene). Teeth make up the majority of the cimolodontan fossil record, allowing inferences of dietary ecology, body size estimates, and phylogenetic proximity. We analyzed morphological disparity within the restricted phylogenetic framework of the Cimolodonta. We addressed 3 questions: (1) Did the conditions of the K-Pg extinction select for or against cimolodontan dental morphologies, if it was selective at all? (2) Do levels of cimolodontan morphological similarity return to pre-extinction levels in the Puercan? and (3) Do the Puercan Cimolodonta recover morphology lost during the extinction, or do the Cimolodonta morphologically diverge from the pre-extinction morphospace? We used Euclidian inter-taxon distance measures derived from dental character data to perform a principal coordinates analysis (PCO), generating a multidimensional representation of morphological similarity. To assess the selectivity versus non-selectivity of cimolodontan extinction across the K-Pg boundary, we analyzed the axes of our morphospace for morphological character gradients. We tested for extinction selectivity to determine the probability of generating the survivor-taxa morphospace by chance. Our results indicate significant (p = 0.0006) selection affecting cimolodontan survival across the K-Pg

extinction. Overall morphospace occupation changed significantly ($p < 0.015$) in the Puercan as well. We attribute this change in morphospace occupation to the diversification of the Taeniolabididae and incomplete recovery of Late Cretaceous morphospace by the Puercan Cimolodonta. Vacancies in the Puercan cimolodontan morphospace may be a result of changes in available dietary resources, or competitive exclusion. The Taeniolabididae occupy a morphospace region distant from the remainder of the Puercan Cimolodonta, supporting independent studies suggesting they were an immigrant taxon rather than a product of rapid phenotypic divergence. Our results indicate selection taking place over the K-Pg extinction for small body size within the Cimolodonta. We also find evidence of partial reoccupation of Late Cretaceous cimolodontan morphospace in the Puercan, indicating ecological niche recovery.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EARLY HOLOCENE *BISON ANTIQUUS* SIZE CLINE ON THE SOUTHERN PLAINS

LEWIS, Patrick, Sam Houston State University, Huntsville, TX, United States, 77340; HORSTMAN, Elisabeth, Sam Houston State University, Huntsville, TX, United States; JOHNSON, Eileen, Museum of Texas Tech University, Lubbock, TX, United States; BUCHANAN, Briggs, Simon Fraser University, Burnaby, BC, Canada

Researchers have suggested a north to south morphocline for bison, with some suggesting this morphocline extends from modern populations into late Pleistocene and early Holocene populations of *Bison antiquus*. Changing climates, small sample sizes, questionable dates, and widely dispersed samples of the bison involved, however, have made determining the extent and magnitude of this size cline difficult to examine, particularly in regional detail. This research uses five early Holocene *Bison antiquus* populations from the Southern Plains to examine the extent of size variation in the region. These populations provide examples of ancient bison from the northern and southern extremes of the Southern Plains, as well as between the two extremes. The bison populations are from Bonfire Shelter (10,230 BP) located in southwestern Texas, three locations on the Southern High Plains of western Texas and eastern New Mexico (Lubbock Lake Landmark stratum 2 population [10,800–8,600 BP], Blackwater Draw stratum 2 population [10,800–8,600 BP], and Plainview [10,000 BP]), and Cooper (10,600–10,500 BP) in western Oklahoma. Metacarpals have been used for this analysis due to large sample size, functional significance, and morphological conservatism. Only length is used and both males and females were examined. Data have been tested with ANOVA for significant differences in size. The most southerly population, from Bonfire Shelter, is the smallest of the populations examined, and the Cooper population the largest. Using an alpha of 0.05, the sites are found to be significantly different (P=0.05). A post-hoc pairwise ANOVA for the five sites shows this result to be due to the difference between Cooper and Bonfire Shelter (P=0.02), but no combination of sites was significant when using the Bonferroni correction for multiple tests (alpha=0.017). Females display a similar pattern but populations do not differ significantly. Results indicate that a north-to-south size cline existed during the early Holocene on the Southern Plains. Significantly smaller bison are present at the southern edge of the Southern Plains, while increasingly larger bison were present farther north.

Technical Session IX (Friday, November 1, 2013, 11:30 AM)

A NEW, EARLY CRETACEOUS TITANOSAURIFORM SAUROPOD DINOSAUR WITH UNIQUE OSTEOLOGY FROM THE HEKOU GROUP OF LANZHOU BASIN, GANSU PROVINCE, CHINA

LI, Liguo, China University of Geoscience Beijing, Beijing, China; YOU, Hailu, Institute of Paleontology and Paleoanthoropology, Beijing, China; LI, Daqing, Gansu Geological Museum, Lanzhou, China; DODSON, Peter, School of Veterinary Medicine, Philadelphia, PA, United States

Here we report a new titanosaurian dinosaur from the Lower Cretaceous Hekou Group in the Lanzhou-Minhe Basin of Gansu Province, northwestern China. This new taxon (Gan Su Geological Museum specimen GSGM ZH(08)-04) comprises three teeth, eight vertebrae, a left scapulocoracoid, and a right ulna and radius. The taxon is characterized by the following unique combination of characters, including seven autapomorphies: long-crowned, spoon-shaped premaxillary teeth; axially elongate parapophyses on the middle cervical vertebra; immense, deep pleurocoels on the lateral surfaces of the cervical and cranial dorsal vertebral centra; low, unbifurcated neural spine fused with the postzygapophyses to form a cranially pointing, triangular plate in a middle dorsal vertebra; an 'XI'-shaped configuration of the laminae on the lateral surface of the middle dorsal vertebral arch; a very long scapular blade with exceptionally straight cranial and caudal edges; and a tall, deep groove on the medial surface of the distal shaft of the radius. Based on our phylogenetic analysis, GSGM ZH(08)-04 belongs to Titanosauria and forms a sister group with Opisthocoelicaudia. It also shares several important features with other sauropods. For instance, it has a pronounced tubercle for the origin of M. triceps longus, which is positioned dorsal to the level of the dorsal margin of the acromion process, similar to the more dorsal of the paired tubercles of *Alamosaurus* and *Sauroposeidon*. In contrast, in *Chubutisaurus, Euhelopus*, and *Daxiatitan*, the tubercle lies ventral to the level of the dorsal margin of the acromion. Also, GSGM ZH(08)-04 bears ventrolaterally elongate parpophyses in its cervical vertebra, as in *Daxiatitan* and *Euhelopus*. Furthermore, its distinctive, 'XI'-shaped dorsal vertebral lamina configuration is more complex than the 'K'-shaped configuration in *Euhelopus*.

The partially fused scapulocoracoid suture and the medially placed coracoid foramen suggest that GSGM ZH(08)-04 probably pertains to a subadult individual. Vertebral centrum length data suggest that the new sauropod may have been only medium-sized, much smaller than the coeval, giant *Daxiatitan* and North American *Sauroposeidon*. Interestingly, the morphology and remarkable length of the scapulocoracoid reveal an unusual relationship between the shoulder and the middle trunk. This discovery sheds new light on the diversity of Early Cretaceous titanosauriforms in China.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

BUSHY-TAILED WOODRAT (*NEOTOMA CINEREA*) RESPONSE TO LATE PLEISTOCENE CLIMATE CHANGE

LIGHTNER, Erik, University of Wyoming, Laramie, WY, United States, 82072; FRASER, Danielle, University of Carleton, Ottawa, ON, Canada; MINCKLEY, Thomas, University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, United States

While small mammals did not share the magnitude of species loss experienced by North American megafauna at the end of the late Pleistocene, they were impacted by climate change and habitat disruption during this time interval. Evidence of small mammal response to these events can be recovered from middens made by woodrats (*Neotoma*) and other small rodents, which are abundant in the late Pleistocene fossil record throughout the western United States and Canada. Because they preserve abundant pollen, plant macrofossils, bones, and fecal pellets, they provide a rich record for paleoclimatic reconstruction as well as for examining biotic response to climate change. Last Canyon Cave (~45°N latitude) is a rockshelter in south-central Montana with a ~50,000 year continuous record of faunal and floral remains including small and medium-sized mammal bones, pollen, and coprolites. Abundant large rodent coprolites and molars suggest occupation of the rockshelter by the bushy-tailed woodrat (*Neotoma cinerea*) after ~15,000 cal. yr BP. We examined the influence of climate on *Neotoma* occupation of Last Canyon Cave using generalized least squares regression with control for temporal autocorrelation. We tested for relationships among the $\delta^{13}C$ values of rodent coprolites, coprolite widths, and the dominant pollen types of the assemblage (*Artemisia*, *Asteraceae*, *Fabaceae*, *Amaranthaceae*, and *Poaceae*). Here, coprolite width is used as a proxy for body size to distinguish woodrats from the other rodent occupants, including *Microtus* spp. and *Peromyscus* spp., and to evaluate how body size in *Neotoma* spp. varied in response to climate change. This analysis revealed no significant correlation between $\delta^{13}C$ values and pollen, likely reflecting a dominance of C_3 plants around the cave and no significant change in dietary preferences during the interval of occupation. However, *Asteraceae* and *Amaranthaceae* abundance were significant predictors of coprolite width ($p<0.05$). An increase in *Asteraceae* and *Amaranthaceae* coincident with the Younger Dryas Chronozone could reflect changes in the timing of seasonal precipitation. *Neotoma cinerea* occupation of the rockshelter in association with this change could suggest steppe/shrubland dietary preferences, or localized expansion in response to changing environmental conditions.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE PALEOICHTHYOFAUNA FROM THE CODÓ FORMATION (APTIAN OF THE PARNAÍBA BASIN) NORTHEASTERN BRAZIL

LINDOSO, Rafael, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; MAISEY, John, American Museum of Natural History, New York, NY, United States; CARVALHO, Ismar, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

The Codó Formation occurs discontinuously over a wide area in the central-north of the Maranhão State, Northeastern Brazil. Predominantly carbonatic, this lithostratigraphic unit contains a diversified paleobiota, comprising plants (including pollen, spores and algae), crustaceans, gastropods, ichnofossils and fishes. The latter are numerous and correlate internal and marginal basins in Northeastern Brazil during the formation of the South Atlantic Ocean, in Western Gondwana. Eleven species are recognised: *Araripelepidotes temnurus, Vinctifer comptoni, Calamopleurus cylindricus, Cladocyclus gardneri, Brannerion latum, Rhacolepis buccalis, Tharrhias araripis, Dastilbe elongatus, Santanichthys diasi, Codoichthys carnavali, Axelrodichthys araripensis* and a lepisosteid. The material comes from four main localities in Maranhão State: Timbiras, Barra do Corda, Brejo and Codó, and was collected in open pits or along the banks of the main rivers draining the center of the Parnaíba Basin. Two specimens, Federal University of Rio de Janeiro – Department of Geology specimen UFRJ-DG 828-P and Research Center of Natural History and Archaeology of Maranhão specimen CPHNAMA-VT 1242 represent the first occurrence of lepisosteids in the Codó Formation. The morphology of the ethmoid region, and lower jaw, the relative proportions of the dorsal, anal and caudal fins, and ganoid scale morphology suggest affinity with genus *Obaichthys*. One specimen, UFRJ-DG 870P, includes about fifty individuals of *Santanichthys diasii* preserved in preferred orientation, on the same bedding plane, consistent with a mass mortality event. These findings confirm the hypothesis of a lacustrine environment for the Codó Formation, with fluctuating levels of oxygen, salinity, temperature, and algal blooms, sometimes resulting in mass mortality of lake populations. As additional discoveries of taxa add to knowledge of the Codó paleobiota, further analysis will provide a better understanding of the paleoenvironmental situation in the Early Cretaceous of Northeastern Brazil.

Symposium 2 (Thursday, October 31, 2013, 2:45 PM)

"TAR PITS" OF THE WESTERN COASTAL NEOTROPICS: PALEOECOLOGY, TAPHONOMY, AND MAMMALIAN BIOGEOGRAPHY

LINDSEY, Emily, U.C. Museum of Paleontology, Berkeley, CA, United States, 94720; SEYMOUR, Kevin, Royal Ontario Museum, Toronto, ON, Canada

Asphaltic deposits, or "tar pits," present a unique opportunity to investigate the paleobiology and paleoecology of Quaternary mammals due to their tendency to accumulate and preserve remains of numerous taxa. This role is especially important in areas with low preservation potential or incomplete sampling, such as the Neotropics. The most well-known asphaltic paleontological locality in tropical South America is the

Talara tar seeps in northwest Peru, but several other highly-productive asphaltic localities have been excavated on the nearby Santa Elena Peninsula (SEP) in southwestern Ecuador. This project combines data from recent excavations on the SEP with analyses of fossils collected from this region currently housed in the collections of the Museo Gustavo Orces in Quito, Ecuador, the Royal Ontario Museum in Toronto, Canada, and the Museum National d'Histoire Naturelle in Paris, France. In general, the communities of megaherbivores are comparable between these geographically-close sites, but La Carolina presents a biodiversity of birds, micromammals, and carnivores considerably higher than the other localities. Taxonomic, geomorphological, and taphonomic data indicate that La Carolina, like Talara, was probably a tar pit "trap" analogous to the famous Rancho La Brea locality in California, USA, while the SEP sites Corralito and Tanque Loma likely represent bone assemblages in marshy or estuarine settings with secondary infiltration of tar. In addition, differences in taxonomic composition between these latter localities suggest variations in local paleoenvironments and may indicate social behavior in some species of ground sloths.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NORTH AMERICAN EOCENE SUCKERS AND THEIR IMPLICATIONS FOR THE SYSTEMATICS OF CATOSTOMIDAE (OSTARIOPHYSI, CYPRINIFORMES)

LIU, Juan, University of Alberta , Edmonton, AB, Canada, T6G 2E9; WILSON, Mark V. H., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

Catostomid fishes are commonly known as suckers. As a group they are widely distributed in North America, with only one of the 72 modern species being endemic to China. Their fossil record in North America can be traced back to the Paleocene Paskapoo Formation of Alberta, Canada. They then diversified taxonomically and morphologically since the early Eocene within western North America. However, all of the Eocene catostomids from North America were without exception originally assigned to the genus *Amyzon*. Based on a large collection of material from Canada and USA, we review the morphological characters of described species and recently discovered specimens.

The more recently discovered fossils from the Allenby Formation of British Columbia, Canada, and the Kishenehn Formation of Montana, USA, suggest that a second, as yet undescribed genus was a contemporary of *Amyzon*. In contrast to *Amyzon*, the potential new genus possesses fewer principal dorsal fin rays (~12), fewer principal anal fin rays (7), and a shallower body. Separate from the new taxon, there are also *Amyzon*-type specimens from the Kishenehn Formation. They possess typical characteristics of *Amyzon* including a deep body, a long dorsal fin base with a larger number of principal dorsal fin rays (23-25), and a variable number of principal anal fin rays (7-10). The shallow-bodied and more elongated juvenile form of the Montana *Amyzon* suggests it might be a new species.

The family Catostomidae consists of four subfamilies: Ictiobinae, Myxocyprininae, Cycleptinae and Catostominae. *Amyzon* has been hypothesized to belong to the subfamily Ictiobinae, which is often considered a basal group of Catostomidae. The largest subfamily, Catostominae, containing 85% of all catostomid species, is usually considered to be the most derived group. One recent molecular phylogenetic study based on nuclear DNA suggested Catostominae might be a basal clade. In our osteological comparisons, members of Catostominae share a number of plesiomorphies with *Amyzon*. Two uniquely shared features are: 1) only hypural 2 is fused to the compound centrum, whereas both hypural 2 and 3 are fused to it in the remaining catostomids; 2) the ethmoid of *Amyzon* and Catostominae is broad, slightly domed anteriorly, and bears a rod-like anterior projection, which is different from the short, or laterally elevated, or triangular projection-bearing ethmoid in others. These features are consistent with the suggestion that Catostominae diverged earlier in catostomid evolution than previously believed.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW TETRAPOD FOSSILS FROM THE TRIASSIC TONGCHUAN FORMATION OF SHANXI PROVINCE, CHINA, AND THE AGE OF THE *SINOKANNNEMEYERIA-SHANSISUCHUS* ASSEMBLAGE

LIU, Jun, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; LI, Lu, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

The Triassic Tongchuan Formation of Shanxi Province, China was long considered barren of fossil tetrapods, with the sole exception of the archosauriform *Yonghesuchus* from Member II of the formation. In contrast, the underlying Ermaying Formation is China's richest source of Triassic tetrapods, the lower part having yielded the *Shaanbeikannemeyeria-Fugusuchus* assemblage and the upper part having yielded the *Sinokannemeyeria-Shansisuchus* assemblage (or *Shansiodon* assemblage).

In 2010, several new fossil localities were discovered in Member I of the Tongchuan Formation. These localities lie in two small areas of Shanxi Province, along the Yellow River. Most notably, Locality B has produced a *Sinokannnemeyeria*-like skeleton, *Shansisuchus*-like vertebrae, and a new species of *Nothogomphodon*; Locality C has produced *Shansisuchus*-like postcranial elements; and Locality D has produced a *Kannemeyeria*-like snout. Locality F has produced specimens of *Parakannnemeyeria* and *Shansisuchus*, in addition to a euparkeriid femur and a problematic, morphologically unusual ischium. These fossils can be referred to the *Sinokannemeyeria-Shansisuchus* assemblage known previously from the upper part of the Ermaying Formation. These new finds suggest an increased diversity of the assemblage, and that the assemblage survived longer than previously realized. This assemblage can in turn be correlated with the *Eryosuchus* fauna of Russia, or the *Cynognathus* C subzone of South Africa. The correlation of these three faunas is consistent with the Perovkan land-vertebrate faunachron. Based on recent dating of volcanic ash beds, the age of the *Sinokannemeyeria-Shansisuchus* assemblage is estimated as Late Anisian to Early Ladinian.

Technical Session XVII (Saturday, November 2, 2013, 2:15 PM)

A NOVEL METHOD FOR TIME-BINNING RATES OF CONTINUOUS CHARACTER EVOLUTION ON A PHYLOGENY

LLOYD, Graeme, University of Oxford, Oxford, United Kingdom; FRIEDMAN, Matt, Univ of Chicago, Oxford, United Kingdom

Phylogenetic comparative methods are often focused on fitting models to phylogenies as a whole or pin-pointing branches or clades of special significance. However, paleontologists are often interested in secular variation in evolutionary rates across entire groups over their evolutionary history. Such 'in-bin' estimates of rate are necessary for testing hypotheses linking shifts in evolutionary rates to hypothesized environmental (e.g., climate) and biological (e.g., ecological release) drivers. Here we introduce a new algorithm for measuring rates of evolution in continuous characters over multiple time bins that returns results as a time series. The algorithm measures relative rates of evolution by first fixing rates in a time bin of the user's choosing, then measuring the degree to which later branches must be extended or contracted to fit a constant-rate model. Estimated parameters include the Brownian motion variance parameter for the first time bin, plus positive scaling factors that when multiplied by this estimate for the first bin give the variance parameters for all remaining time intervals; rates of phenotypic change are therefore expressed relative to that in the first time interval. Parameters are estimated via maximum likelihood, along with approximate uncertainty surrounding their true values. The only inputs to the algorithm are a time-scaled tree, continuous values for the tips, and a list of time-bins.

Here we apply the new algorithm to a published dataset of a functional measure in 97 species of early tetrapod across 13 stage-level time-bins, from the Late Silurian to Asselian. We show a trend of increasing rates, but with a major low in the Tourniasian, coincident with "Romer's Gap". Using an approximation technique to provide error bars we show that this bin is characterized by exceptionally high error, likely due to relatively low summed branch lengths during this interval. We anticipate this new technique to be a boon to future phylogenetic comparative studies by paleontologists, as it better utilizes data sampled from multiple time horizons.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A NEW DINOSAUR FREEWAY IN THE CRETACEOUS OF WESTERN COLORADO: TOWARDS A WORLD CLASS TETRAPOD TRACK SAMPLE AND DATABASE FOR THE CRETACEOUS DAKOTA GROUP

LOCKLEY, Martin, Univ of Colorado Denver, Denver, CO, United States, 80217-3364; HOUCK, Karen, Univesity of Colorado Denver, Denver, CO, United States; LIM, Jong Deock, National Research Institute of Cultural Heritage, Daejon, Korea, Republic of (South); KIM, Kyung Soo, Chinju National University, Chinju, Korea, Republic of (South)

The track-rich Albian Cenomanian coastal plain deposits of the Dakota Group, known on Colorado's eastern slope as the "Dinosaur Freeway" have produced more than 80 tetrapod tracksites. The well-documented tetrapod ichnofauna is dominated by tracks of ornithopods (*Caririchnium*), gracile coelurosaurs (*Magnoavipes*) and crocodylians (*Hatcherichnus*). Tracks of other tetrapods, including birds, pterosaurs, ankylosaurs and turtles are rare. Recent studies of tetrapod ichnofaunas in the Dakota Group on the Western Slope of Colorado, 300 km west of the eastern slope tracksites, reveal at least 40 additional sites with a significantly different ichnofaunas. This western ichnofauna is dominated by tracks of ankylosaurs (*Tetrapodosaurus*) and swim tracks of crocodylians (*Hatcherichnus*) and pterosaurs (*Pteraichnus*). Athough present, ornithopod tracks are uncommon, and tracks of turtles and theropods are rare. The theropod tracks mostly differ from *Magnoavipes*. The ankylosaur track samples are the largest from the USA, and the pterosaur tracks are the largest in size (length up to 25 cm) known from the Cretaceous of North America. Compared to the east, the western slope facies is coal-rich with a high proportion of deep tracks, many with slide and skin traces. Swim tracks are also very abundant.

Although not previously reported, the western slope sample provides evidence of an extensive new Dinosaur Freeway region, broadly correlative with the eastern slope. However, the two regions display distinctly different ichnofaunas, even though both represent the initial transgressive deposits of the Western Interior Seaway. Precise correlation between the eastern and western slope track beds would potentially connect the two terrains across the Rocky Mountain divide, link two dinosaur freeways into a much larger ichnological province, and elucidate regional temporal (geochronological) and paleoecological relationships. The track-rich Dakota Group, documented in at least 50 papers, has now yielded some 120 tracksites, two thirds of which have yielded diagnostic material (about 440 University of Colorado Museum specimens including 90 from the western slope). Although the tetrapod ichnofauna of the Dakota Group is one of most intensively studied, collected and documented, the present study proves that large regions with distinctive ichnofaunas remain unexplored.

Technical Session III (Wednesday, October 30, 2013, 2:15 PM)

THE EVOLUTION AND BIOGEOGRAPHIC DISTRIBUTION OF ANKYLOSAURIA: NEW INSIGHTS FROM A COMPREHENSIVE PHYLOGENETIC ANALYSIS

LOEWEN, Mark, Natural History Museum of Utah, Salt Lake City, UT, United States, 84108; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, United States

The origin and phylogenetic relationships within Ankylosauria are currently poorly understood. Previous parsimony analyses have focused on cranial features or cranial and postcranial features. We conducted a novel phylogenetic analysis of Thyreophora with comprehensive sampling of taxa (70) and characters (284), representing a 35% increase in taxon sampling and a 67% increase in character sampling over the most recent published study. In addition to the inclusion of a wide variety of cranial and postcranial characters, this is the first analysis to assess postcranial armor characters beyond the presence of a tailclub. We recover *Scelidosaurus* as the basal most member of Ankylosauria (i.e., closer to *Ankylosaurus* than to *Stegosaurus*), with *Minmi*, *Liaoningosaurus* and *Antarctopelta* as basal ankylosaurians. *Scelidosaurus* shares many synapomorphies of Ankylosauria including: cranial ornamentation, mandibular ornamentation, a pelvis wider than long, fused cervical rings, shoulder spines and lateral caudal plates. Additionally, this study is the first to recover a well-supported polacanthid clade basal to the split between ankylosaurids and nodosaurids. Based on this topology, nodosaurids are only unambiguously known from North America and Europe with all of the European taxa belonging to a separate sub-clade. Basal ankylosaurians have a Pangean distribution, better explaining their presence in the Late Cretaceous of Australia and Antarctica. Polacanthids comprise 8 taxa from North America and Europe and persist from the Late Jurassic into the early Aptian. There is a major turnover during the middle Aptian, with basal ankylosaurs being completely replaced by ankylosaurids in Asia, and polacanthids replaced by nodosaurids in North America and Europe. Some Asian ankylosaurid lineages likely dispersed to western North America by the middle Campanian. There are at least two clades of late Campanian ankylosaurids in western North America, both nested among Asian taxa. Current evidence suggests that nodosaurids never dispersed to Asia from either North America or Europe, even though nodosaurids on both continents persisted until the end of the Cretaceous.

Technical Session VI (Thursday, October 31, 2013, 8:00 AM)

NEW RECORDS OF EUTHERIAN AND METATHERIAN MAMMALS FROM THE GOLER FORMATION OF CALIFORNIA AND THEIR IMPLICATIONS FOR LATE PALEOCENE PROVINCIALITY

LOFGREN, Donald, Raymond Alf Museum of Paleontology, Claremont, CA, United States, 91711; WILLIAMSON, Thomas, New Mexico Museum of Natural History, Albuquerque, NM, United States; NYDAM, Randall, Midwestern Univ, Glendale, AZ, United States

The Goler Formation is the only rock unit on West Coast of North America that has yielded a diverse assemblage of Paleocene vertebrates. Intense prospecting over the past two decades in member 4a-4b of the formation has resulted in recovery of over eighty specimens of eutherian and metatherian mammals, representing twenty species. The Goler Assemblage includes three new eutherian species, the plesiadapid, *Nannodectes lynasi*, and two hyopsodontids, *Promioclaenus walshi* and *Protoselene ashtoni*. Two other taxa, *Golerdelphys stocki* and *Peradectes* sp. are the first metatherians to be reported from Paleocene strata on the West Coast. *Golerdelphys stocki* is a new genus and species of basal herpetotheriid and the only late Paleocene herpetotheriid reported from North America. The mammalian assemblage from member 4a-4b is middle Tiffanian (Ti3-Ti4a) based on comparison to faunas from well-known Tiffanian sites in the Western Interior. A minimum of forty percent of the presently known Goler mammalian taxa are not reported elsewhere, indicating a significant degree of endemism. Comparison to seven Ti3-Ti4a aged sites from the Western Interior indicates that the Goler Assemblage has a closer affinity to more southern faunas (southern Wyoming to Texas), than northern faunas (northern Wyoming, North Dakota, and western Canada). Presence of late Paleocene-early Eocene marine strata in the uppermost member of the Goler Formation indicates that the Goler Basin was probably adjacent to the Pacific Ocean during most of its existence. Also, significant distances and one or more paleodrainage divides separated the Goler Basin from Western Interior Paleocene basins, factors that limited the dispersal of mammals and contributed to the formation of a discrete faunal province on the West Coast of North America during the late Paleocene.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ORIGINS OF THE PTYCTODONTID PLACODERMS

LONG, John, Flinders University, Adelaide, Australia; YOUNG, Gavin, The Australian National University, Canberra, Australia; LEE, Mike, South Australian Museum, Adelaide, Australia

In recent years a number of competing hypothesis have emerged about placoderm relationships (as either monophyletic or paraphyletic) and the interrelationships of the various placoderm clades. Ptyctodontids comprise one of the most specialised clades within the placoderms, characterised by short broad skulls with short median nuchal plates, very large eyes, durophagous dentition with robust crushing tooth plates, short trunk shields with high anterior lateral plates and sometimes bearing multiple median dorsal plates. The presence of claspers and prepelvic claspers in some ptyctodontids lead certain researchers back in the 1960s to suggest they could be directly ancestral to the modern holocephalans. They have been placed at various positions within phylogenetic schemes: as the sister group to all other placoderms, as sister group to petalichthyids, and as the sister group to phyllolepids plus arthrodires. A new discovery of a complete 3D skull and braincase of an Early Devonian (Emsian) ptyctodontid –like placoderm from the Taemas-Wee Jasper limestones of SE Australia has been investigated using micro-CT tomography with enlarged 3D prototyping. It displays a typical ptyctodontid dermal skull roof with sunken laterosensory canals and small nuchal combined with a completely ossfied endocranium showing petalichthyid-like anatomy. A new set of phylogenetic analyses using parsimony and Bayesian methods is presented showing that ptyctodontids are the sister taxon to petalichthyids. The analysis, incorporating mainly taxa with relatively complete anatomical data sets, also provides a more robust platform for reinvestigating the currently disputed phylogenetic position of placoderms within deeper gnathostome phylogeny.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

BIODIVERSITY CRISES IN THE HISTORY OF RHIZOMYINE RODENTS

LÓPEZ-ANTOÑANZAS, Raquel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; FLYNN, Lawrence, Harvard University, Cambridge, MA, United States; KNOLL, Fabien, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

Combinations of cladistic and biodiversity analyses highlight the phenomena of speciation, extinction, and diversity changes in a given group over time. This allows us to establish when biodiversity crises occurred and thus to deduce their possible causes. The study of the relationships of rodents belonging to the subfamily Rhizomyinae by means of a cladistic analysis and the conversion of the resulting cladogram into a strato-cladogram has allowed determining rates of biodiversity change, speciation, and extinction for this group. They were calculated based on variants of a deterministic exponential model of taxon growth. These analyses have allowed inferring that the rhizomyines suffered from three biodiversity crises in the Serravallian, Messinian, and Piacenzian. The loss of biodiversity in the evolutionary history of these rodents is due to an increase in the extinction rate more than to a speciation decline. The three times of biodiversity crisis can be correlated with as many environmental events. The first may correspond to a significant cooling due to the restoration of a major Antarctic ice-sheet (15-13 Ma). Primitive Asian rhizomyines lived in a warm and wet climate. The increase of aridity caused the extinction of most of the primitive lineages of this group (e.g., *Prokanisamys* spp., *Kanisamys potwarensis*) and the first appearance and diversification of taxa with higher crowned cheek teeth and, generally, fossorial adaptations. The second may be linked to the rise of the Himalayas at about 9-8 Ma. They would have reached sufficient height to produce a rain shadow in Central Asia. This led to the extinction of most of the lineages that had diversified during the Tortonian. Finally, the fast and drastic uplift of the Tibetan Plateau at 3.6 Ma resulted in further aridity and the local extinction of the rhizomyines in Pakistan, where they had a flourishing history by Miocene time. From then on, the geographic distribution of this group of rodents has been restricted to that of today, i.e. eastern Africa and southeastern Asia.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC RELATIONSHIPS OF THE EUROPEAN PAROMOMYIDAE (PRIMATES, MAMMALIA) AND THEIR BIOGEOGRAPHIC IMPLICATIONS

LÓPEZ-TORRES, Sergi, University of Toronto, Toronto, ON, Canada, M5S 2S2; SILCOX, Mary, University of Toronto Scarborough, Scarborough, ON, Canada

Plesiadapiforms represent the first adaptive radiation of Primates, appearing near the Cretaceous-Paleogene boundary. Eleven families of plesiadapiforms are recognized, including the Paromomyidae, which are known from North America, Europe, and Asia. Four species of Paromomyidae, all belonging to the genus *Arcius*, have been reported from Europe: *A. fuscus*, *A. lapparenti*, and *A. rougieri* from France, and *A. zbyszewskii* from Portugal. *Arcius* sp. is also known from the Masia de l'Hereuet fossil site in northeastern Spain, and a specimen identified as *A. lapparenti* has been described from the Abbey Wood site in England.

A comprehensive cladistic analysis of the European paromomyids has never previously been performed. Existing conceptions of the relationships between the various species of *Arcius* suggest that *A. rougieri* represents a more primitive stage than *A. fuscus* and *A. lapparenti*. *Arcius zbyszewskii* was suggested to be the most primitive species of the European paromomyids, closely related to *A. rougieri*. The Spanish specimens were suggested to be closely related to *A. lapparenti*, but not part of the same species. A total of 157 dental characters were analyzed for the four species of *Arcius* and the *Arcius* sp. specimens from Spain. The single specimen from England is analysed separately from the French *A. lapparenti*. Parsimony based cladistic analysis using TNT yielded a single-most parsimonious cladogram rooted with *Paromomys maturus*. The results agree with *A. zbyszewskii* being the most primitive species. However, *A. fuscus* is positioned as the sister taxon of *A. rougieri* and *A. lapparenti*, and the Spanish material seems to pertain to a quite primitive lineage, instead of being closely related to *A. lapparenti*. In a biogeographic sense, the results of the new cladistic analysis follow a west-to-east pattern. The most primitive species, *A. zbyszewskii*, is known from Silveirinha, Portugal; the more derived *Arcius* sp. from Masia de l'Hereuet is from northeastern Spain; and the other three species are from central Europe. This might suggest that southwestern Europe could have been the entry point for paromomyids from North America to this continent via Greenland.

Technical Session XVII (Saturday, November 2, 2013, 1:45 PM)

QUANTIFYING TRIASSIC SEDIMENTATION ACROSS THE WESTERN UNITED STATES: PERCEPTION, PRESERVATION, AND PALEONTOLOGY

LOVELACE, David, University of Wisconsin-Madison, Madison, WI, United States, 53706; BUTLER, Richard, GeoBio-Center Ludwig-Maximilians-Universität, München, Germany

Spanning just over 50 million years, deposits of Triassic age captured and preserved an amazing array of information ranging from biological evolution to global tectonics to climate change. Within North America, the western USA provides the greatest temporal range of Triassic sedimentation. The spatiotemporal distribution of these strata was analyzed using a macrostratigraphic approach. Hiatus bound packages of sediment were quantified to determine rates of initiation, truncation, and accumulation, as well as total volume and lithologic diversity. The results of this analysis demonstrate a significant difference between Early Triassic and Late Triassic deposition, while recording the absence of the majority of Middle Triassic terrestrial strata. Continentally derived Middle Triassic sediment is markedly limited in the marine record, indicating this is not simply a matter of sediment bypass. The low volumes of terrigenous sediment in Middle Triassic

marine strata suggest the extensive paleosols observed along the base of the Late Triassic unconformities may represent a long-lived time-surface. Early Triassic strata are dominated by fine-grained siliciclastics whose average volume is nearly five times that of the more lithologically heterogeneous Late Triassic strata, suggesting different control mechanisms. Paleobiological data (vertebrate genera and ichnogenera) were culled from the Paleobiology Database for each stratigraphic unit of the Triassic in the western USA in order to quantify their relationships through space and time. The most notable difference is the relative abundance (>75%) of ichnotaxa relative to body fossil taxa. The Late Triassic exhibits a much higher abundance (>80%) of body fossil taxa relative to ichnotaxa until the End-Triassic extinction, where tracks once again dominate (>80%). The observation that tracks represent the majority of the faunal diversity during two of the five major biotic crises recovery intervals may be the result from low populations, high sedimentation (e.g., dilution), or be an artifact of taphonomy.

Technical Session XVII (Saturday, November 2, 2013, 3:30 PM)

CRANIAL STRUCTURE IN THE EARLY DEVONIAN ONYCHODONT *QINGMENODUS YUI* AND ITS IMPLICATIONS FOR THE PHYLOGENETIC POSITION OF ONYCHODONTIFORMES AMONG SARCOPTERYGIANS

LU, Jing, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; ZHU, Min, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; AHLBERG, Per, Uppsala University, Uppsala, Sweden; QIAO, Tuo, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

The Onychodontiformes is an enigmatic Devonian group of sarcopterygians characterized by large, sigmoid parasymphysial tooth whorls, and its monophyly is generally agreed. However, whether the Onychodontiformes is positioned among stem sarcopterygians or among crown sarcopterygians is still debated, partially due to the paucity of data on onychodont neurocranial anatomy. *Qingmenodus yui* from the Pragian (Early Devonian) of China is one of the oldest onychodonts, and has a well-ossified kinetic braincase. The examination of the holotype (an otoccipital portion, Institute of Vertebrate Paleontology and Paleoanthropology [IVPP] V16003.1) and two new braincase specimens (IVPP V 16003.5-6) by means of high-resolution computed tomography (HRCT) reveals more neurocranial features of onychodonts, and provides a new basis for clarifying the phylogenetic relationships of the group. The posterior extremity of the ethmosphenoid has a strong anterodorsal slope, a condition similar to that in *Onychodus*, coelacanths and porolepiforms, and different from the posterodorsal slope in stem sarcopterygians (e.g., *Psarolepis* and *Achoania*). The nasal capsules are very large and ventrally extended. The supraorbital and main lateral-line canals have a broad and compressed cross-section and many small branches opening on the surface of skull roof. The trajectory of the supraorbital canals is lyre-shaped, as in rhipidistians, *Styloichthys* and some coelacanths such as *Euporosteus*. In the snout endoskeleton, many canals for the superficial ophthalmic nerve send out ramifying branches. These canals topologically correspond to the rostral tubuli in basal dipnomorph *Youngolepis* and Devonian lungfishes. The digital restoration also shows that many of these ramifying branches extend anterodorsally and enter into the supraorbital canal. The supraotic cavity has an elongate posterior portion mesial to the labyrinth cavity, like that of the tetrapodomorph *Eusthenopteron*. Remarkably, *Qingmenodus* is very similar to the Devonian coelacanth *Diplocercides* in possessing a prominent processus connectens, the broadest otoccipital division of the cranial cavity across its midmost part, and a large sacculus in the inner ear region. A hyomandibular of the holotype preserved *in situ* has been restored by HRCT, and its proximal end shows possible double articulation facets as in coelacanths and rhipidistians. All these new data suggest that the phylogenetic position of onychodonts is in or near the crown sarcopterygians, warranting further investigation with a more detailed cladistic analysis.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE MOST COMPLETE JUVENILE PHYTOSAUR SKULL: *REDONDASAURUS* FROM THE UPPER TRIASSIC CHINLE GROUP AT GHOST RANCH, NEW MEXICO

LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, United States, 87104-1375; SPIELMANN, Justin, New Mexico Museum of Natural History, Albuquerque, NM, United States; RINEHART, Larry, New Mexico Museum of Natural History, Albuquerque, NM, United States; SULLIVAN, Robert, New Mexico Museum of Natural History, Albuquerque, NM, United States

Redondasaurus is the geologically youngest known North American phytosaur and an index fossil of the Apachean land-vertebrate faunachron. In the Rock Point Formation (Chinle Group) at the Whitaker quarry, Ghost Ranch, New Mexico, a nearly complete juvenile skull of *Redondasaurus* was preserved among the many skeletons of the dinosaur *Coelophysis*. Approximately 220 mm total length, it is the best preserved and most complete juvenile phytosaur skull of its ontogenetic stage known. The skull and lower jaws are nearly complete, only missing the anterior snout tip and anterior end (symphyseal tip) of the lower jaw. This skull shows that many of the diagnostic cranial features of *Redondasaurus* are present in small specimens and thus not subject to ontogenetic change, including septomaxillae that wrap around the outer margin of the external narial opening, thickened orbital margins, and inflated posterior nasal behind the external narial opening. However, the juvenile skull does not possess some features that diagnose adult *Redondasaurus*, including supratemporal fenestrae concealed in dorsal view and reduced antorbital fenestrae. These differences are attributable to differential growth of selected parts of the skull, particularly the great expansion of the squamosals to conceal the supratemporal fenestrae in the adult. Thus, the juvenile skull of *Redondasaurus* demonstrates that juvenile phytosaurs can be diagnosed and assigned to taxa defined on adult characters. We assembled a growth series of five *Redondasaurus* skulls from which we assessed skull metrics and allometry. Relative growth data for this dataset of *Redondasaurus* skulls, which range in length from 220 to 1205 mm, as log-transformed metrics better fit a linear regression than a polynomial, which indicates simple allometry where shape changes during ontogeny occurred along a single constant trajectory. The allometry of the *Redondasaurus* skull is similar to that of numerous other phytosaur species, except in the postorbital region, which apparently grows in negative allometry as opposed to the positive allometry seen in others. The data thus imply that this is an important ontogeny-based diagnostic character of *Redondasaurus*, but a larger sample size will be required to confirm the hypothesis.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EXAMINING THE CONGRUENCE BETWEEN DIFFERENT SOURCES OF PHYLOGENETIC DATA FROM ARTIODACTYLA

LUDTKE, Joshua, University of Calgary, Calgary, AB, Canada, T2N 1N4; RACICOT, Rachel, Yale University, New Haven, CT, United States

Genomic sources of phylogenetic data are abundant for extant and recently-extinct species. This abundance allows for dense character sampling of extant species and provides a critical test of the ability of phenomic data to determine phylogenetic relationships of extant taxa. In some cases, genomic phylogenetic trees are increasingly congruent on what may be true phylogenetic signals among extant taxa, while phenomic trees continue to produce incongruence. Although there are examples in which singular sources of genomic data provided erroneous evolutionary hypotheses, phenomic data are often *a priori* labeled as being less informative than genomic data without much discussion of why.

The abundance of both phenomic and genomic data within the Artiodactyla makes this clade an ideal system to investigate factors leading to incongruence between these data sets. Phenomic and genomic sources of phylogenetic data, when analyzed separately, yield different topologies; few phenomic analyses support the inclusion of Cetacea within Artiodactyla, whereas nearly all genomic analyses do. However, when phenomic and genomic sources of phylogenetic data are used in combined analyses within Artiodactyla, phenomic data increase support for, and aid in the resolution of, branching events primarily supported by genomic data.

Our study analyzes published combined phylogenetic matrices of Artiodactyla to determine how genomic and phenomic data contribute to the combined topology. We investigated the interaction between partitioned branch support (how much a source of data supports a clade in a combined analysis) and Bremer branch support in separate analyses (how much a source of data supports a clade in its own analysis), also known as hidden branch support. Our analysis separated different sources of genomic (e.g., mitochondrial and nuclear) and phenomic (e.g., cranial, postcranial, non-osteological) data to determine how these sources of data interact to produce a combined topology. As expected, phenomic data are mixed in their ability to inform combined analyses: phenomic support for some genomic clades is low or non-existent. However, phenomic data show hidden branch support for many groups within Artiodactyla. Phenomic data are found to be informative, but, like genomic data, work better when combined with other data than by theirselves.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

PTYCHOGASTERINAE (TESTUDINES: GEOEMYDIDAE) IN THE VALLÈS-PENEDÈS BASIN (NE IBERIAN PENINSULA): NEW REMAINS AND TAXONOMIC REVISION

LUJÁN, Àngel H., Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; DELFINO, Massimo, Università degli Studi di Torino, Torino, Italy; CASANOVAS-VILAR, Isaac, Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain

"Ptychogasterids"—here distinguished as a subfamily (Geoemydidae: Ptychogasterinae)—constitute an extinct clade of freshwater testudinoids, characterized by the presence of two "ptychogasterid" spikes amongst other synapomorphies. A single species with many synonyms—*Ptychogaster* (*Temnoclemmys*) *batalleri*—has been traditionally recognized in the Vallès-Pendedès Basin (NE Iberian Peninsula). This species, the type of subgenus *Temnoclemmys*, was originally described in this basin, where no taxonomic revision of these turtles has been performed for many decades. We report new ptychogasterine material from several Vallès-Penedès localities and, on the basis of this and previously published material, we further revise their taxonomy as well as the phylogenetic relationships of the subgenus *Temnoclemmys*.

Our results record the subgenus *Ptychogaster* s.s. for the first time in the Basin, ranging from the MN4 (early Miocene) to the MN7+8 (middle Miocene), although available remains are too scarce to provide a species assignment. However, most of the available remains are attributable to the subgenus *Temnoclemmys*. Fragmentary early Miocene (MN4) remains could not be identified to the species level, whereas the more abundant and complete remains are attributed to *P.* (*T.*) *batalleri*. Some of the late Miocene new remains are larger than previously recorded for this taxon, but otherwise fit well with previously known specimens from the MN9 and MN10. The new material expands the chronostratigraphic range of this species in the Vallès-Penedès Basin back to the middle Miocene (early MN7+8), and further shows that *"Testudo" celonica* is a junior subjective synonym of *P.* (*T.*) *batalleri*.

A cladistic analysis of ptychogasterines, which for the first time includes *Temnoclemmys*, strongly supports the monophyly of the genus *Ptychogaster*, and further suggests that *Temnoclemmys* might be the sister-taxon of the subgenus *Ptychogaster*. Although the internal phylogeny of the genus is not well enough resolved, a relatively basal position for *P.* (*T.*) *batalleri* and *P.* (*P.*) *ronheimensis*, as suggested by previous authors, is supported. Emended diagnoses for *Ptychogaster* and *Temnoclemmys* are provided.

Technical Session IV (Wednesday, October 30, 2013, 2:00 PM)

TAXONOMY, BIOGEOGRAPHY, AND PHYLOGENY OF MIOCENE ENDEMIC SOUTH AMERICAN UNGULATES (MAMMALIA) FROM THE LAGUNA DEL LAJA REGION, ANDEAN MAIN RANGE, CENTRAL CHILE

LUNA, Daniel, University of California Santa Barbara, Santa Barbara, CA, United States, 93106-9630; FLYNN, John, American Museum of Natural History, New York, CA, United States; CROFT, Darin, Case Western Reserve University, Cleveland, OH, United States; WYSS, Andre, University of California Santa Barbara, Santa Barbara, CA, United States

A stratigraphically superposed series of early-late Miocene fossil mammal assemblages has been recovered from the Andean Main Range of Chile, near Laguna del Laja (LdL; ~37.5º S, 71º W), shedding light on the poorly known extra-Patagonian history of South American Neogene mammals. Localities within the Cura-Mallín and overlying Trapa-Trapa formations at LdL, from which several hundred specimens have been recovered, are well constrained stratigraphically and with high precision $^{40}Ar/^{39}Ar$ ages, providing a robust temporal framework for the fossiliferous horizons spanning ~20-9 Ma. Rodents from LdL have been reported to exhibit high levels of endemism throughout the stratigraphic section. Herein we provide a detailed account of the ungulates from the Cura-Mallín Formation at LdL; these range in age from ~20-15 Ma. Specimens referred to *Protypotherium*, *Pachyrukhos*, *Colpodon*, and *Astrapothericulus*, together with radioisotopic ages, indicate that faunas pertaining to the Colhuehuapian, Santacrucian, Friasian?, and Colloncuran South American Land Mammal "Ages" (SALMAs) occur in direct stratigraphic superposition at LdL. In addition, new species of *Pachyrukhos* and *Colpodon*, plus four new typotherian genera, occur at LdL, heightening the pattern of endemism already observed in the rodent faunas. The five new taxa described in this study are typotherian notoungulates, including four interatheriines and one hegetotheriine. The new material and taxa from LdL provide the basis for a taxonomic revision of *Protypotherium* and *Pachyrukhos*, as well as robust phylogenetic analyses of the Interatheriinae and Hegetotheriinae, thus contributing to our understanding of the evolution of these diverse typotherian clades. Given the geographic proximity of faunas from LdL with roughly coeval counterparts in neighboring regions of Argentina, the high level of endemism across multiple SALMAs at LdL is striking. This provinciality of the Andean faunas, relative to Argentine assemblages, likely reflects sampling of a regionally distinct and isolated paleoenvironment, potentially related to uplift of the central Chilean Andes in this area.

Preparators' Session (Thursday, October 31, 2013, 8:15 AM)

UNDER THE HEADWALL: FIELD LOGISTICS OF EXCAVATING FOSSILS FROM LARGE VERTICAL EXPOSURES

LUND, Eric, Ohio University, Athens, OH, United States, 45701; LAWRENCE, David, Ohio University, Athens, OH, United States

*Field collection techniques for recovering vertebrate fossils have remained relatively unchanged since the late 19th Century. Traditional methods include: (1) removal of overburden using picks and shovels; (2) careful excavation of fossils with hand tools; and (3) removal of specimens within protective plaster jackets. Occasionally, specific locality characteristics require the development of alternative field collection techniques. Here we describe field logistics associated with excavating and collecting fossils from large, vertical exposures. Quarries situated at the base of large vertical headwalls (e.g., cut-banks, erosional cliffs) can result in insurmountable overburden, producing vertical excavation surfaces necessitating unique collecting approaches. To complicate matters, matrix can vary from poorly consolidated to highly indurated sedimentary facies. Fossil horizons can also extend deep into the vertical surfaces causing precarious destabilization of overburden as quarry faces are expanded into the headwalls. Moreover, fossil horizons can lie near water seeps or the water table, resulting in damp to waterlogged matrix that severely limits the types of consolidants (e.g., Paraloid B-72, Rhoplex B60A) and jacketing techniques that may be applied. Effective approaches include: (1) careful mining of fossil specimens from the quarry face; (2) block removal of larger and more complex materials; and (3) hours to days of block desiccation prior to conventional methods of stabilization and protection. The friable condition of waterlogged specimens can be transformed to a highly durable state once the surrounding matrix has dried; subsequent laboratory preparation of specimens can reveal exquisitely preserved details. The geological and paleontological importance of some localities warrants a multi-phase collecting effort, and insights gathered over the past several years of field excavations are documented for use in other locales with similarly challenging collecting conditions.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

TESTING MOLECULAR HYPOTHESES OF LATE PLEISTOCENE EQUID ABUNDANCE IN NORTH AMERICA: HORSES FROM GYPSUM CAVE, NEVADA

LUTZ, Christina, George C. Page Museum , Los Angeles, CA, United States, 90036; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States

Horses (genus *Equus*) are a common taxon in Pleistocene faunas throughout North America. Molecular studies have proposed that there may only have been two species of horses present in North America during the later Pleistocene, one stilt-legged and the other stout-limbed. To test this hypothesis, we examined specimens from Gypsum Cave, a late Pleistocene limestone cavern in the Frenchman Mountains of southern Nevada. Originally excavated in 1930-31, Gypsum Cave yielded multiple well-preserved fossils of *Equus* and other late Pleistocene megafauna. Preservation is exceptional, including soft tissues; fossils from the site have previously yielded both radiocarbon dates and DNA. Horse fossils from Gypsum Cave dating to ~13 ka were included in earlier molecular studies assessing late Pleistocene equid diversity in North America, therefore quantifying the entire sample of horse fossils from the site was warranted. Remains of *Equus* at Gypsum Cave are well represented in the assemblage. Multiple skeletal elements, both cranial and postcranial, are preserved. As noted, some fossils retain soft tissues including ligaments, tendons, skin, and hooves. Based upon dental elements, the sample includes two adults, two subadults, and five juveniles. Five left metatarsals, four with fused distal epiphyses, when combined with the dental elements indicate a minimum number of ten individuals in the sample. All of these fossils represent a small stilt-legged species, confirmed metrically and through previous mDNA analysis. Radiocarbon dates associated with these remains yielded ages of ~13 ka. Additionally, a single terminal phalanx encased within an intact hoof represents a large species; this fossil has been previously dated to ~25 ka. Based upon these data, two species of horse are present at Gypsum Cave: a large stout-limbed species and a smaller stilt-legged form. Lack of more diagnostic remains precludes specific assignment for any of these fossils at present. Comparison of these remains with fossils from other Pleistocene localities in the Mojave Desert (e.g., Lake Manix, Kokoweef Cave, Tecopa) confirmed the presence of small stilt-legged horses elsewhere in the region. In contrast, more coastal assemblages (e.g., Rancho La Brea) lack stilt-legged equids altogether, instead preserving two stout-limbed species, the larger *Equus "occidentalis"* and the smaller *E. conversidens*. We conclude that there were at least three species of *Equus* in North America in the late Pleistocene: large and small stout-limbed species and a smaller stilt-legged form.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW PISTOSAUROID (REPTILIA: SAUROPTERYGIA) FROM THE LATEST LADINIAN XINGYI MARINE VERTEBRATE LEVEL, SOUTHWESTERN CHINA

MA, Le-tian, Peking University, Beijing, China; JIANG, Da-yong, Peking University, Beijing, China; RIEPPEL, Olivier, The Field Museum of Natural History, Chicago, IL, United States; MOTANI, Ryosuke, University of California, Davis, CA, United States; TINTORI, Andrea, Università degli Studi di Milano, Milano, Italy

Triassic stem pistosauroids are believed to be closely related to the plesiosaurs, the crown taxon of Sauropterygia that comprised cosmopolitanly distributed predators in Jurassic and Cretaceous marine ecosystems. Eight genera of Triassic stem pistosauroids were reported, but the complete cranial osteology was only known for a few, and *Yunguisaurus* was the only one to date represented by a complete skeleton. A new complete and articulated skeleton of a pistosauroid, with a skull perfectly preserved in three dimensions, was collected from the latest Ladinian (Middle Triassic) of Xingyi in Guizhou Province, southwestern China. The new specimen has two apomorphies: the pineal foramen is located far posteriorly in the parietal skull table, and the parietal is raised into a distinct sagittal crest. There are about 33 cervical vertebrae, 16 dorsal vertebrae, and 4 sacral vertebrae. The anterior 10 caudal vertebrae are preserved. Five carpal and four tarsal ossifications are present, and the hindlimb shows a phalangeal formula of 3 (?)- 3- 4- 5- 5, indicating hyperphalangy for the fifth digit. These characters allow us to refer this new specimen to pistosauroids. The constricted snout, the fused parietals, and the jugal entering the posterior margin of the orbit indicate that the new specimen is more similar to the pistosauroid *Cymatosaurus* than to the geographically and stratigraphically closer *Yunguisaurus*. But it still differs from *Cymatosaurus* which has reduced nasals, paired frontals, and the pineal foramen close to the middle of the skull table. However, the new specimen also shares some interesting morphological similarities with *Nothosaurus*, such as the elongate upper temporal fenestra whose longitudinal length is 3.1 times that of the orbit, the unpaired frontal, the plate-like occiput with no distinct paroccipital process, and the horizontally oriented supraoccipital. Although the monophyly of the infraorder Pistosauroidea was found to be well supported, the interrelationships among them remain controversial. Our new complete specimen provides new information that helps to solve the interrelationships among Triassic pistosauroids. A preliminary phylogenetic analysis confirms this new taxon as a member of Triassic pistosauroids, within which the monophyly of (*Pistosaurus* + *Augustasaurus*) is again supported.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

AGGREGATION OF MORPHOLOGICAL CHARACTERS ACROSS STUDIES USING AN ONTOLOGY-BASED PHENOTYPE APPROACH

MABEE, Paula, University of South Dakota, Vermillion, SD, United States, 57069; DECECCHI, Alexander, University of South Dakota, Vermillion, SD, United States; IBRAHIM, Nizar, , Chicago, IL, United States; Sereno, Paul, Univ of Chicago, Chicago, IL, United States; BALHOFF, Jim, NSCENT, Raleigh, NC, United States

Comparative descriptions of vertebrate morphology have been formalized in the phylogenetic systematic literature, yet they remain uncomputable and thus difficult to integrate across studies or with developmental or genetic data. The Phenoscape team has developed and used anatomy, quality, and taxon ontologies to represent the free-text descriptions of character states for taxa as 'Entity-Quality' (EQ) statements, or 'taxon phenotypes'. We have annotated close to 3000 fin and limb phenotypes for 787 extant and fossil sarcopterygian taxa from 938 characters from 38 papers for the Phenoscape Knowledgebase (kb.phenoscape.org), where morphological variation of vertebrates, including fossils, is linked to genetic mutants of vertebrate models (zebrafish, mouse, Xenopus), thus enabling formulation of evo-devo hypotheses. In the process of annotation, a character state from an original matrix is frequently decomposed into multiple EQ phenotypes. Such atomization enables similar phenotypic variants (e.g., changes in humerus shape) to be automatically aggregated across studies. Using fin/limb phenotypes as a focus data set, we contrast and characterize the sum of these data with their matrix-based descriptions from component studies. Morphological data in this computable format can be browsed, sorted and aggregated in ways that present new views of character evolution. Translating character states into multiple phenotypes, however, means that it is not possible to automatically reconstruct a supermatrix from component data sources. We describe the workflow and challenges involved in applying

phylogenetic codes to taxon phenotypes. With its emphasis on integrative morphology and phenotypic analysis, we propose Phenoscape as a powerful new tool for paleontological research.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE FIRST LOOK AT THE RELATIVE ABUNDANCES OF TAXA FROM THE RICHARDS SPUR LOCALITY OF OKLAHOMA, USA

MACDOUGALL, Mark, University of Toronto Mississauga, Mississauga, ON, Canada, L5L1C6; MEER, Tooba, University of Toronto Mississauga, Mississauga, ON, Canada; REISZ, Robert, University of Toronto Mississauga, Mississauga, ON, Canada

The Richards Spur locality in Oklahoma, USA, is unique in that the early Permian (289 ma) carbonate fossiliferous in-fills of the Ordovician Limestone quarry preserve a diverse Paleozoic tetrapod assemblage. The majority of studies published on the Richards Spur tetrapods have largely concentrated on alpha taxonomy, with little work being done on the paleoecology and taphonomy of the locality. Of particular interest is the paleoecology of the locality, as the Richards Spur assemblage is distinct from those of most other early Permian localities in representing an upland depositional environment with a rich endemic population of exclusively terrestrial tetrapods. The upland nature of Richards Spur, and a lack of large bodied taxa at the locality suggest a palaeoecology that is distinct from all of the other Permian lowland, deltaic assemblages. Currently, only the taxonomic diversity at Richards Spur is relatively well known. In contrast to other known Paleozoic fossil tetrapod localities, the vast amount of fossil material available from Richards Spur makes a study of relative abundance, and its paleoecological significance feasible. Large fossiliferous blocks of clay taken from the fissures of Richards Spur were prepared. Elements obtained from the blocks were sorted, counted, and identified. The results of this study reveal for the first time that anamniotes are the most abundant tetrapods at Richards Spur, making up almost 2/3 of the identified elements, with the most common taxon being *Doleserpeton annectens*. Reptiles are the next most commonly found elements, with *Captorhinus aguti* being the must abundant reptile taxon, whereas other members of Reptilia, specifically parareptiles and varanopid synapsids, are relatively rare. Identified elements were also separated into size classes, with the skeletal elements of smaller taxa being much more abundant than the elements of larger taxa, suggesting a size bias towards smaller taxa at Richards Spur. Interestingly, even smaller elements of large lowland taxa, such as *Dimetrodon*, *Ophiacodon*, and *Edaphosaurus*, are not present among the sorted material, suggesting that these taxa, commonly found in the fluvio-deltaic localities of the early Permian, may not have been present at Richards Spur.

Technical Session IV (Wednesday, October 30, 2013, 3:30 PM)

AGE OF THE TARIJA FAUNA, BOLIVIA: IMPLICATIONS FOR *EQUUS* DISPERSAL AND CALIBRATION OF GABI 3

MACFADDEN, Bruce, Florida Museum of Natural History, Univ of Florida, Gainesville, FL, United States, 32611

The highly fossiliferous badlands in the Tarija basin, southern Bolivia, have produced a classic Ensenadan mammalian fauna representing the height of the Great American Biotic Interchange (GABI). Although traditionally accepted to be middle Pleistocene age, a recent study of supposedly interbedded radiocarbon ages has advocated for a younger (Lujanian) SALMA for the Tarija Fauna. In contrast, here a recently published radioisotopic determination of 0.76 ± 0.03 Ma is described for an ash within the Tolomosa Formation, which contains the Tarija Fauna. This geochronological calibration point corroborates a fission-track age and magnetostratigraphic correlation from the 1980s recording the Jaramillo subchron and Bruhnes-Matuyama boundary within the Tarija fossiliferous sequence. A biostratigraphic study of the equids confirms that horses (Family Equidae) are abundantly represented throughout the sequence at Tarija, including definitive evidence of the genus *Equus* (*insulatus*) at all fossiliferous levels recorded in the UF collections. Given the age of Tarija Fauna, these occurrences of *Equus* span an age range from 0.99 Ma to less than 0.76 Ma during the middle Pleistocene, or Ensenadan SALMA. Over the past decade, refinements in geochronological calibrations indicate that GABI was actually a series of separate immigration events, or pulses, during the Pliocene and Pleistocene. Studies from the classic localities in Argentina, where the Pleistocene SALMAs are characterized, postulate that the genus *Equus* was part of GABI 4 that defines the base of the late Pleistocene Lujanian SALMA at 0.125 Ma. However, the biostratigraphic occurrences of *Equus* at Tarija demonstrably indicate an earlier arrival of this genus into South America during the middle Pleistocene Ensenadan at about 1 Ma, i.e., GABI 3. While the FAD (first appearance datum) of *Equus* in South America is earlier than previously accepted for the classic sequences in Argentina, the presence of the species *E. neogaeus* may still be an index fossil for the Lujanian SALMA.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A NEW TITANOSAUR (DINOSAURIA, SAUROPODA) FROM THE LATE CRETACEOUS BAURU BASIN, BRAZIL

MACHADO, Elaine, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; AVILLA, Leonardo, Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro, Brazil; NAVA, William, Museu de Paleontologia de Marilia, Marília, Brazil; CAMPOS, Diogenes, Museu de Ciências da Terra, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

To date, there are only eight valid titanosaurid species described from Brazilian deposits. Besides the exceptional skull of *Tapuiasaurus macedoi* and the partial upper jaw of *Maxakalisaurus topai*, all other Brazilian taxa lack cranial elements. Here we describe a new specimen, housed at Museu de Paleontologia de Marília (MPM 125R) that was collected near Presidente Prudente city, São Paulo State. It comes from the Adamantina Formation, whose age is regarded as Turonian-Santonian. The new specimen is composed of a right dentary, two cervical vertebrae, three incomplete sacral vertebrae, a portion of an ischium and ilium, one ungual and other fragmentary elements. The surface of the right dentary is weakly ornamented with pits, grooves, and foramina. In dorsal view, this bone is L-shaped, resulting in the so-called squared jaw morphology of the lower jaw, as seen in *Bonitasaura* and *Antarctosaurus wichmannianus*, but differing from the more rounded condition reported in *Tapuiasaurus*, *Rapetosaurus*, *Nemegtosaurus*, and *Malawisaurus*. The cervical vertebrae possess some potential autapomorphies such as the presence of anteriorly directed accessory prezygapophyseal articulation surfaces and intraprezygapophyseal laminae with a V shape in dorsal view. The sacral vertebrae are preserved lacking most of the centra and the tips of the neural spines. The exact number of sacral elements in this species is unknown. All three are tightly connected, but suture marks between them indicate that they are not completely fused. The ungual is curved, laterally compressed and slightly asymmetrical, with one side less convex than the other. The less convex side bears a marked sulcus. A tuberosity that resembles a callus can be observed on the ventral view, although it cannot be confirmed that it is pathological. Despite the fact that it is difficult to establish the phylogenetic position of the new Brazilian specimen, it can be excluded from some clades such as the Lognkosauria and the derived Saltasaurinae. Due to the particular shape of the dentary, MPM 125R seems to be more closely related to *Antarctosaurus* and *Bonitasaura*, whose phylogenetic position is also not well established. The problems regarding titanosaur phylogeny is not recent and consensus seems still far away. In part this is due to the incomplete material of several taxa, which is also the case of MPM 125R. Nonetheless, the new specimen possess a unique combination of features and is clearly distinct from all other titanosaurs that show comparable material, increasing the titanosaur diversity in Brazil.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW PLEISTOCENE MEGAFAUNA LOCALITIES IN SANTA BARBARA COUNTY, CALIFORNIA: PALEONTOLOGICAL RECONNAISSANCE OF THE MARINE TERRACE DEPOSITS AT VANDENBERG AIR FORCE BASE

MACIAS, Melissa, University of California Santa Barbara, Santa Barbara, CA, United States, 93109; KITAO, Eiko, Santa Barbara City College, Santa Barbara, CA, United States; GRAY, Robert, Santa Barbara City College, Santa Barbara, CA, United States

*Late Pleistocene alluvial deposits near Vandenberg Air Force Base (VAFB) in Santa Barbara County have yielded various megafauna fossils, but the Base itself has not been studied in detail as a paleontological resource due to highly restricted military access. The coastal boundaries at VAFB are platforms of emergent marine terraces overlain by continental alluvial deposits that span over 55 kilometers of undeveloped coastline. Although radiometric dating has not been completed on marine terraces within VAFB, correlation between marine terrace deposits to the north and south yield ages of oxygen isotope stage 5e (5e-120ka) for the higher terrace, and stage 5a (5a-80ka) for the lower terrace. Paleontological reconnaissance was conducted along the coast to identify vertebrate fossil material along eroding sea cliffs and associated drainages. Thirty-three new fossil localities with over 80 individual fossils were recorded in the 80ka terrace, with Rancholabrean taxa including: *Bison sp., Camelops hesternus, Equus occidentalis, Mammuthus colombii, Mammut americanum, Paramylodon harlani, Platygonus sp., and Smilodon sp.* Although many localities consist of isolated individual bones, a high concentration was found at Brown's Beach 'Eiko's Elephant Graveyard' (EEG). Thirty nearly complete fossil bones were recovered in a 25 square meter section with over half identified as *Paramylodon harlani*. The fossils were encapsulated in fine silt and clay with lenses of yellow sand and carbonaceous plant matter. Depositional analysis suggests an isolated body of water within a braided meander system, providing excellent conditions for vertebrate fossil preservation. New fossil localities at VAFB will provide valuable data for paleontological resources in Santa Barbara County. These localities will add to the knowledge of Rancholabrean megafauna found in southern California.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE FIRST RECORD OF *OSBORNODON IAMONENSIS* FOR OREGON AND OTHER CANIDS OF THE ARIKAREEAN, FROM COGLAN BUTTES, OREGON

MACKENZIE, Kristen, University of Oregon, Eugene, OR, United States, 97403; ORCUTT, John, Cornell College, Mount Vernon, IA, United States; HOPKINS, Samantha, University of Oregon, Eugene, OR, United States

Coglan Buttes, Oregon, the only Arikareean vertebrate locality in the northwestern Great Basin, contains a diverse macro- and micro-fauna. Carnivores are well represented by an indeterminate canid, several hesperocyonines, one borophagine, and several canines. The hesperocyonine, *Osbornodon iamonensis* is reported for the first time from Oregon despite its extensive temporal and spatial distribution. Mandibles with partial dentition and associated postcrania represent one individual of *O. iamonensis* which offers the opportunity to describe its postcranial morphology. Its distal radius and ulna are subequal in diameter and are not robust as in more basal canids. The ulnar styloid is not tapered as in cursorial canids. These new data suggests *O. iamonensis* had less derived cursorial morphology. *O. iamonensis* was likely an opportunistic ambush predator. The stratum yielding *O. iamonensis* also produced a borophagine mandible (*Paracynarctus* sp.) with both meso- and hypocarnivorous characters. These canids are coeval with a diverse assemblage of camelids, oreodonts, rodents, equids, and moschids. This assemblage is similarly diverse to the coeval John Day Basin assemblages, but differs somewhat ecologically. Stenomylines requiring open habitat are not found at Coglan Buttes, but various protolabines dominate the assemblage. Burrowing rodents and the moschid *Blastomeryx* are the next most abundant respectively. This suggests that

Coglan Buttes may have been a mixed open woodland transitioning to savannah. Strata down-section have produced several species referable to Caninae, including *Leptocyon*. These canids have been found with a diverse rodent assemblage from the same locality. While there are some differences in taphonomy between the two localities, there appears to be a real difference in ecology represented by changes in taxon representation through the section at this critical new site.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

MORE OF THE FEMUR OF *MOROTOPITHECUS*

MACLATCHY, Laura, University of Michigan, Ann Arbor, MI, United States, 48109; KINGSTON, John, University of Michigan, Ann Arbor, MI, United States; KITYO, Robert, Makerere University, Kampala, Uganda

Morotopithecus bishopi from northeastern Uganda is one of the oldest known hominoids, radiometrically dated to > 20.6 Ma. Fragmentary vertebral and scapular remains attributed to *Morotopithecus* have previously been used to reconstruct a positional repertoire that included derived behaviors such as dorsostable lumbar postures and use of the arms above the head. In addition, specimen MUZM (Makerere University Zoology Museum) 80, partial right and left femora, has cross-sectional properties indicative of high axial loading, such as might be caused by sustained muscular contractions during behaviors such as slow climbing. In sum, these behaviors contrast with those reconstructed for contemporaneous species of *Proconsul*, considered to be pronograde quadrupeds. Ongoing research at the Moroto II locality since 1994, when MUZM 80 was discovered, has resulted in the recovery of additional femoral fragments, such that the length of the right femur can now be directly measured. Complete long bones are exceedingly rare among fossil catarrhines. We used linear regression to examine scaling relationships between femoral shaft length and proximal and distal femoral joint size (femoral head diameter and bicondylar width) in extant nonhuman hominoids (5 species), cercopithecoids (7 species), *Morotopithecus*, and previously described *Proconsul* femora with almost complete shafts. We find that hominoids have shorter femoral shafts relative to proximal and distal joint sizes than do cercopithecoids; *Morotopithecus* resembles hominoids in having a short shaft, while *Proconsul* has a longer shaft, more like quadrupedal monkeys. The relatively short femoral shaft length complements earlier interpretations that *Morotopithecus* loaded the hindlimbs and forelimbs differently in behaviors such as orthograde slow climbing. The short shaft may also reflect reduced integration between the hindlimbs and forelimbs, which has been linked to the overall evolvability of hominoid limbs, although this inference must remain speculative in the absence of forelimb shafts.

Symposium 4 (Saturday, November 2, 2013, 12:00 PM)

PLEISTOCENE LARGE MAMMAL DISPERSALS AND REGIONAL EXTIRPATIONS IN HIGH-LATITUDE NORTH AMERICA

MACPHEE, Ross, American Museum of Natural History, New York, NY, United States, 10024; ZAZULA, Grant, Yukon Palaeontology Program, Whitehorse, YT, Canada

The extinct North American Late Pleistocene (LP) megafauna is traditionally regarded as having disappeared en masse during the Pleistocene/Holocene transition (P/HT), but given their diversity we question whether all taxa declined at the same rate and in the same manner. During glacial periods, communities in high-latitude North America (unglaciated Alaska/Yukon) were dominated by large grazers adapted to open steppe-tundra habitats (e.g., *Mammuthus*, *Bison*, *Equus*). Although browsers and mixed-feeders such as *Mammut americanum*, *Megalonyx jeffersonii*, *Camelops hesternus*, and *Castoroides ohioensis* were certainly present in Pleistocene Alaska/Yukon, their fossils are rare. Moreover, although these taxa or close allies ranged from the tropics to the Arctic, unlike Holarctic large grazers they failed to disperse intercontinentally via Beringia. This probably reflects periodical ecological constraints linked to paleogeography, vegetation and ultimately climate, but to test this proposition requires good chronological data. The existing high-latitude radiocarbon record for LP megafaunal populations is meagre and contains a number of doubtful (and therefore potentially misleading) ages. For example, the current mastodon record implies that these proboscideans were continually present in ice-free parts of the Arctic during LP, and persisted there into the last glacial maximum. Using modern techniques, including ultrafiltration and single amino acid dating, we consistently found that Alaska/Yukon samples of *Mammut* yielded ages that were either non-finite or effectively so. These results minimally suggest that mastodons (and their preferred habitats) were absent from high latitudes even before the beginning of radiocarbon time (reliable range, ≤ 40,000 bp). Preliminary dates on Yukon *Camelops* also appear to fit this pattern. Although adequate chronological data are lacking, habitat and dietary preferences inferred for *Megalonyx* and *Castoroides* suggest similar chronological restriction. We conclude from this that dispersals of large browsers/mixed-feeders to high latitudes from their mid-continental core ranges were successful only during warm periods. We hypothesize that final (Last Interglacial) high-latitude occupation was followed by extirpation regionally no later than the onset of full Wisconsinan glaciation, ~75,000 bp. Afterwards, mastodons, giant beavers, ground sloths, and camels never ranged so far north again, and were restricted to the mid-continent until their complete extinction near the P/HT.

Technical Session I (Wednesday, October 30, 2013, 9:45 AM)

REAPPRAISAL OF THE EARLY PERMIAN AMPHIBAMID *TERSOMIUS TEXENSIS* AND SOME REFERRED MATERIAL

MADDIN, Hillary, Harvard University, Cambridge, MA, United States, 02138; FRÖBISCH, Nadia, Museum für Naturkunde, Berlin, Germany; EVANS, David, Univ of Toronto at Mississauga, Toronto, ON, Canada

The relevance of amphibamid dissorophoid temnospondyls to the discussion of the evolutionary origin of some or all of the modern amphibian groups (lissamphibians) has prompted a recent increase of studies focused on this group of small, mostly Permian-aged taxa. Despite these advances many questions remain, and for some taxa it has been difficult to establish a stable position within amphibamid phylogeny. One such taxon is *Tersomius texensis*. Details of the morphology of the holotype of *T. texensis*, as well as the accuracy of the taxonomic assignment of three skulls in the collections of the Museum of Comparative Zoology to the early Permian taxon, has been called into question. Here we re-evaluate these materials in light of recent discoveries, and test the validity of the assignment of the three MCZ specimens to *T. texensis*. The results of our phylogenetic analyses corroborate our morphological assessments, revealing only one of the three skulls (MCZ 1912) is assignable to *T. texensis*. We identify MCZ 1415 as *Pasawioops* cf. *P. mayi*, otherwise known only from Oklahoma, and MCZ 1911 as a new genus and species of dissorophid. Recent work on specimens from the Fort Sill assemblage has expanded the number of amphibamids present from one to three (*Doleserpeton*, *Pasawioops*, and '*Tersomius*'). Our work has expanded the number of amphibamids in the Archer City Bone Bed from one to two (*Tersomius* and *Pasawioops*), suggesting amphibamid diversity may be greater in Permian assemblages than previously thought. Restudy of these materials previously referred to *T. texensis* suggests a closer look at historical collections from the Permian of Texas may reveal a greater alpha diversity and important occurrences of taxa that will further contribute to our understanding of early Permian ecosystems.

Technical Session X (Friday, November 1, 2013, 11:30 AM)

THE ABRUPT COLLAPSE OF A DIVERSITY HOTSPOT? RECONSIDERING VALLESIAN (LATE MIOCENE) DIVERSITY IN ITS TYPE AREA

MADERN, Anneke, Naturalis Biodiversity Center, Leiden, Netherlands; CASANOVAS VILAR, Isaac, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallè, Spain; ALBA, David, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola Valles, Spain; DEMIGUEL, Daniel, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola Valles, Spain; VAN DEN HOEK OSTENDE, Lars, Natural Museum of Natural History, Naturalis, Leiden, Netherlands

The Miocene was a turbulent time, marked by major faunal turnovers and climate changes, with an overall trend towards drier and more seasonal conditions. In the early Vallesian (11.1-9.7 Ma), the European area with the highest diversity corresponds to the Vallès-Penedès Basin (Catalonia, Spain), which represents a true diversity hotspot. During the late Vallesian the distribution of mammals in Europe seems more even and hotspots are less apparent. After the early Vallesian climax, there appears to have been a sudden diversity drop at 9.6 Ma, known as the Vallesian Crisis. Initially, this crisis was considered a local event, characterized by the extinction of certain mammal species of middle Miocene origin. However, more recent works consider the Vallesian Crisis to have affected all European faunas, implying the disappearance of most forest-adapted taxa. Reconstructing past biodiversity is a major goal in paleontology, but in order to recognize non-random patterns in a chaos of data, biases must be controlled. A common bias is uneven sampling, where richer or more intensively sampled sites or time intervals contain more rare taxa and thus show a higher diversity. A peak in data quality could lead to an overestimation of the recorded diversity. To assess such biases, robust diversity measures are needed, taking into account sample size and the probability of finding a certain taxon at a specific site. To assess the effects of the quality of the large mammal record, we compiled a quantitative database of the Vallesian macromammal record of the Vallès-Penedès Basin, where the Vallesian Crisis was first recognized. Our results show that extinction rates in the type area might be overemphasized because of the intensive sampling of the richest locality, the site of Can Llobateres 1, which immediately precedes the crisis. Overall sampling before the crisis is much better than afterwards, which inflates diversity and exaggerates extinction rates. Therefore, we calculated new diversity estimates independent of sample size using rarefaction and sampling probability. Our calculations show that many genera that purportedly disappeared during the late Vallesian have a discontinuous record during the early Vallesian and are generally very rare. Since the sampling effort in the late Vallesian sites is comparatively lower, we cannot discount that at least some of those taxa persisted during the late Vallesian. We conclude that the crisis was not a single major event occurring at the early/late Vallesian boundary, but a more protracted extinction period.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW IBERIAN REMAINS OF THE EURASIAN JAGUAR *PANTHERA GOMBASZOEGENSIS* (CARNIVORA, FELIDAE) AND A TAXONOMIC REVISION OF EURASIAN FOSSIL JAGUAR-LIKE CATS

MADURELL-MALAPEIRA, Joan, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; AURELL-GARRIDO, Josep, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; MOYÀ-SOLÀ, Salvador, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain

Fossil jaguar-like cats are recorded from early to early middle Pleistocene Eurasian localities ranging from 2.0 to 0.7-0.6 Ma, but their taxonomic status as well as their phylogenetic relationships with the extant *Panthera onca* remain controversial. Thus, they have been variously assigned to several (sub)species: *Panthera toscana*, *P. schreuderi*, *P. gombaszoegensis* and *P. onca georgica*. Moreover, fossil jaguar-like remains from the late early Pleistocene of North America have been attributed to *P. onca augusta*. Most recently, a single jaguar species with four subspecies (*P. onca toscana, P. o. gombaszoegensis, P. o. georgica* and *P. o. augusta*) has been recognized from the Pleistocene of Eurasia and America, their distinction mostly relying on lower cheek teeth morphology. The mandible from Dmanisi (Georgia, ca. 1.8 Ma) attributed to *P. o. georgica* displays a higher p3 than in other European and American subspecies, with no prominent lingual cingulum in the p4 and no lingual basal bulge in the m1. We report

unpublished fossil remains of jaguar-like cats from the Iberian localities of La Puebla de Valverde (Teruel, ca. 2.0 Ma), Cueva Victoria (Murcia, ca. 1.0 Ma), Gran Dolina (Atapuerca, ca. 0.8 Ma), and Cal Guardiola D4 and Vallparadís Estació EVT7 (Terrassa, ca. 1.0-0.8 Ma). The lower cheek teeth have comparable (or smaller) maximum buccolingual width compared to the Dmanisi mandible, although the p3 of the latter is relatively higher. Three out of four of the studied p4 display a more or less prominent cingulum, whereas the remaining one merely displays a relictual one. Finally, none of the studied m1 displays a lingual basal bulge. Based on the newly-reported remains, and taking into account the scarce fossil record of Eurasian jaguar-like cats as well as the great dental variability displayed by extant and fossil big cats, we conclude that is more parsimonious to include all the Eurasian jaguar-like cats in a single species, *Panthera gombaszoegensis* (with *P. schreuderi, P. toscana* and *P. onca georgica* being their junior synonyms). Further discoveries and more detailed analyses would be required in order to assess the taxonomic status of this Eurasian taxon compared to extant and fossil *Panthera onca* from America.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

IDENTIFYING ISOLATED SHED TEETH FROM THE KIRTLAND FORMATION OF NORTHWESTERN NEW MEXICO

MAGANA, James, California State Polytechnic University, Pomona, Pomona, CA, United States, 91768; D'AMORE, Domenic, Daemen College, Amherst, NY, United States; MOLNAR, Ralph, University of California- Berkeley, Berkeley, CA, United States; HALL, Justin, University of Southern California, Los Angeles, CA, United States

Identification of isolated theropod dinosaur teeth has potential use as an ecological tool indicating predator/prey relationships, as well as for extending geographic and temporal ranges. We used geometric morphometrics, a tool for analyzing shape variance while controlling for size, to examine and attempt to classify isolated theropod teeth from the Kirtland Formation of northwestern New Mexico. Isolated teeth were compared with teeth of known taxonomic affinity from a *Tyrannosaurus rex*, an *Albertosaurus libratus*, and an adult and juvenile *Bistahieversor sealeyi*. Landmarks were digitized in 2D from photographs of the isolated teeth and comparative sample using the software package TpsDig2.16. Two type 1 landmarks were digitized at the base of each tooth and 31 equidistant semi-landmarks outlined the curvature of the tooth. Only teeth that were not heavily worn or broken, where landmarks were easily visible or easily extrapolated, were used in this study. A Procrustes superimposition was conducted followed by a principal components analysis using TpsRelw. The first three principal components (PC) represented the vast majority of the shape variance. PC1 (74.67%) described apical-basal elongation. PC2 (11.77%) described whether the mesial or distal edge of the tooth was longer. PC3 (6.46%) described the apical shape (bulbous or pinched). Known *Bistahieversor sealeyi* teeth clustered together in two clusters, one for adults and one for juveniles. The largest isolated New Mexico teeth clearly clustered with adult *B. sealeyi*. Two smaller isolated teeth clearly clustered with juvenile *B. sealeyi*, while a single specimen plotted on the opposite end of axis 1, likely due to incomplete preservation at the base. Isolated teeth were primarily separate from both *T.rex* and *A. libratus*; the majority of teeth from these species were noticeably more elongate.

Technical Session X (Friday, November 1, 2013, 9:15 AM)

TESTING FOR ECOLOGICAL NICHE STABILITY OF MAMMALIAN SPECIES FROM THE LAST GLACIAL MAXIMUM TO PRESENT

MAGUIRE, Kaitlin Clare, UC Berkeley, Berkeley, CA, United States, 94720

Understanding the stability of a species' ecological niche through time is important for interpreting the paleoecology and evolution of extinct organisms and especially for providing insights into how extant species will respond to ongoing global change. Recent studies both support and refute the stability of ecological niches through time. Here, I add to this body of work by comparing the ecological niches of 15 mammalian species (from Eulipotyphla, Lagomorpha, Rodentia, Carnivora, and Artiodactyla) during the last glacial maximum (LGM) to their present ecological niches. I employ mean annual temperature and mean annual precipitation as the two key niche axes. Occurrence data are from the FAUNMAP and GBIF databases. I focus on environmental niche space as opposed to traditional studies that are more concerned with modeling species distributions in geographic space. This approach allows differentiating between the environmental space, potential niche space, and realized niche space.

I standardized sample sizes for the present day and the LGM by subsampling the present realized niche space 100 times, setting sample size equal to that which defined the fossil realized niche space. Subsamples were compared to each other to test for realized niche similarity (niche stability), and the comparisons supported the validity of using small fossil sample sizes in testing for ecological niche stability through time. Similar analyzes were performed on a simulated dataset for which the realized niche space did shift through time, and also supported the assumption that fossil sample sizes were adequate to assess whether or not niches had shifted.

Only two of the species (*Sylvilagus audobonii*, *Thomomys bottae*) I examined had LGM realized niche space within their present day realized niche space, suggesting niche stability in those cases. However, the majority of the species had LGM realized niche space either completely or partially outside their present day niche space suggesting niche shifts are common. These differences cannot be accounted for by the lack of available environmental space between the two time periods, further suggesting that the realized niche shifted for these species. Modeling that assumes niche similarity through time needs to better account for the reality that some species will occupy shifting or different environments through time, and comparisons of fossil and recent ranges is an effective way to identify those taxa.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

DISTAL PHALANGEAL EVOLUTION IN EARLY EUPRIMATES

MAIOLINO, Stephanie, Stony Brook University, Stony Brook, NY, United States, 11776; BOYER, Doug, Duke University, Durham, NC, United States

Unlike most mammals, living primates possess nails instead of claws. However the pattern of evolution of this trait in the earliest primates is not well-studied. Some researchers even suggest parallel evolution along different primate clades. Assessing the morphology of distal phalanges of the earliest euprimates, the adapiforms and omomyiforms provide the most direct evidence bearing on these issues. We assembled a sample of early and middle Eocene primate specimens including earliest Eocene *Teilhardina brandti* from the Bighorn basin, early Eocene omomyiforms and adapiforms from the Washakie Basin, middle Eocene adapids and omomyiforms from the Bridger Basin, as well as a distal phalanx attributed to *Adapis parisiensis*.

A series of 12 linear and 1 angular measurements were taken on a sample of lateral distal phalanges from adapiforms, omomyiforms, and 34 extant primate species. Linear measurements were size-adjusted through division of the geometric mean. Data were analyzed using multivariate methods such as principal components analyses based on correlation matrices. Preliminary analyses demonstrate clear differences in distal phalangeal morphology between the first two major radiations of euprimates (adapiforms and omomyiforms). Specifically, adapiforms analyzed so far possess lateral distal phalanges that are proximally claw-like and distally nail-like. Omomyiforms, on the other hand, lack similarities with claw-bearing species. Little variation through time in either the omomyiforms or adapiforms sampled demonstrates that the two clades differed from one another early on in the course of distal phalangeal evolution. This is similar to observations made on other postcranial elements such as tarsals. Further, adapiforms share some similarities with both lemuriform strepsirrhines as well as platyrrhine monkeys (e.g., *Aotus*), while omomyiforms display a wide morphological range and variably share similarities with living tarsiers and lorisiform strepsirrhines.

Technical Session III (Wednesday, October 30, 2013, 2:45 PM)

CRANIAL AND MANDIBULAR SHAPE CHANGES DURING THE EVOLUTION OF CERATOPSIAN DINOSAURS

MAIORINO, Leonardo, Universita Roma Tre, Rome, Italy; FARKE, Andrew A., Raymond M. Alf Museum of Paleontology, Claremont, CA, United States; KOTSAKIS, Tassos, Universita Roma Tre, Rome, Italy; PIRAS, Paolo, Universita Roma Tre, Rome, Italy

Ceratopsia (Dinosauria: Ornithischia) was widespread in Laurasia from the Late Jurassic through the Late Cretaceous. During the last 60 million years of their evolution, their size increased along with the development of elaborate facial horns and frills. In order to investigate shape changes across ceratopsians, we applied two-dimensional geometric morphometrics using a 36 landmark configuration for 120 skulls and a 30 landmark configuration for 118 lower jaws. 3D Principal Component Analyses performed on the two samples confirm different cranial and mandibular morphologies among clades; within ceratopsids both centrosaurines and chasmosaurines have similar mandibular shapes. An evolutionarily significant allometric signal exists between major clades, but not within clades, except for protoceratopsids. Even after accounting for phylogeny (Phylogenetic Generalized Least Squares), the relationship between shape and size is still significant. Partial Least Squares Analysis indicates high co-variance between cranial and lower jaw shape. We also explored morphological integration between the skull and lower jaw (RV coefficient). Results show decreasing morphological integration: skulls and jaws were more integrated in basal taxa than the later ones. Linear regressions between shape and time demonstrate a greater morphological disparity for ceratopsians in the Late Cretaceous than the Early Cretaceous. Phenotypic evolutionary rate analyses on shape and size revealed a significant phenotypic shift in skull shape at the nodes for psittacosaurids and *Protoceratops* spp, and for psittacosaurids and centrosaurines in lower jaw shape. Skull size shows a significantly decreasing rate for for psittacosaurids and leptoceratopsids, and an increasing rate for protoceratopsids and ceratopsids. Only psittacosaurids show a significant decrease in the rate of change of lower jaw size. These previously unquantified patterns in cranial evolution suggest that ceratopsids were characterized by greatly disparate frill morphologies but with a less disparate feeding apparatus than in basal clades, possibly related to climatic and floral changes in latest Cretaceous.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

CHONDRICHTHYAN REMAINS FROM THE SHARK RIVER FORMATION (MIDDLE EOCENE) AND KIRKWOOD FORMATION (EARLY MIOCENE) LAG DEPOSIT, MONMOUTH COUNTY, NEW JERSEY

MAISCH, IV, Harry, Brooklyn College, Brooklyn, NY, United States, 11210; BECKER, Martin, William Paterson University, Wayne, NJ, United States; CHAMBERLAIN, JR., John, Brooklyn College, Brooklyn, NY, United States

A lag deposit that separates the middle Eocene Squankum Member of the Shark River Formation from the early Miocene Asbury Park Member of the Kirkwood Formation near Farmingdale, Monmouth County, New Jersey preserves an unreported chondrichthyan assemblage representing at least 24 species including: *Hexanchus agassizi*, *Notorynchus primigenius*, *Odontaspis* cf. *O. acutissima*, *Carcharias cuspidata*, *Straitolamia macrota*, *Jaekelotodus trigonalis*, *Cretolamna* sp., *Carcharoides catticus*, *Isurus oxyrinchus*, *Xiphodolamia ensis*, *Carcharocles auriculatus*, *Carcharocles chubutensis*, *Hemipristis serra*, *Carcharhinus* cf. *C. priscus*, *Carcharhinus* sp., *Negaprion* cf. *N. eurybathrodon*, *Abdounia recticona*, *Galeocerdo latidens*, *Galeocerdo aduncus*, *Galeocerdo contortus*, *Physogaleus secundus*, *Sphyrna* sp., *Pristis* sp., and *Myliobatis* sp. This assemblage is similar to other contemporaneous middle Eocene and early Miocene faunas found across the Atlantic and Gulf coastal plains in the United

States and elsewhere globally. The taphonomic conditions under which the Farmingdale assemblage was deposited provides a means to analyze the utility of chondrichthyan teeth in chronological analysis. Locally, sea level regression resulted in the exhumation of middle Eocene chondrichthyans from the Shark River Formation and absence of Oligocene sediments. Subsequent transgression mixed these middle Eocene chondrichthyans with early Miocene chondrichthyans in a basal lag deposit belonging to the Kirkwood Formation. The Farmingdale assemblage coincides with the great Cenozoic radiation of fishes and documents the appearance of carcharhiniforms as the dominant shark order in today's oceans.

Symposium 4 (Saturday, November 2, 2013, 9:00 AM)

GROWTH PATTERNS OF EARLY JURASSIC ANTARCTIC DINOSAURS INFERRED FROM PALEOHISTOLOGICAL ANALYSIS

MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, United States, 60605; BOUDREAU, Diana, Augustana College, Edwards, IL, United States; HAMMER, William, Augustana College, Rock Island, IL, United States; SMITH, Nathan, Howard University, Washington DC, DC, United States

The Early Jurassic Hanson Formation dinosaurs from Antarctica document some of the highest paleolatitude terrestrial vertebrates in the fossil record, yet information on whether and how polar light and temperature regimes impacted their biology remain poorly understood. We undertook a histological study of two of the five dinosaur specimens collected from the Hanson Formation to examine their growth physiology. Five skeletal elements were sampled from the large, crested theropod *Cryolophosaurus ellioti*. Axial elements (rib, gastralia) preserve 9-10 lines of arrested growth (LAGs), with the last few closely packed indicating a slowdown or cessation of growth. Limb bones, however, preserved fewer LAGs, with wide and well vascularized zones between the outermost LAGs indicating continuing rapid growth. This significant degree of bone heterochrony may have methodological implications for the interpretation of determinate growth in theropods. Age estimates for *Cryolophosaurus* following retrocalculation are 12-15 years, a range for which individuals of the lower latitude theropods *Allosaurus*, *Gorgosaurus*, and *Albertosaurus* exhibit femoral lengths (a common proxy for body size) comparable to *Cryolophosaurus*.

Histological analysis of a new basal sauropodomorph skeleton collected in 2011 exhibits highly vascularized fibrolamellar bone without distinct growth marks, indicative of rapid, uninterrupted growth. The specimen has a femoral length of 277 mm, a size at which specimens of the roughly contemporaneous *Massospondylus* exhibit 8-9 LAGs. This indicates that basal sauropodomomorphs, which are the most abundant faunal element of the Hanson Formation, could grow rapidly as juveniles, a characteristic also observed in lower latitude taxa such as *Mussaurus* and *Plateosaurus*.

Differing growth strategies have been observed in the histology of polar dinosaurs. Some recent and extinct high latitude amniotes manifest LAGs throughout ontogeny, unlike their lower latitude conspecifics or congenerics, suggesting an environmental effect on growth. This was not manifest in our juvenile sauropodomorph, however. Although *Cryolophosaurus* preserves scant histological evidence of its earliest ontogeny, results are broadly concordant with patterns of growth and bone formation in lower latitude theropods. Therefore, the limited sample available to us indicates little environmental effect on growth in Early Jurassic polar dinosaurs, in keeping with a previous study on polar ornithopod and theropod dinosaurs from the Cretaceous of Australia.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

COMBINED SIMULTANEOUS VERTEBRATE MUSCULOSKELETAL 3D MODEL CREATION IN SIMM AND CAD - IS IT WORTH THE EFFORT?

MALLISON, Heinrich, Museum fuer Naturkunde Berlin, Berlin, Germany

SIMM is a computer program that allows 3D modeling of muscles on skeletons, including muscle wrapping on geometric primitives, during motion. It has been successfully used in vertebrate paleontology research. Muscles, tendons and ligaments are modeled as point-to-point lines. One muscle can have many points, and primitive geometric bodies can be added as wrapping objects to make muscle-bone and muscle-muscle intersection impossible. 3D bodies can be attached to them to visualize muscle volumes, and can be given mass data. However, they cannot be created in SIMM. Muscles in SIMM are linear (they cannot split or fuse), so that complex shapes of muscle-tendon units like accessory tendons need to be represented by several distinct entities.

Computer Aided Design (CAD) programs allow volumetric, but normally static, 3D modeling. Either polygon meshes or NURBS (non-uniform rational B-spline) objects can be used. In either case, objects representing muscles can be deformed to adapt their shapes to neighboring objects representing bones, muscles, or other tissues. Muscle paths, both straight and wrapping around objects, must be created by tedious manual editing. In contrast to SIMM, muscles can have shapes that differ from a simple rope, so that large attachments can be visualized as well as muscle bellies. Complex muscle architecture can be shown with one object, although it is usually simpler to use several 3D bodies. It is easily apparent that both modeling approached complement each other in their capabilities. However, is it worth the effort to use both, and especially both simultaneously? Using the nearly complete digital skeleton of the prosauropod dinosaur *Plateosaurus engelhardti* GPIT/RE/7288 I tested how using each method influenced application of the other. The higher-quality display of bones in the CAD program made it easier to find origins and insertions for muscles, and aided in determining which point to use in SIMM for spread-out muscle origins. Also, the easier display handling and the ability to use clipping planes and transparencies in the CAD approach greatly aided path conflict resolution, with the final version being transduced into SIMM. Also, paths of superficial muscles, where bone shapes offer little guidance, were easier to determine if deep muscles were visualized as 3D bodies. Vice versa, the SIMM models made modeling muscle and tendon wrapping in CAD easier, and helped in understanding the inter-muscle relationships during motion. In sum, combining both methods cost little time for the knowledge gained.

Technical Session III (Wednesday, October 30, 2013, 4:00 PM)

PACHYCEPHALOSAUR DOMES: ALLOCHTHONOUS OR AUTOCHTHONOUS?

MALLON, Jordan, Canadian Museum of Nature, Ottawa, ON, Canada, K1P 6P4; EVANS, David, Univ of Toronto at Mississauga, Toronto, ON, Canada

North American pachycephalosaurs have long been known from isolated frontoparietal domes, which constitute most of their fossil record. This material is mainly associated with alluvial plain deposits, and occurs less often in coastal or marine paleoenvironments. Early work suggested that these domes tend to be heavily worn, as though they had rolled in a stream. This interpretation is widely cited, and implies that the domes originated at higher elevations; some authors have even suggested that pachycephalosaurs inhabited piedmont settings. Unfortunately, quantitative studies of dome wear are lacking, and these early hypotheses have yet to be tested.

Here, we test the hypothesis that pachycephalosaur domes are allochthonous within their host systems, by quantifying the degree of wear in >100 domes collected from Upper Cretaceous deposits in Alberta. There is little evidence that domes are routinely worn, as predicted by the transport hypothesis (TH). Rather, domes generally exhibit little surface wear (mode=sub-angular, skewness=0.53, kurtosis=-0.27). There is also no trend whereby domes become increasingly more worn further away from their hypothesized origin near the sediment source area, as predicted by the TH ($y=-0.79x-87.04$, $r^2=0.23$, $p<0.05$). Finally, occurrence data show that pachycephalosaurs are no more abundant in piedmont settings than elsewhere. Within the Belly River Group, unworn pachycephalosaur material is often found in the Foremost Formation, which is strongly marine influenced, as well as in a low-energy, estuarine mud-filled incised valley deposit near Manyberries at the top of this group. Although it should be noted that degree of wear does not necessarily correspond to length of transport, we find no taphonomic support for the TH. These domes likely represent autochthonous deposits that have undergone extensive reworking of surrounding elements before final deposition. Sedimentological work on these units also supports an autochthonous origin for the majority of domes from Alberta. As such, pachycephalosaurs likely inhabited the inland alluvial plain settings where their domes are routinely found, rather than environments farther upland.

Technical Session VIII (Thursday, October 31, 2013, 4:00 PM)

MIDDLE TRIASSIC CONTINENTAL FAUNAS FROM GONDWANA: THE CHANARES FORMATION TETRAPOD ASSEMBLAGE, A CASE STUDY FROM WESTERN ARGENTINA

MANCUSO, Adriana, IANIGLA - CONICET, Mendoza, Argentina; GAETANO, Leandro, IDEAN - Dpto. de Cs. Geológicas, Facultad de Ciencias Exactas Naturales, Universidad de Buenos Aires, Capital Federal, Argentina; LEARDI, Juan, IDEAN - Dpto. de Cs. Geológicas, Facultad de Ciencias Exactas Naturales, Universidad de Buenos Aires, Buenos Aires, Argentina; ABDALA, Fernando, University of the Witwatersrand, Johannesburg, South Africa; ARCUCCI, Andrea Beatriz, Universidad Nacional de San Luis, San Luis, Argentina

Ladinian tetrapod faunas are poorly represented worldwide and only a few assemblages allow the analysis of these early Mesozoic communities. The Chañares Formation in western Argentina is unique in its diverse and well-preserved non-marine tetrapod assemblage. The taphonomical analysis of the Chañares fossiliferous levels, under precise stratigraphical and paleoenvironmental control, reveals that a good representation of the original tetrapod composition is present in the recovered assemblage. Hence, it is possible to hypothesize on the paleoecological significance of the assemblage and the interactions among its different components. Mass estimations and morphology-based paleobiological inferences allowed us to propose the putative trophic structure of this community. The tetrapod record includes a high diversity of archosauriforms, with at least twelve taxa, but only known by few specimens (17.3% of the specimens collected). Synapsids are very abundant (82.7% of the specimens collected) but only represented by four genera. The Chañares tetrapod fauna was numerically dominated by middle-sized herbivorous (i.e., *Massetognatus pascuali*) and small faunivorous cynodonts (i.e., *Probainognathus jenseni*). Large herbivorous dicynodonts and middle-sized faunivorous cynodonts were also present but only constitute ~15% of the specimens found. Non-archosaurian archosauriforms and ornithodirans were mainly represented by small to middle-sized slender forms (~16% of the specimens collected). The paracrocodylomorphs (e.g., *Luperosuchus*) are identified as the top-predators of the Chañares community with estimated body masses between 350 and 500 kg. The traversodontid cynodont *M. pascuali* and the dicynodont *Dinodontosaurus*, with body masses that reached approximately 43 and 360 kg, respectively, are the only taxa recognized as exclusively herbivorous. Compared with the Chañares tetrapod assemblage, the *Dinodontosaurus* Assemblage Zone from southern Brazil shows remarkably low archosauriform diversity and the large dicynodont *Dinodontosaurus* dominates the assemblage numerically. The putative Ladinian Upper Omingonde Formation assemblage of Namibia shows clear dominance of traversodontid cynodonts, as occurs in the Chañares assemblage, and low representation of the other forms. In contrast, non-marine tetrapod assemblages from Laurasia of equivalent age are dominated by temnospondyl amphibians not known from the Chañares levels in spite of the fluvial/lacustrine nature of its deposits.

Technical Session XIV (Saturday, November 2, 2013, 9:45 AM)

SYNCHROTRON-BASED CHEMICAL IMAGING REVEALS PLUMAGE PATTERNS IN *ARCHAEOPTERYX*.

MANNING, Phillip, University of Manchester, Manchester, United Kingdom; WOGELIUS, Roy, University of Manchester, Manchester, United Kingdom; BERGMANN, Uwe, Stanford Synchrotron Radiation Lightsource, Menlo Park, CA, United States; SCHWARZ-WINGS, Daniela, Naturhisdorisches Museum, Berlin, Germany; SELLERS, William, University of Manchester, Manchester, United Kingdom

Color can indicate age, sex, and diet, as well as play roles in camouflage, mating and establishing territories of many species of bird. Feather and integument color depend on both chemical and structural characteristics. The combination of melanosome morphology (structural) and trace metal biomarkers (chemical) has previously been used to infer color and pigment patterns in a range of extant and fossil organisms. Melanin pigments are the most widely used pigments in birds and consist of several covalently linked indoles and are considered unusually large polymers compared to most natural pigments. The sheer size and complexity of these molecules determines their precise structure and their physical properties and controls their bonding to other components (e.g., proteins, metal ions). Eumelanin pigments are most prevalent (>75%) and furnish dark, black or brown hues in both extant invertebrates and vertebrates. There is variation in size between the two main melanin molecules, with eumelanin forming larger, rod-like granules that are insoluble in almost all solvents. Pheomelanins that form reddish-brown pigments are smaller, globular granules compared to eumelanin and are soluble in alkaline solutions. In this study, three key specimens of *Archaeopteryx* were subjected to non-destructive chemical analysis in order to investigate the potential for pigment preservation in feathers of this early bird. Synchrotron Rapid Scanning X-ray Fluorescence (SRS-XRF) maps are combined with sulfur X-ray Absorption Near Edge Structure (XANES) spectroscopy to provide the first map of organic sulfur distribution within whole fossils, and demonstrate that organically derived endogenous compounds are present. The distribution of copper, nickel, and organic species of sulfur in two *Archaeopteryx* specimens are strongly controlled by feather structure, but only lighter elements (phosphorus, sulfur) are comparable with a third *Archaeopteryx* specimen analyzed in this study. The distribution of trace-metals and organic sulfur in *Archaeopteryx* supports remnant endogenous eumelanin pigment have been preserved in the feathers of this iconic fossil. The distribution of organometallic compounds is used to predict the complete feather pigment pattern and show that the distal tips and outer vanes of feathers were more heavily pigmented than inner vanes. This pigment adaptation might have impacted upon the structural and mechanical properties of early feathers, steering plumage evolution in *Archaeopteryx* and other feathered theropods.

Technical Session IX (Friday, November 1, 2013, 11:15 AM)

TAXONOMIC AFFINITIES AND BIOGEOGRAPHIC IMPLICATIONS OF THE PUTATIVE TITANOSAURS (DINOSAURIA: SAUROPODA) FROM THE LATE JURASSIC TENDAGURU FORMATION OF TANZANIA

MANNION, Philip, Imperial College London, London, United Kingdom; SCHWARZ-WINGS, Daniela, Museum für Naturkunde, Berlin, Germany; UPCHURCH, Paul, University College London, London, United Kingdom; WINGS, Oliver, Museum für Naturkunde, Berlin, Germany; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

The Late Jurassic Tendaguru Formation of Tanzania, southeastern Africa, records a diverse and abundant sauropod fauna, including the flagellicaudatan diplodocoids *Dicraeosaurus* and *Tornieria*, and the brachiosaurid titanosauriform *Giraffatitan*. However, the taxonomic affinities of other sauropod taxa and remains are poorly understood. Here, we critically reassess these problematic taxa, using new phylogenetic analyses to explore their placement within Sauropoda. In particular, there has been much debate regarding the position of *Janenschia*. This taxon has played a prominent role in discussions of titanosaur origins, with various authors referring at least some remains to Titanosauria, making it the earliest and only pre-Cretaceous body fossil evidence of this clade. A detailed re-description of the holotype, and all referrable remains, of *Janenschia* supports its validity and placement as a basal macronarian, outside of Titanosauriformes. *Australodocus* has previously been suggested to represent a diplodocid, brachiosaurid and titanosaur: CT scans of its internal pneumatic tissue structure support a somphospondylan identification, making it the only known pre-Cretaceous representative of that clade. However, its affinities within Somphospondyli cannot be fully determined at present. New information on the internal pneumatic tissue structure of the presacral vertebrae of the enigmatic *Tendaguria*, coupled with a full re-description, demonstrates its position as a basal eusauropod, close to the neosauropod radiation. A dorsal vertebra from the Early Cretaceous of the UK shares features with the unusual morphology of *Tendaguria*, and might indicate a previously unrecognized non-neosauropod lineage that survived the Jurassic/Cretaceous boundary. A previously referred caudal sequence cannot be assigned to *Janenschia*: it displays several features indicating a close relationship with Middle–Late Jurassic East Asian mamenchisaurids. It can be diagnosed by five autapomorphies, including anterior caudal ribs that curve strongly anteriorly, and thus represents a new taxon. The presence of a putative mamenchisaurid in the Late Jurassic of southern Gondwana indicates an earlier and more widespread diversification of this clade prior to the geographic isolation of East Asia than previously realized. The Tendaguru Formation shares representatives of nearly all sauropod lineages with contemporaneous global faunas, but displays a greater range of diversity than any of those other formations considered individually.

Technical Session VI (Thursday, October 31, 2013, 9:00 AM)

SYSTEMATICS OF PALEOGENE *LEPTACODON* AND *PLAGIOCTENODON* (MAMMALIA, NYCTITHERIIDAE) WITH DESCRIPTION OF A NEW SPECIES FROM THE LATE PALEOCENE OF THE CLARKS FORK BASIN, WYOMING, USA

MANZ, Carly, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States, 32609; BLOCH, Jonathan, Univ of Florida, Gainesville, FL, United States

Nyctitheriids are small, insectivorous Paleogene mammals that have alternately been linked to Eulipotyphla (shrews, moles, hedgehogs), Euarchonta (primates, tree shrews, dermopterans), and Chiroptera. This range of suggested relationships and an early Paleocene appearance in the fossil record suggests they may be key to understanding early boreoeutherian evolution. The nyctitheriid *Leptacodon* is considered the most primitive but is very similar in dental morphology to *Plagioctenodon*, leading to their suggested synonymization. A new nyctitheriid from the late Paleocene Willwood Formation, Clarks Fork Basin, WY, increases the known diversity of nyctitheriids at that time to six species. It matches the *Plagioctenodon* hypodigm in having a reduced lower third premolar (p3) with an anteriorly canted protoconid and a lower fourth premolar (p4) paraconid that is positioned high on the trigonid. The new species differs from all *Plagioctenodon* in having larger, more anteriorly projecting paraconids on p3-4. Although similar in size to *P. dormaalensis*, it differs in having larger, more anterolingually shifted molar paraconids and two mental foramina rather than one. A cladistic analysis of 39 dental characters for 14 taxa referred to *Leptacodon* or *Plagioctenodon* and rooted with Cretaceous eutherian *Maelestes gobiensis* results in a single most-parsimonious cladogram. Results show *L. donkroni*, *L. proserpinae*, and *L. munusculum* forming a basal monophyletic clade that is the sister to the rest of the ingroup, suggesting they might be best classified outside of *Leptacodon*. *L. packi* is sister taxon to a clade that includes *L. tener* (type species of *Leptacodon*) and all other species, which mostly form a successively nested topology up to *P. krausae* (type species of *Plagioctenodon*). As currently recognized, *Leptacodon* is paraphyletic with respect to *Plagioctenodon*, making a generic distinction problematic. A new classification based on more rigorous phylogenetic analyses of Nyctitheriidae is needed. The new species is sister taxon to *P. krausae* + *P. savagei*. The paratype includes a petrosal, humeri and an innominate. The postcrania have features similar to those in euarchontans associated with arboreal behaviors, including a spherical capitulum on the humerus and an elliptical acetabulum with cranial buttressing. In contrast, the petrosal and dentition more closely resemble those of Eulipotyphla suggesting that similarities to Euarchonta arose independently.

Preparators' Session (Thursday, October 31, 2013, 10:45 AM)

LASER CLEANING OF MACROVERTEBRATE FOSSILS FROM THE UPPER CRETACEOUS SITE OF "LO HUECO" (CUENCA, SPAIN)

MARCOS, Fátima, UNED, Madrid, Spain; BLANCO, Manuel, IPCE, Madrid, Spain; DÍAZ, Soledad, IPCE, Madrid, Spain; ORTEGA, Francisco, UNED, Madrid, Spain

The site of "Lo Hueco" (Fuentes, Cuenca Province, Spain) has yielded an abundant collection of vertebrate fossils representing fishes and reptiles (turtles, squamates, crocodiles and dinosaurs) from Campanian-Maastrichtian levels. One of the most immediate objectives for action on the collection of skeletal remains is the proper conservation of all its elements and, as a priority, the choice of the specific preparation techniques that allow its analysis and documentation.

The vertebrates from "Lo Hueco" present diverse modes of preservation. Usually, a phosphatic matrix, covered by the clays that are the predominant lithology, constitutes the skeletal remains at the site. Often, the periosteal surface is covered with a ferruginous crust that may have variable thickness, and may differently affect the surface of the fossil. Some bones also show radial microcracks in secondary osteons and ferruginous rings in Haversian channels.

Usually, these crusts hinder access to the specimen, making difficult, for example, proper consolidation, and in many cases, can impede the assessment of morphological features. However, removing these crusts is not simple. So far, tests with various well-known preparation techniques, both mechanical and chemical, to remove ferruginous crusts from the bone surfaces indicate that safe limits of preparation are not so evident, and that is difficult to avoid damaging the surface of the samples.

In order to select alternative methodologies for the preparation of the fossils with fewer side effects on their surfaces, several laser cleaning techniques and evaluation protocols have been tested. These techniques were previously applied to remove layers and surface deposits of lithic materials in the field of cultural heritage. However, their application in paleontological preparation is not yet widespread and their effectiveness is not well delimited.

Different pulsed Nd:YAG laser devices have been used. They emit in the fundamental wavelength 1064nm (infrared) and one of them is able to also emit in the second (532nm, green) and third harmonics (355nm, ultraviolet). The pulse duration is in the range of nanoseconds (6-8ns) or microseconds (60-120µs) and the energy ranges from 50mJ to 2J, depending on the device used.

Results are not absolutely conclusive, but tests indicate that, under certain conditions that can be identified by previous analysis, the ferruginous crusts on the "Lo Hueco" fossils can be removed using laser-cleaning techniques.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

MORPHOMETRICS AND MICROWEAR ANALYSES SUGGEST TOOTH-DIGGING POCKET GOPHERS (*THOMOMYS* SPP.) CLAIMED CLIMATE-HARDENED SOILS THROUGH INCREASED INCISOR PROCUMBENCY

MARCY, Ariel, Stanford University, Stanford, CA, United States, 94305; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States; HADLY, Elizabeth, Stanford Univ, Stanford, CA, United States

Morphological adaptations for digging, a changing environment, and interspecific competition shape the unique allopatric distribution of five species of northern Californian pocket gophers (*Thomomys* spp.). Previous GIS analysis of museum specimen localities demonstrated that subgenus *Megascapheus* pocket gophers separate into soils with higher percent soil clay, bulk density, and shrink-swell capacity. While clay and bulk density stay constant for thousands of years, low precipitation and high temperatures harden linear extensible soils in days. These conditions favor *Megascapheus*, suggesting a mechanism for a gradual replacement event during the Pleistocene-Holocene transition. During this period of increasing aridity, *Megascapheus* pocket gophers expanded northward and displaced predominantly claw-digging species. We hypothesize that increased tooth-digging in *Megascapheus* pocket gophers afforded by rostrum-remodeling and increased body size allowed these species to out-compete predominantly claw-digging species in hardened soils. Morphometric data from 450 adult female crania demonstrate that the angle of procumbency for genus *Thomomys* gophers is positively correlated with harder soil as defined by higher percent clay, bulk density, and linear extensibility. Further, dental microwear textures of incisors may further be affected by soil characteristics. Understanding how morphological changes most likely influence current populations of pocket gophers will improve our understanding of species turn-over events in the past and predict how species may respond to environmental changes in the future. Current climate models do not include factors controlling soil hardness, despite its impact on all organisms that depend on a stable soil structure.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

MORPHOMETRIC APPROACHES TO TAXONOMIC QUESTIONS IN IGUANODONTIAN DINOSAURS

MARQUART, Chloe, University of Cambridge, Cambridge, United Kingdom

The historic 'wastebasket' genera *Iguanodon* and *Camptosaurus* have received significant systematic attention recently, resulting in the creation of 16 new genera within the last five years, all sourced from material formerly referred to these taxa. Given the rapid nature of these changes, there is the possibility that the proliferation of genera may be due to subjective changes in the perception of specific levels of variability, rather than wholly objective reanalysis of existing material.

To analyze this trend, morphometric methods including Principal Component Analysis, Discriminant Function Analysis, Cluster Analysis and Procrustes ANOVA have been applied to investigate the shape of the ilium across ankylopollexian iguanodonts. Studies of large deposits such as Bernissart reveal that taphonomic forces are a statistically significant and largely random source of variation within the sample, though they do not exceed disparity due to generic differences in this instance. The quantification of the influence of taphonomy on shape is an important development, as it must be carefully investigated to separate its effects from those of biological processes. Surveys of well-represented genera, such as *Camptosaurus*, reveal that the traits which separate that taxon from recently created and closely allied species, such as *Uteodon* and *Cumnoria* are continuous in character and variable within *Camptosaurus* itself.

This finding was mirrored in a morphometric study of extant *Caiman* crocodilians, which found that the most prominent visual differences between species and subspecies were also highly variable within groups and largely continuous in character. This implies that some traits, which seem to be discrete in the fossil record, may actually be more continuous than they appear, due to small sample size not reflecting true variability. Comprehensive qualitative observations of ankylopollexian material from across the USA and Europe were used to supplement the quantitative analyses and further reveal that many traits used to separate these genera are more plastic than previously supposed.

Overall, a holistic approach to taxonomic questions needs to be undertaken in order to extract genuine evolutionary signals from fossils deposited at different times and in different places. Although the nature of species remains an intractable problem, combining qualitative and quantitative approaches to taxonomy provides our best hope for an objective understanding of morphology.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE EVO-ECO-BIO CURRICULUM: HELPING SECONDARY SCHOOL STUDENTS DISCOVER, EXPERIENCE, AND CONNECT TO THEIR LIFE HISTORY, TO THEIR BIOSPHERE, AND TO PROCESSES IN NATURE

MARRS, Barbara, Silverado High School, Victorville, CA, United States, 92395; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States

Biology and its subgroups, ecology and evolution, are all principal components of the State of California secondary school science curriculum. However, implementing these Science, Technology, Engineering and Mathematics (STEM) subjects presents multiple challenges for today's secondary school science educators. Because of financial cutbacks, grade 7 – 12 educators continue to be confronted by large class sizes, less instructional time, fewer classroom and lab supplies, and, most importantly, fewer field trips and/or classroom outreach programs. Additionally, most of today's students live in a primarily technological and virtual world, with little or no direct connection to nature or their biosphere. The EVO-ECO-BIO Curriculum was developed to help students personally discover, experience, learn, and connect to their past history (evolution), to the biosphere and current challenges for life on their planet (ecology), and to the life processes operating in them and throughout nature (biology). The goal was to take a local resource that was readily available (the San Bernardino County Museum) and present students with a project that enabled them to view the museum exhibits through "EVO-ECO-BIO eyes," encouraging them to actively experience the knowledge-gaining and make their own personal connections. The EVO-ECO-BIO Curriculum transformed an "ordinary trip to the local museum" into an adventure that gave students the opportunity to personally discover and experience the never-ending story of their past, present, and future. Using this curriculum, secondary school science educators can transform a local resource (smaller museum, zoo, visitor center, or any other local institution) into an evolution, ecology, and biology experience that will enable their students to be actively involved in the learning process and encourage them to make their own EVO-ECO-BIO connections to their own lives.

Technical Session XVIII (Saturday, November 2, 2013, 2:00 PM)

EARLY LATE CRETACEOUS (CENOMANIAN) MAMMALS AND OTHER VERTEBRATES FROM THE MATA AMARILLA FORMATION OF SOUTHERN PATAGONIA (ARGENTINA)

MARTIN, Thomas, Universität Bonn, Bonn, Germany; GOIN, Francisco, Museo de La Plata, La Plata, Argentina; CHORNOGUBSKY, Laura, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; GELFO, Javier, Museo de La Plata, La Plata, Argentina; SCHULTZ, Julia, Universität Bonn, Bonn, Germany

*Extensive screen-washing of 4.5 metric tons of matrix at the 3LAG0-locality near Tres Lagos, southwestern Santa Cruz Province, Patagonia has produced the southernmost known Mesozoic mammalian remains. The Mata Amarilla Formation of the Austral basin is represented in its lower part by shallow marginal marine to lagoonal mud-, silt- and fine-grained sandstones with intercalated tuff layers. Long considered to be of a Coniacian age, it has recently been radiometrically dated as middle Cenomanian. The 3LAG0-locality belongs to the upper part of the lower Mata Amarilla Formation with grey mudstones of an estuarine environment. The fossils occur in a bonebed of few centimeters thickness with abundant aquatic vertebrate remains such as hybodontiform and neoselachian teeth, holostean and teleostean scales and bones, dipnoan (*Atlantoceratodus iheringi*) tooth plates, pleurodiran turtle plates and bones, crocodile teeth, as well as much rarer terrestrial vertebrate remains such as questionable pterosaur teeth, and theropod and ?ornithopod teeth.

The mammalian remains comprise a right lower molar of a stem dryolestidan ("paurodont") with two subequal roots, a disto-lingual portion of a right upper stem dryolestidan molar preserving stylocone, metacone and metastyle as well as an incomplete left lower docodont molar with a strongly enlarged and strongly bucco-cervically shifted cusp d. An additional docodont tooth fragment represents cusps X and Y of an upper molar, and a double-rooted single-cusped premolar is also attributed to docodonts.

Although fragmentary, the mammalian teeth provide important information on Mesozoic mammalian evolution in South America as they bridge the gap between the Jurassic and the Late Cretaceous records on that continent. The lower stem dryolestidan ("paurodont") molar suggests close affinities to North American and European representatives. The docodont teeth are the first unambiguous record of that group in South America and represent their geologically youngest occurrence. The lower molar differs from all other known docodonts by its very large and bucco-lingually shifted cusp d which emphasizes the endemic South American mammalian evolution in the Cretaceous.

Symposium 2 (Thursday, October 31, 2013, 2:30 PM)

THE LATE PLEISTOCENE VERTEBRATE FAUNA OF THE TALARA TAR SEEPS (NORTHWESTERN PERU) - PAST, PRESENT AND FUTURE

MARTINEZ, Jean-Noël, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru; CADENILLAS, Richard, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru; ZAPATA, John Percy, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru

The paleontological site known as the Talara Tar Seeps (Piura Region, northwestern Peru) compares well with other fossiliferous deposits in asphalt, such as Rancho La Brea (California, U.S.A.) or Inciarte (Maracaibo Region, Venezuela). All these sites worked like natural traps, as can be deduced by their diverse fossil record with a strong representation of carnivores and birds. The late Pleistocene vertebrate fauna of the Talara Tar Seeps is mostly known by more than 27 000 fossil bones and teeth collected by Gordon Edmund in January 1958, presently housed in the Vertebrate Paleontology Department of the Royal Ontario Museum. Since then, part, but not all, of the fauna has been described in theses and publications. Since Edmund's work, the still richly fossiliferous locality of the Talara Tar Seeps has been almost completely abandoned except for a short visit by the Black Hills Institute in the last decade of the twentieth century. The Paleontological Institute at the National University of Piura (about 120 kilometers south of Talara), created in 2001, "rediscovered" this fossiliferous locality in 2002 and, during the past ten years, has made some superficial collecting at the Talara Tar Seeps, mainly in 2003 and 2007. The major emphasis of this work has been on the small mammals, which has increased our knowledge of this part of the fauna– particularly the bats (four identified species) and the sigmodontine rodents (three identified species). This has demonstrated the presence of some extant species that today live in wetter highland environments located several hundred kilometers east of Talara. The updated faunal list for the Talara Tar Seeps is indicative of a grassland habitat with at least isolated groups of trees present and a permanent freshwater supply. However, there is still much to do to improve this interpretation of the habitat through rigorous taphonomic and stratigraphic studies, which definitely cannot be achieved by occasional superficial fossil collecting. The challenge recently assumed by the Paleontological

Institute at the National University of Piura is to begin long-term systematic excavations at the Talara Tar Seeps, the first in more than half a century.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TRIASSIC-JURASSIC BOUNDARY IDENTIFIED WITH VERTEBRATE FOSSILS IN NORTHWESTERN ARGENTINA (MARAYES-EL CARRIZAL BASIN)

MARTÍNEZ, Ricardo, Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan, San Juan, Argentina; APALDETTI, Cecilia, Museo Paleontológico Egidio Ferugio, Trelew, Argentina; PRADERIO, Angel, Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan, San Juan, Argentina; FERNANDEZ, Eliana, Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan, San Juan, Argentina; COLOMBI, Carina, Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan, San Juan, Argentina

Located on Northwestern Argentina, Marayes-El Carrizal is an extensional continental basin developed during the Early Mesozoic at the southwestern margin of Pangea. Quebrada del Barro Formation is the uppermost unit of the sequence and the only one of this Basin in which vertebrate fossils have been found. The controversial age of the Quebrada del Barro Formation has been regarded as Cretaceous, Rhaetian and Norian by different authors. Based on the recent find of the dinosaur *Leyesaurus marayensis*—a basal sauropodomorph closely related to the South African genus *Massospondylus*—a Lower Jurassic age of the Quebrada del Barro Formation was suggested. Here we report the discovery of a new faunal association from the upper layers of the Quebrada del Barro Formation that includes eucynodonts, pseudosuchids, basal sauropodomorphs, and sphenodontids. Preliminary comparative analyses indicate that some of the new findings have close affinities with *Chaliminia* (Cynodontia: Tritheledontia), *Pseudhesperosuchus* (Pseudosuchia: 'Sphenosuchia'), and *Riojasaurus* (Dinosauria: Sauropodomorpha); all of them known from the Late Triassic (Norian) Los Colorados Formation. On the other hand, a geologic survey conducted by the authors indicates that all the finds of the massospondylid *Leyesaurus*—used to suggest a Lower Jurassic age to the Quebrada del Barro Formation—are located in a different and overlaying stratigraphic unit. The new faunal association, which includes at least three equivalent components of the La Esquina fauna from Los Colorados Formation, supports the Norian age of the Quebrada del Barro Formation whereas the overlaying new unit includes only basal sauropodomorphs typical from Lower Jurassic strata.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

INTEGRATION PATTERNS IN THE EVOLUTION OF CARNIVORAN LIMBS: AN APPROACH BASED ON 3D GEOMETRIC MORPHOMETRICS

MARTIN-SERRA, Alberto, Universidad de Malaga, Malaga, Spain; FIGUEIRIDO, Borja, Universidad de Malaga, Malaga, Spain; SERRANO, Francisco, Universidad de Malaga, Malaga, Spain; JANIS, Christine, Brown Univ, Providence, RI, United States; PALMQVIST, Paul, Universidad de Malaga, Malaga, Spain

Terrestrial locomotion, as with any other complex biological activity, needs the concerted work of several anatomical structures. Therefore, this coordinated activity should also entail a number of coordinated morphological changes in limb bones as a result of natural selection acting on structures constrained by morphological integration. However, as any morphological pattern is shaped by embryonic development, it is not clear to what extent natural selection can enhance patterns of morphological integration directly involved in function. In this study, we explore morphological integration between fore- and hind limb bones in a wide sample of living and extinct mammalian carnivores with the aim of better understanding some functional aspects of locomotor evolution in quadrupeds. We compared the strength of morphological integration among the taxa with a specialized type of locomotion (i.e. canids and hyaenids) and those with non-specialized locomotion (i.e. felids and ursids) by using three-dimensional methods of geometric morphometrics.

We collected landmarks from the proximal bones of the appendicular skeleton: scapula, humerus, radius, and ulna (for the forelimb); pelvis, femur, and tibia (for the hind limb). Different Partial Least Squares Analyses (PLS) were performed between pairs of connected bones (within limbs) and between functional or anatomically homologous bones (between limbs).

These comparisons showed that both allometry and phylogeny increased the level of morphological integration. Once the effects of allometry and phylogeny were removed, a robust pattern emerged through the entire dataset showing that the strength of morphological integration within and between limbs increased from the more proximal bones to the more distal ones. The morphological changes associated with this pattern of integration were depicted by a gradient of slenderness vs. robustness. Furthermore, specialized taxa showed higher values of morphological covariation within and between limbs, especially for the more distal bones, than non-specialized taxa.

These results indicate that, despite constraints resulting from embryonic development, natural selection has shaped the patterns of morphological integration in the appendicular skeleton of carnivoran mammals.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE ESTIMATED RANGE OF INTRASPECIFIC VARIATION IN RECENT DELPHINID SKULLS AND ITS APPLICATION FOR THE TAXONOMY OF THE EXTINCT DELPHINOIDEA

MARUYAMA, Satoshi, Kyoto University, KYOTO, Japan

Skulls of recent Delphinoidea were studied for the purpose of reconsidering the taxonomy of the genus *Kentriodon* (Kentoriodontidae, Delphinoidea) from the view point of intraspecific variation in the Delphinoidea.

Ranges of intraspecific variation were examined in 48 skulls of Short-beaked common dolphin (*Delphinus delphis*), 68 skulls of Bottlenose dolphin (*Tursiops truncatus*), and 120 skulls of Narrow-ridged finless porpoise (*Neophocaena asiaeorientalis*) for extinct species. The taxonomical standards of *Kentriodon* were reconsidered on the basis of the estimated range of the variation in the Delphinoidea. The skull fossil of the kentriodontid dolphin was discovered from the lower–middle Miocene Niniu Group, Hidaka, Hokkaido, Japan. This specimen is called the Hidaka specimen here. This study was compared to the Hidaka specimen according to the estimated range of intraspecific variation.

As a result, I reconsidered 30 characters for taxonomic characters of species included in Kentriodon. The result means that 18 of 30 characters are not suitable, because these 18 characters cover a large range of intraspecific variation. Another 12 characters, such as the position of the anterior end of the pterygoid sinus and the position of the posterior ends of alveoli, are suitable for taxonomic standards because of the small range of the intraspecific variation. The Genus Kentriodon has five species, *K. pernix*, *K. obscurus*, *K. hobetsui*, *K. schneideri*, *K. fuchsii*. *K. fuchsii* does not have a described skull, so the Hidaka specimen was compared to *K. fuchsii*, using each humerus. This comparison results in this specimen being significantly different from *K. fuchii*. The skull of the specimen was compared to *Kentriodon* species except to *K. fuchii*. The Hidaka specimen is distinguished from four species on the basis of the 12 stable characters. The Hidaka specimen is a new species of genus *Kentriodon*.

This study indicates that estimating the range of Delphinoidea intraspecific variation is available for the taxonomy of the fossil species.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

CATHETOSAURUS* AS A VALID SAUROPOD GENUS AND COMPARISONS WITH *CAMARASAURUS

MATEUS, Octávio, FCT- Universidade Nova de Lisboa & Museu da Lourinha, Caparica, Portugal; TSCHOPP, Emanuel, Universidade Nova de Lisboa & Museu da Lourinhã, Caparica, Portugal

Here we report a nearly complete camarasaurid sauropod from Wyoming (Howe-Stephens Quarry, Upper Morrison Formation), which shares three character states with *Camarasaurus lewisi* that was originally described as its own genus, *Cathetosaurus*. The shared states are the following, and are not present to the same degree in other *Camarasaurus* species: i) the pelvis is rotated anteriorly, such that the pubis projects posteroventrally, and the ischium projects posteriorly, ii) lateroventrally projecting spurs in the neural spines of the last dorsals; iii) posterior cervical and anterior dorsal diapophyses bearing an anterior projection lateral to the prezygapophysis.

Given the lack of a skull in the holotype specimen of *Cathetosaurus lewisi*, the new specimen (Sauriermuseum Aathal specimen SMA 0002) adds considerable information, which allows the recognition of several additional differences to known skulls. The number of autapomorphies is herein considered enough to revive *Cathetosaurus* as a genus distinct from *Camarasaurus*. Additional skull autapomorphies of *Cathetosaurus* are: i) frontals with anterior midline projection into the nasals; ii) trapezoidal supraoccipital (more expanded dorsally than ventrally), iii) lateral spur on the dorsal part of the lacrimal, iv) fenestrated pterygoid; and v) the large pineal foramen between the frontals.

Cathetosaurus shares with *Camarasaurus* (as camarasaurid synapomorphies) the following characters: broad robust teeth, lacrimal with long axis directed anterodorsally, anterior cervical neural spines bifid, twelve cervical vertebrae, quadratojugal with short anterior ramus that does not extend anterior to the laterotemporal fenestra, posterior cervical and anterior dorsal neural spines bifid, and scapular blade with rounded expansion on the acromial side.

The genus *Camarasaurus* remains, at least, with the following autapomorphies: conspicuous groove passing anteroventrally from the surangular foramen to the ventral margin of the dentary, and anterior caudal neural spines broad transversely.

The body proportions of the new specimen are peculiar: the head is large, the limbs are short when compared with the presacral vertebral column, the ribs are long, such that the lower part of the ribcage is well below the knee level. These characters, and the rotation of the pelvis provided larger gut volume to this taxon.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FEEDING BEHAVIOR AND THE FUNCTIONAL ANATOMY OF THE NECK IN THE LONG-SNOUTED CHORISTODERANS *CHAMPSOSAURUS* AND *SIMOEDOSAURUS* (REPTILIA: DIAPSIDA)

MATSUMOTO, Ryoko, Kanagawa Prefectural Museum of Natural History, Kanagawa, Japan; EVANS, Susan, Univ College London, London, United Kingdom

Choristoderes are freshwater diapsid reptiles that were distributed across Laurasia from the Jurassic to the Miocene. The most fully known genera are the large, long-snouted neochoristoderes, *Champsosaurus* and *Simoedosaurus*. These two genera co-occur in several Paleogene horizons in Europe and North America and, by comparison with extant crocodiles, both are thought to have been piscivores. This raises the question as to how they partitioned the niche. Previous hypotheses have focused mainly on rostral morphology. As *Champsosaurus* has a proportionally longer, narrower snout than *Simoeodosaurus*, it has been interpreted as more gavial-like in its feeding strategy. However, neck movements also have an important role in feeding. The living *Gavialis gangeticus* uses rapid lateral movements of the head and neck to attack schools of fish under water, whereas wide-snouted crocodiles like *Alligator mississippiensis* dismember large prey by spinning the head-neck and body. Comparisons of extant crocodiles show that these behavioral differences are matched by differences in the morphology of the cervical joints, vertebrae and musculature.

Choristoderes cannot be examined to the same level of detail, but a comparison of the cranio-cervical region of *Champsosaurus* and *Simoedosaurus* has revealed two important differences. Firstly, the zygapophysial facets in the posterior part of the neck

are horizontal in *Champsosaurus*, but more vertical in *Simoedosaurus*. Secondly, the occipital region of *Champsosaurus*, but not *Simoeodosaurus*, is characterized by laterally expanded basal tubera that may have provided attachment surfaces for the m. rectus capitis anterior, a muscle involved in dorsolateral movement of the head on the neck. Like the gavial, therefore, *Champsosaurus* may have used its slender snout to grab fish from shoals using lateral sweeping motions of the head and neck. *Simoedosaurus*, on the other hand, is less likely to have swung the neck actively during prey capture and may instead have fed on larger single prey items.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE PALEOECOLOGY OF THE FROGS FROM THE EARLY PLIOCENE SITE OF LANGEBAANWEG (WEST COAST, SOUTH AFRICA)

MATTHEWS, Thalassa, Iziko Museums of South Africa, Cape Town, South Africa; PATTERSON, David, The George Washington University, Washington, WA, United States

Previous research on the Anura (frogs) from the west coast Early Pliocene site of Langebaanweg (Western Province, South Africa) focused on identifying various Anuran families. This study represents the first quantitative study from which palaeoecolgical inferences could be made of the frogs from the site. Anurans are effective indicators of climatic and environmental change, have small home ranges, and can provide, high resolution information about the environment. A large variety of aquatic and terrestrial habitats are used by frogs for breeding, and anurans thus have the potential to provide new and detailed environmental information relating to the nature of the aquatic and terrestrial environments available in the area at Langebaanweg during the time of accumulation of the fossils. They also have the added potential to provide detailed information as regards the type of water/moisture available, e.g., pan, deep body of water, running river. The frogs thus provide important palaeoenvironmental and palaeoclimatic information, and shed a light on the events which led to their accumulation, and thus on the formation of the fossil dig site assemblage which is extremely problematic and poorly understood. The frog populations from the two main fossil-bearing Members, the Langeberg Quartzose Sand Member (LQSM) and the purportedly slightly younger Muishhond Pelletal Phosphate Member (MPPM) were investigated as they represent different depositional environments and thus provide different ecological information. The LQSM represents floodplain deposits, while the MPPM contains fossils laid down in river channels. The humeri and ilia were the most diagnostic, and among the most well-preserved, bodyparts. The Bufonidae, Breviceptidae, Pyxicephalidae, Arthroleptidae, and Pipidae were represented in the LQSM, as well as several unidentified taxa. In the MPPM the Bufonidae (two or possibly more taxa), Breviceptidae, Pyxicephalidae, Arthroleptidae, Pipidae, Hyperoliidae, and Heleophrynidae appear to be present, together with some unidentified taxa.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

***ELPISTOSTEGE* AND THE LIGHT AND DARK SIDE OF THE MOON: NEW DATA ON THE PALEOENVIRONMENT OF THE FISH-TO-TETRAPOD TRANSITION**

MATTON, Olivier, Parc national de Miguasha, Nouvelle, QC, Canada, G0C 2E0; CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QC, Canada; BÉCHARD, Isabelle, Université du Québec à Rimouski, Rimouski, QC, Canada; CARON, Alain, Université du Québec à Rimouski, Rimouski, QC, Canada; ARSENEAULT, Dominique, Université du Québec à Rimouski, Rimouski, QC, Canada

Paleoenvironmental considerations of the fish-to-tetrapod transition have suggested that early tetrapods and their closest relatives, the elpistostegalian fishes, were exploiting a range of habitats. Three Middle-Late Devonian elpistostegalian taxa are most critical to understand this environmental-evolutionary transition. The late Givetian *Panderichthys* is associated with a deltaic environment, whereas the early-middle Frasnian *Tiktaalik* is associated with a non-marine depositional setting. The middle Frasnian *Elpistostege watsoni* is preserved in the renowned Escuminac Formation (Miguasha, Quebec, Canada), a siliciclastic formation interpreted as an estuarine environment. Based on sequential stratigraphy, the Escuminac Formation (119 m) was recently characterized by five transgressive/regressive sequences within an inner wave-dominated estuary showing shifts in continentalization. Furthermore, isotopic (Rb-Sr) analyses of bioapatites support a brackish to marine environment. All known *Elpistostege* material, including the very first complete specimen recently discovered, has been found in laminated horizons associated with transgressive or highstand components of the stratigraphic sequences. The new specimen has been found in association with the acanthodian *Triazeugacanthus* and *Homalacanthus*, the conchostracan *Asmusia* and the lignophyte *Archaeopteris*, in a horizon displaying a regular alternation of dark (clay and amorphous organic matter) and light (silt-size calcite and quartz) laminae forming couplets. Individual lamina thicknesses were measured on high resolution digital images of the enclosing bed in order to evaluate the pattern of thickness variation. Precise positioning of the new specimen of *Elpistostege* was determined by crossdating of chronological data based on the laminate nature of the sediments. In addition to the regular alternation of thicker siltstone and thinner organic shale laminae, a supplementary order of periodicity has been identified. Stacking of couplets displays a pattern of upward thickening and thinning composed of ca. 30 to 35 laminae, suggesting a lunar cycle. *Elpistostege* seems to be associated systematically with tidal facies. A tidally influenced estuarine setting is thus corroborated for the Escuminac Formation and *Elpistostege*, which is compatible with the fish-to-tetrapod transition.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DENTAL VARIATIONS AND ANOMALIES IN EXTINCT PILOSAN SLOTHS (MAMMALIA, XENARTHRA)

MCAFEE, Robert, Ohio Northern University, Ada, OH, United States, 45810

Dental anomalies are expressed in a variety of ways from variations in tooth number to changes in tooth morphology. The occurrence of such variations is well documented within extant mammals and also in a number of extinct mammals, which has led to an increased understanding about the evolution of tooth development and in establishing the speciation of taxa. Dental variations, such as anodontia and hyperdontia, have recently been recognized in the two extant genera of sloths, *Bradypus* and *Choloepus*, at a frequency of less than 3%. A review of dental anomalies within the extinct pilosan ground sloths reveals a somewhat greater diversity of taxa exhibiting variations away from the typical 5/4 or 4/4 dental pattern than previously documented and with some taxonomic implications. Most anomalies are of a rare frequency similar to the rate found in extant sloths, such as the single documented cases of anodontia via connation in *Eremotherium* and hyperdontia (supernumerary tooth) in *Megalonyx*. The recently erected taxon of *Lestobradys* from the Miocene of Uruguay appears to a possible erroneous creation as the supposed M1 occurs anterior to or within the diastema space and just posterior to the caniniform, which is a where many such supernumerary teeth occur in *Choloepus*. The late Pleistocene mylodontids *Mylodon* and *Paramylodon* both exhibit rather frequent anodontia of the upper caniniforms. The base dental formula for *Mylodon* was long thought be 4/4 but recent evidence shows many individuals born with a 5/4 as exhibited by a juvenile specimen, as well as alveolar scaring in adult specimens at that tooth location, indicating the loss is postnatal instead of prenatal. *Paramylodon* also stands out by the high frequency of postnatal loss of the upper caniniforms but is more anomalous with the loss occurring in either one or both sides as seen in specimens from the La Brea tar pits (55.5%). Increased tendency toward a 4/4 dentition in this genus could correlate with environmental factors to cause the loss as individuals age, possibly from tooth damage, but the occurrence of this anomaly in other populations instead suggests a shift that could have become prenatal and worthy of a true speciation event, had the taxon survived the Pleistocene mass extinctions. The similarities in the tooth loss in *Mylodon* and *Paramylodon* (e.g. high frequency, tooth position) also suggests a need to re-examine the relationship between these two genera as specimens of *Glossotherium*, the proposed sister taxon for *Paramylodon*, have yet to exhibit any loss of the upper caniniforms or other variations.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

USING VERTEBRAL MORPHOLOGY TO PREDICT HABITAT PREFERENCE IN EXTINCT SNAKES

MCCARTNEY, Jacob, Ohio University, Athens, OH, United States, 45701

Snakes are preserved in the fossil record primarily as isolated vertebrae, so inferences of paleoecology must be made from these elements. Habitat preference is a major aspect of ecology that determines the area available for habitation, the amount and type of prey available, and the predators and competitors present. Different habitats present different challenges to locomotion, and because snakes are (nearly) limbless, locomotory behaviors are performed exclusively by the trunk. In this study, I used a phylogenetic flexible discriminant analysis (pFDA) to construct a predictive model of habitat preference for snakes based on linear measurements of isolated vertebrae. I created separate models for vertebrae at specific percentages of total precloacal number (i.e., 5%, 10%, etc.). The training data are well sorted, with misclassification rates below 25% for each vertebral position. However, misclassifications increase when vertebrae arise from an uncertain serial position near the specified one, as is the case with most fossil specimens. Nevertheless, this method reveals low ecological diversity in two continental African faunas from the early Cenozoic. Most of the fossils are categorized as terrestrial or fossorial, and none are categorized as aquatic. Whether this is a result of misclassifications, sampling bias in the fossil record, or represents a true picture of the faunas is unclear. In addition to the difficulty of identifying proper serial position, fossil vertebrae are often damaged, limiting the number of measurements and specimens that can be included in any study of this sort. However, the relative dearth of full body fossils and cranial remains for the majority of extinct snakes means that any inferences of paleobiology must be made on vertebral elements. The importance of snakes as climatological and ecological indicators in the fossil record makes investigations such as this an important avenue for continued research.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW DISCOVERIES OF DINOSAURS AND OTHER VERTEBRATES FROM THE UPPER CRETACEOUS (CAMPANIAN) MENEFEE FORMATION OF NEW MEXICO

MCDONALD, Andrew, University of Pennsylvania, Philadelphia, PA, United States, 19104; WOLFE, Douglas, Renaissance Environmental Management, Phoenix, AZ, United States; HEDRICK, Brandon, University of Pennsylvania, Philadelphia, PA, United States; CORDERO, Samantha, University of Pennsylvania, Philadelphia, PA, United States; LAING, Adam, University of Pennsylvania, Philadelphia, PA, United States

Middle Campanian–late Maastrichtian fossil assemblages from the Western Interior of North America are among the richest and most diverse on Earth, and provide an invaluable record of the evolution of terrestrial vertebrates near the end of the Mesozoic. However, Turonian–early Campanian (~94–78 Ma) terrestrial vertebrates are far scarcer in the Western Interior, obscuring the early evolutionary histories of many clades. Recently, this gap started to fill with new discoveries, such as those from the Turonian Moreno Hill Formation of New Mexico; the Turonian–Coniacian Straight Cliffs Formation of Utah; Santonian beds in Mexico; and the early Campanian Foremost

Formation of Alberta, Lower Two Medicine Formation of Montana, and Wahweap Formation of Utah.

In 2011, we began field work in the early Campanian Allison Member of the Menefee Formation on Bureau of Land Management sections in the San Juan Basin of northwestern New Mexico. Based upon past biostratigraphic correlations in the overlying Cliff House Sandstone and Lewis Shale, the Allison Member in our field area is approximately 81–78 Ma, similar to radioisotopic age estimates obtained by other workers from the Menefee farther east in the San Juan Basin. Previous collecting in the Allison Member by other workers has yielded important vertebrate material elsewhere in the San Juan Basin, including abundant microvertebrate fossils, an indeterminate centrosaurine skeleton, the holotype skull of the alligatoroid *Brachychampsa sealeyi*, and other fragments.

Our field work has significantly expanded this vertebrate record; so far, we have discovered partial skeletons of two ankylosaurs, a hadrosaurid, a possible ceratopsid, a theropod, and a large crocodylomorph, as well as isolated dinosaur elements. We have also discovered material, including two partial shells, that suggests the presence of at least two turtle taxa, and numerous fossil plants including *in situ* tree stumps and well-preserved leaves. This material is currently under preparation and study, and will be analyzed in the contexts of phylogeny, biogeography, and Western North American Cretaceous paleogeography.

Symposium 2 (Thursday, October 31, 2013, 4:00 PM)

A REEXAMINATION OF THE ORIGIN OF ASPHALT PRESERVED BIOTAS: ARE WE STUCK IN THE SAME OLD PARADIGM?

MCDONALD, H. Gregory, National Park Service Museum, Fort Collins, CO, United States, 80525

While people have utilized tar as a source of raw material for thousands of years, the formal study of the biota naturally preserved in tar and recovered from “tar pits” is a relatively new discipline within paleontology that started in the early 20th century with the formal excavations at Rancho La Brea in southern California. Rancho La Brea can be thought of as the “holotype” of tar pit deposits and since its initial excavations many new tar pit preserved biotas have been found, both in California, and elsewhere in the world; Peru, Ecuador, Trinidad, Venezuela, Cuba, Iran, Angola, and Azerbaijan. Often these new biotas are compared to Rancho La Brea and it is often used as the model or reference by which these new sites have been interpreted. The simple Rancho La Brea standard model is that after oil seeps to the surface it forms a semi-viscous sticky surface which serves as a trap, much like a giant sheet of flypaper. Herbivores become mired and in turn become bait which attracts predators or scavengers, which in turn, become entrapped. This often results in a disproportionate number of carnivores to herbivores preserved in the site and an ecologically unbalanced representation of the local ecosystem in terms of the number of individuals represented from the different trophic levels. There is often an a priori assumption that if a fauna is preserved in asphalt, it should have a disproportionate number of carnivores. Other aspects of the Rancho La Brea model include the preservation of insects and plant material, which are often not preserved under other conditions, as well. This is not always the situation. Examination of the biota from other “tar pits” indicates that there is not always a disproportionate number of carnivores and they may even be absent from the fauna. Also at these other sites, more easily perishable parts of the biota, such as insects, which are common at Rancho La Brea, are not preserved, nor is plant material present. While in all of these sites, asphalt has contributed to the preservation of the fossils, at many of these sites, unlike at Rancho La Brea, the presence of the tar is secondary and not the primary cause of the site formation. In these cases a different taphonomic pathway led initially to the preservation of the biota present. The interpretation of site formation of any tar preserved biota should be on a case by case basis and the presence of asphalt should not lead to an a priori assumption that it was the primary cause of site formation.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW DATA ON A PARTIAL SKELETON REFERRED TO *STRUTHIOMIMUS ALTUS* (ORNITHOMIMIDAE) FROM DINOSAUR PROVINCIAL PARK, ALBERTA

MCFEETERS, Bradley, Carleton University, Ottawa, ON, Canada, K1S 5B6; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, United States; SCHRÖDER-ADAMS, Claudia, Carleton University, Ottawa, ON, Canada

Late Cretaceous North American ornithomimids have a complex taxonomic history with disagreement over how many species can be distinguished and which characters are reliably diagnostic. The Belly River Group of Dinosaur Provincial Park has one of the best-sampled dinosaur assemblages in the world with the potential to help sort out ornithomimid taxonomy, with at least three ornithomimid taxa present. Royal Ontario Museum (ROM) 1790 is a partial ornithomimid skeleton collected in Dinosaur Provincial Park in 1934 but never given a complete description. It has previously been referred to *Struthiomimus altus* on the basis of hind limb proportions, but the taxonomic utility of this character has been challenged, and modern diagnoses of *S. altus* have focused on forelimb characters not preserved in ROM 1790. The preserved material includes the pelvis, hind limbs, fragmentary caudal vertebrae and the preorbital region of the skull. The premaxillary bill is spade-shaped in ventral view, and more pointed that that of “*Struthiomimus samueli*” and Asian ornithomimids. The incisive foramen is absent, unlike in *Gallimimus* and *Garudimimus*. Numerous small pits are present on the external surfaces of the nasals and maxillae. There is a small lateral boss on the lacrimal. The anterior caudal vertebrae are very poorly preserved and diagnostic characters cannot be determined. The lateral margin of metatarsal III is relatively straight. The fourth metatarsal is not distally divergent from the third, unlike *Ornithomimus*. Pedal unguals are relatively broader than in *Ornithomimus*, agreeing with other specimens of *Struthiomimus*. ROM 1790 is compared to other ornithomimids including the type specimen of *S. altus* to evaluate the taxonomy of *Struthiomimus*, which is currently represented by a single named species throughout the Campanian Dinosaur Park Formation and into the lower Maastrichtian Horseshoe Canyon Formation. New data from this specimen is used to reassess the stratigraphic distribution of the taxon in the Belly River Group.

Technical Session II (Wednesday, October 30, 2013, 11:15 AM)

IDENTIFYING ISOLATED POSTCRANIA USING DISCRIMINANT ANALYSIS

MCHORSE, Brianna, Harvard University, Cambridge, MA, United States, 02139; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States; MCLAUGHLIN, Win, University of Oregon, Eugene, OR, United States; DAVIS, Edward, University of Oregon, Eugene, OR, United States; HOPKINS, Samantha, University of Oregon, Eugene, OR, United States

Isolated postcrania are often preserved but rarely identified beyond the family level. As a result, they offer a potentially untapped resource for studies of extinct diversity. Successfully assigning those postcranial bones to genera or species refines our knowledge of taxonomic diversity, evenness, and relative abundances, improving the resolution of paleoecological studies. Linear morphometric analyses of isolated postcranial bones demonstrate remarkably high identification success rates for many assemblages, including antilocaprids, camelids, and equids. These identifications can uncover surprising diversity, as illustrated by the few studies to attempt this technique. Discriminant analysis of linear measurements is an ideal approach to identifying isolated skeletal elements, as it captures more subtle morphological variation than visual examination of linear biplots but is more straightforward than three-dimensional morphometric methods. Further, data from multiple unassociated skeletal elements can be integrated using Bayesian inference; by specifying informative priors for relative abundance from previous elements, adding each successive element increases the posterior confidence in the relative abundances in the fauna. We test our approach on a known, artificially created assemblage of modern cervid, camelid, and antilocaprid postcrania from 24 individuals. In a mixed training assemblage of astragali, metatarsals, cubonaviculars, and calcanea, iterative discriminant analysis with informative priors had success rates ranging from 87.5% to 100%. After the first iteration, identifications were 100% accurate until the calcaneum iteration, after which the final accuracy dropped; this drop suggests calcanea may not be an appropriate bone to use in our approach.

Our method is simple but has the potential to quickly and significantly improve knowledge of the ungulate paleoecology. This is particularly true at several candidate sites rich with unidentified postcrania, including Virgin Valley, McKay Reservoir, and Cajon Valley . Further applications include developing greater certainty in taxonomic assignments to isolated postcrania used in ancient DNA studies. While here we focus on ungulates, the method should transfer well to other mammalian groups, shedding light on hidden diversity and improving any studies that rely on identification.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

INCORPORATING LIFE HISTORY TRAITS AS DISCRETE MORPHOLOGICAL CHARACTERS IN PHYLOGENY RECONSTRUCTION

MCHUGH, Julia, Osu-Center For Health Sciences, Tulsa, OK, United States, 74107

Patterns of ontogenetic change can provide information on the phylogenetic history of a group. However, quantifying the transformation of morphology during the life history of an extinct organism into discrete morphological characters can be problematic. Moreover, many extinct taxa are known exclusively from immature specimens, which are often included in phylogenetic analyses by scoring them for adult morphology. The effects of the combination of including immature taxa and ontogenetic characters in phylogeny reconstruction have not been explicitly explored previously. Here, using temnospondyl amphibians as an empirical dataset, six phylogenetic matrices were generated to test topological changes resulting from three different methods of incorporating ontogenetic information, and also to test the inclusion and exclusion of immature taxa scored for adult morphology. Both taxon and character sampling affected resulting topologies: 1) inclusion of immature taxa improved tree resolution when ontogenetic characters were omitted; 2) if adult and juvenile morphologies were coded as separate ontogenetic characters, then the exclusion of immature taxa improved resolution in recovered trees; and 3) if ontogenetically variable morphologies were coded as states within single characters, then the inclusion of immature taxa had a greater effect on node support than node recovery. This implies that the incorporation of morphological characters coding for ontogenetic variation cannot be disentangled from the decision to include or exclude immature taxa in a phylogenetic analysis during matrix construction, particularly in analyses of non-amniote tetrapods. Additionally, the use of differing methods to incorporate ontogenetically variable morphologies and immature taxa can be applied to test underlying causes of lability in subclades and ‘wild card’ taxa and establish areas of stability in the resultant topologies.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

LATE CRETACEOUS MARINE VERTEBRATE FAUNA FROM THE FAIRPORT CHALK MEMBER OF THE CARLILE SHALE IN SOUTHERN ELLIS COUNTY, KANSAS, U.S.A.

MCINTOSH, Annie, DePaul University, Chicago, IL, United States, 60614; SHIMADA, Kenshu, DePaul Univ, Chicago, IL, United States; EVERHART, Michael, Sternberg Museum of Natural History, Hays, KS, United States

The Carlile Shale is an Upper Cretaceous formation deposited in the middle of the Western Interior Seaway, an epicontinental sea in North America. The Fairport Chalk represents the lowest member of the Carlile Shale and is characterized by chalky to marly shale beds that were deposited during the peak transgressive phase of the Seaway during the middle Turonian. The Sternberg Museum of Natural History in Hays, Kansas, U.S.A.,

harbors a collection of marine vertebrate fossils from the Fairport Chalk in southern Ellis County, Kansas. The fossil fauna consists of at least 15 taxa, including 11 chondrichthyans (*Ptychodus mammillaris*, *P.* cf. *P. whipplei*, *Scapanorhynchus raphiodon*, *Johnlongia* sp., *Cardabiodon* sp., *Cretoxyrhina mantelli*, *Cretolamna appendiculata*, *Archaeolamna kopingensis*, *Telodontaspis agassizensis*, *Squalicorax* cf. *S. falcatus*, and *Squalicorax* sp.), three osteichthyans (Plethodidae indet., *Pachyrhizodus* sp., and *Enchodus shumardi*), and one reptilian (*Coniasaurus crassidens*). This fauna is important because it provides a glance at the paleoecology of the Western Interior Seaway during the height of its transgression. The taxa of this unit show wide ecologic diversity, with examples of small to medium-sized opportunistic (*Squalicorax*), large predaceous (*Cardabiodon* and *Cretoxyrhina*), and durophagous (*Ptychodus*) sharks, as well as small (*Enchodus*), medium-sized (Plethodidae and *Pachyrhizodus*), and large (*Ichthyodectes*) bony fishes. Another notable finding is the occurrence of *Telodontaspis agassizensis* in which the species was previously known only from Cenomanian deposits, making the specimen from the Fairport Chalk the geologically youngest record for the species. Many taxa in the ichthyofauna reported here also occur stratigraphically below (e.g., Greenhorn Limestone) and above (e.g., Niobrara Chalk) the unit, suggesting a relatively stable fish community across a broader geologic time frame (mid-Cenomanian through at least the Santonian) in the Western Interior Seaway.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

SEXUAL DIMORPHISM IN THE POSTCRANIA OF EXTANT ARTIODACTYLA AND IMPLICATIONS FOR FALSELY ELEVATED DIVERSITY IN THE PALEOMERYCIDAE

MCLAUGHLIN, Win, University of Oregon, Eugene, OR, United States, 97403; DAVIS, Edward, University of Oregon, Eugene, OR, United States

Extant Artiodactyla posses a range of sexual dimorphism, from limited soft tissue differences to extensive body mass and head gear variation between sexes. Modern biological studies are typically limited to soft tissue and mass differences, methods of differentiation offering no possible application to the fossil record. This study examines intraspecific and interspecific morphometric variation within a subset of four extant artiodactyl families: the bovids, cervids, camelids, and antilocaprids. While dental material is generally used to diagnose species in the fossil record, postcrania can be equally informative given adequate analysis. Furthermore, postcrania are well represented in the fossil record, so the ability to distinguish species from these elements can add to species richness and abundance data, improving overall understanding of paleoecological communities. Preliminary results suggest morphometric analysis of bones such as the astragalus can be used to diagnose sexes, even in taxa supposedly lacking sexual dimorphism. Furthermore, variation in the articular surface of the cubonavicular is diagnostic at the species level for extant camelids. These observations offer a potential for diagnosing sexual dimorphism in extinct artiodactyls, specifically the family Paleomeryicidae, where species and even generic level diversity may be artificially elevated from the misinterpretation of males and females as different taxa. The Barstovian North American Land Mammal Age contains *Bouromeryx*, *Rakomeryx*, *Dromomeryx*, and *Subdromomeryx*. While *Bouromeryx* represents a separate invasion of European palermeryicids into North America, the remaining closely related taxa differ only in size and headgear elaboration. Comparison to variation observed in extant artiodactyls phylogenetically bracketing the paleomerycids sheds light on how much variation is to be expected from sexual variation as opposed to the current interpretation of variation from species level differences.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

FOSSIL MARINE VERTEBRATES FROM THE MIDDLE GRANEROS SHALE (UPPER CRETACEOUS: MIDDLE CENOMANIAN) IN SOUTHEASTERN NEBRASKA, U.S.A.

MEGLEI, Alexander, DePaul University, Chicago, IL, United States, 60614; SHIMADA, Kenshu, DePaul Univ, Chicago, IL, United States; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, United States

The Graneros Shale is an Upper Cretaceous formation that formed in the Western Interior Seaway of North America during the mid-Cenomanian (ca. 97 Ma). Fossil vertebrates are known to occur in the Graneros Shale, but the taxonomic diversity of the vertebrate fauna at the middle portion of the formation is poorly understood. In this study, we report an assemblage of fossil vertebrates from the mid-Graneros Shale in southeastern Nebraska, U.S.A., based on specimens housed in the University of Nebraska State Museum, Lincoln. The fauna consists of at least 11 taxa, including eight chondrichthyans (Hybodontidae indet., *Squalicorax curvatus*, *Carcharias amonensis*, *Archaeolamna* cf. *A. kopingensis*, *Cretodus semiplicatus*, *Cretolamna appendiculata*, *Cardabiodon* sp., *Cretoxyrhina mantelli*), one osteichthyan fish (*Enchodus gladiolus*), and two reptilians (Chelonia indet. and Plesiosauria indet.). The most common vertebrate taxon at the locality is *A.* cf. *A. kopingensis*. One notable characteristic of our fauna is the scarcity of *Squalicorax* and *Enchodus* that are quite common in other mid-Cenomanian localities although this may be due to a collecting bias towards larger specimens through surface collecting. The fauna includes taxa indicative of a nearshore, but fully marine, environment that is consistent with previous paleoenvironmental inferences made for the Graneros Shale based on lithological and invertebrate evidence. The identified vertebrate taxa are mostly carnivorous, suggesting the abundant existence of small prey taxa in the water during the deposition of the mid-Graneros Shale that also represents the initial stage of a major transgression of the Seaway.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

***DIOGENORNIS FRAGILIS*, THE OLDEST RATITE: CLAWS, LOCOMOTOR BEHAVIOR AND TAXONOMIC IMPLICATIONS**

METELLO, Tiago, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

The oldest known ratite (= Struthioniformes) is *Diogenornis fragilis* which have been recovered from the infilling fissures of the São José de Itaboraí basin (upper Paleocene), Rio de Janeiro State, Brazil. It was first described as a rheid, but further studies placed it in the clade Casuariidae. No ungual phalanges were originally referred to this species, but these bones are important to tetrapod locomotor behavior as they are the first and last bones to touch the substrate during locomotion. Two isolated ungual phalanges, recovered in the Itaboraí Basin, were assigned to *D. fragilis* due to the morphology of the neurovascularis groove and flexor tuberosity, typical of Ratitae, with *D. fragilis* being the sole ratite species described from Paleocene. The material comprises two distal phalanges of digits III and IV, probably of the left foot. The phalanx of digit IV is largely asymmetrical in dorsal view. It bears a single neurovascularis groove that extends from the mid region to the tip on both sides, as in *Struthio camelus*. This feature distinguishes the phalanx of *D. fragilis* from *Rhea americana* and *Dromaius novaehollandiae*, where the groove is smaller and branched proximally. The phalanx IV has expansions in the distal half on the plantar surface as in *S. camelus*. The phalanx of digit III, in dorsal view, is more symmetrical and elongated than the phalanx IV; it also bears the lateral-plantar extensions in the distal half, but the joint region is elliptically shaped, differing from all other ratite species, in which this region is more triangular. The morphology of Itaboraí phalanges is closer to the phalanges of *S. camelus*. This similarity may be related to the basal position of *D. fragilis*, which is close to the Rheidae–Casuariidae clade and closer to Struthionidae in comparison to the Holocene Rhea, Emu and Cassowary. A careful comparison of the other bones of *D. fragilis* with *S. camelus* and an phylogenetic analysis including *D. fragilis* is required. The geometry of the claw with the inner curvature of 28.9º, outer curvature of 59º, and relative thickness of 0.2 exclude the possibility of predatory, perching or climbing locomotor behavior, but supports a cursorial behavior for the most basal known ratite. Cursorial behavior is well established in the beginning of the ratite group as well in the modern forms, but further functional morphology studies will provide more detailed information between similarities and differences to modern ratites.

Technical Session VI (Thursday, October 31, 2013, 12:00 PM)

LITTLE TITANS OF THE EOCENE: COPE'S RULE OR SAMPLING ARTIFACT?

MIHLBACHLER, Matthew, New York Institute of Technology College of Osteopathic Medicine, Old Westbury, NY, United States, 11568-8000; SAMUELS, Joshua X., John Day Fossil Beds National Monument, Kimberly, OR, United States

Brontotheres are a classic example of 'Cope's rule', the tendency for lineages to evolve larger body size. Earlier reconstructions of brontothere evolution suggest a strong directed size trend, stemming from "fox terrier"-sized early Eocene perissodactyls (*Danjiangia* and *Lambdotherium*) and ending with late Eocene taxa of titanic size, *Megacerops* and *Embolotherium*. In recent decades, numerous Asian discoveries have increased the number of small-bodied brontotheres known throughout Eocene time, including: *Pygmaetitan*, *Acrotitan*, *Nanotitanops*, *Balochititanops*, and *Eotitanops pakistenensis*. Likewise, the middle Uintan (ca. 44Ma) Nut Beds from the Clarno Formation of central Oregon have produced abundant remains of a small, unnamed North American brontothere representing a new genus and species. The discovery of numerous small brontotheres casts doubt on a single directed trend in brontothere size evolution. To test for evolutionary size trends, we conducted a parsimony analysis of Brontotheriidae, including all known species, using a data matrix of 92 characters. Body mass estimates were derived from dental measurements (using M2 area, m2 area, and P4 area) and optimized, a posteriori, onto the consensus cladogram. Unresolved polytomies in the strict consensus were resolved by majority rule. Terminal branch body mass values are significantly correlated with patristic distance (Pearson correlation coefficient = 0.75). Nodal body mass values were calculated using squared change parsimony. Within the cladogram, positive changes (62%) are more abundant than negatives (38%) with an average positive change. A significant trend for increasing size persists, although the inclusion of recently discovered species has considerably weakened the trend. In recent decades, the rate of discovery of small brontotheres has greatly increased relative to discoveries of large brontotheres, possibly due to changes in how paleontologists sample the globe for fossils. If a high rate of small species discovery persists, the apparent trend in body size evolution will continue to diminish, suggesting Cope's rule is a sampling artifact rather than a significant evolutionary phenomenon.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TAPHONOMIC INDICATORS OF WOLF DEN ASSEMBLAGES

MILIDEO, Lauren, Penn State University, University Park, PA, United States, 16802; GRAHAM, Russell, Penn State Univ, University Park, PA, United States

Paleontological assemblages represent a palimpsest of diverse processes and events, each of which may alter the record that is ultimately available to paleontological study. Proper interpretation of any paleontological assemblage thus requires understanding of the taphonomic pathways it has experienced. It is imperative to outline, as completely as possible, the biases that have affected the assemblage, in order to establish the parameters of the data that an assemblage contains. Such biases limit the types of conclusions and interpretations we can expect to extract from a given assemblage; hence, identifying the biases (i.e. the limitations of the data) of an assemblage is a necessary first step in a well-founded analysis of a paleontological assemblage. Study of modern bone assemblages helps to provide this fundamental knowledge. Workers have suggested that some paleontological assemblages may represent, in whole or in part, the activity of various

carnivores at den or lair sites, and actualistic taphonomic studies have included examinations of the dens of various modern carnivores.

Our study is a description of the taphonomic and spatial attributes of a vertebrate bone assemblage from a modern wolf (*Canis lupus*) den located in Nunavut, Canada. The assemblage consists almost exclusively of caribou (*Rangifer tarandus*) bones. Basic descriptive statistics of the assemblage, including types of elements and numbers and ages (general categories) of individuals represented, are calculated, and we establish a weathering profile. An analysis of bone damage, including examining the frequency of markings and fractures indicative of consumption by carnivores, is presented. Overall, the assemblage contains a high number of juvenile bones, a large component of early weathering stages, and significant damage associated with carnivore consumption. Spatial analyses of the den bone assemblage reveal both similarities and differences in the spatial patterning of bones exhibiting various damage types and weathering stages. Finally, the implications of these actualistic analyses for paleontological assemblages, and in particular for the effects that sampling and collection methods may have on the final assemblage available to study, are explored. Analysis of spatial data, bone damage, bone weathering, and taxa present, all may aid in the identification of a fossil wolf den-derived assemblage; furthermore, sampling technique may either capture or mask these data, leading to potential confusion about site type or assemblage origin.

Technical Session II (Wednesday, October 30, 2013, 12:00 PM)

SIZE-BIASED MODERN BONE ACCUMULATIONS CAN ACCURATELY RECORD WHOLE-COMMUNITY ECOLOGY

MILLER, Joshua, University of Cincinnati, Cincinnati, OH, United States, 45221; BEHRENSMEYER, Anna, Smithsonian Institution, Washington, DC, United States; LYONS, Kate, Smithsonian Institution, Washington, DC, United States; ETE, Taphonomy Group, Smithsonian Institution, Washington, DC, United States

Comparisons between modern bone accumulations and their source communities have demonstrated fidelity to species diversity across a variety of environments, ecosystems, and taxonomic groups. However, residual biases in skeletal assemblages could skew representation of other ecological attributes of source communities. Body size bias (i.e., differential preservation of species as a function of body size) has been documented in modern and fossil death assemblages and is considered a major taphonomic challenge to studying fossil ecosystems. Size-bias may be particularly problematic if functional aspects of the ecosystem (e.g., dietary characteristics, preferred habitats) are non-randomly distributed across body size and taxonomic groups. Using functional ecological traits of the diverse, non-volant mammal community (87 species) in Amboseli National Park, Kenya, we test how biases characteristic of the overall Amboseli death assemblage (45 species) could affect reconstructions of the source community and its ecosystem. To establish the functional ecological space of the living Amboseli community, we used the literature to bin species according to four variables; (i) preferred sheltering habitat (17 categories, e.g., grassland, woodland, underground cavity), (ii) preferred feeding habitat (16 categories, e.g., grassland, woodland, arboreal), (iii) dietary mode (11 categories, e.g., browser, grazer, insectivore), and (iv) activity time (7 categories, e.g., diurnal, nocturnal, nocturnally-dominated crepuscular). We then compared the richness and distribution for each of the four ecological variables in the death assemblage to that of the entire living community using Jaccard similarity, Spearman's rank-order correlation, and the Probability of Interspecific Encounter (evenness). Using Monte-Carlo simulations, we then assessed whether these empirical comparisons were significantly different from a random draw of species from the source community. Results show that while our sample of the Amboseli death assemblage is non-random (i.e., size-biased) with respect to the non-volant mammal community as a whole, the death assemblage accurately captures the functional dimensions of the ecosystem within expectations of a random draw. Logistic regression and additional resampling simulations further show that the size-bias inherent to the Amboseli death assemblage is not a major driver of deviations between the functional ecological properties of the living community and those represented by the death assemblage.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

WHEN SPECIALISTS BECOME GENERALISTS: LONGIROSTRY IN *ALLIGATOR*

MILLER-CAMP, Jessica, University of Iowa, Iowa City, IA, United States, 52242

Due to its availability, *Alligator mississippiensis* is the species most frequently used in studies of crocodylian development and evolution in the United States. Our familiarity with it has resulted in *A. mississippiensis* historically being thought of as representing an 'average', 'normal', or 'typical' crocodylian skull shape. Ecologically it is a generalist, eating a wide variety of food types. However, it arose from a specialist brevirostrine lineage. Ancestrally, Globidonta- and perhaps all of Alligatoroidea- is characterized by short snouts and large, blunt back teeth likely adapted for durophagy. Here, I use geometric morphometrics, traditional morphometrics, and ancestral state reconstruction to analyze the evolution of snout and jaw joint shape and size in Alligatoroidea. Taxa from both Alligatoroidea and Crocodyloidea were sampled to compare the evolution of longirostry and snout shape between clades that are ancestrally brevirostrine and of a more 'typical' crocodylian length, respectively. Whenever possible, juveniles through large adults were sampled to compare phylogenetic and ontogenetic change. Alligatoroidea is found to be ancestrally brevirostrine with longirostry evolving in *Diplocynodon* and *Alligator*. *Alligator mississippiensis* is found to be longirostrine with respect to its ancestral state, but average with respect to living crocodyloids. Longirostry is often taken to mean both long and slender when it is more accurate to think of it merely in terms of length. While *Alligator* includes longirostrine species, they do not possess the thinner snouts characteristic of extant crocodyloids. This is reflected in their more generalist ecology. Common thought holds that generalists evolve into specialists, that are evolutionary dead ends less able to adapt to changing environments. However, this study demonstrates a case of a specialist clade producing a generalist lineage when the Earth was cooling to temperatures less favorable to them. This has implications for our understanding of adaption and niche partitioning during times of environmental stress.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE WESTERNMOST RECORD OF THE GENUS *MICROCHOERUS* (OMOMYIDAE, PRIMATES) IN THE IBERIAN PENINSULA AND ITS PALAEOBIOGEOGRAPHIC IMPLICATIONS

MINWER-BARAKAT, Raef, Institut Catala de Paleontologia, Barcelona, Spain; MARIGO, Judit, Institut Catala de Palaeontologia, Barcelona, Spain; BADIOLA, Ainara, Universidad del Pais Vasco, Bilbao, Spain; MOYA-SOLA, Salvador, Institut Catala de Palaeontologia, Barcelona, Spain

The family Omomyidae includes some of the earliest primates, which were abundant and diverse in the Northern Hemisphere during the Eocene. Omomyids were small-bodied primates, generally nocturnal and with insectivorous-frugivorous diets. Within this family, the subfamily Microchoerinae is exclusively recorded from Europe, ranging primarily from the early to late Eocene, with some genera (*Pseudoloris, Microchoerus*) lasting into the early Oligocene in the Iberian Peninsula. Fossil remains of microchoerines are scarce, so the knowledge of this group is still far from complete. Specifically, the record of *Microchoerus* is quite sparse in the Iberian Peninsula. Here we report new material of *Microchoerus* from the late Eocene (Headonian, MP18) site of Zambrana (Miranda-Trebiño Basin, northern Iberian Peninsula). The studied specimens, consisting of two mandible fragments bearing p3-m3 and p4-m3, were not identified at the generic level until now. The teeth resemble in size and morphology those of *M. erinaceus* from Hordle Cliff, although some differences prevent us from making a definitive ascription to this species. Some traits, such as the development of the mesoconid and hypoconulid in the m1 and m2, and the shape of the hypoconulid lobe in the m3, are intermediate between those of *M. erinaceus* and *M. edwardsi*. Thus, the material from Zambrana fits well in the lineage of *Microchoerus* present in Europe, representing an intermediate form between the two mentioned species. The described material represents the first finding of a primate from the Miranda-Trebiño Basin, and also the westernmost record of the genus *Microchoerus* in the Iberian Peninsula and the most recent record of a primate from the Western Iberian Bioprovince. Moreover, the identification of this microchoerine, with clear similarities with the representatives of this genus described from other European sites, provides further support for the presence of paleogeographic and/or paleoecologic filters which allowed the coexistence of the endemic fauna (rodents and perissodactyls) and other typical European fauna (primates and artiodactyls) in the western region of Iberia during the late Eocene.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DEAD BIRDS IN THE DIRTY GROUND: HOW TO KNOW WHEN THEY'RE NOT AROUND

MITCHELL, Jonathan, The University of Chicago, Chicago, IL, United States, 60637

Differences in disparity between fossil ecosystems are difficult to determine, as both true ecological signal and taphonomic biases shape the distribution of morphologies in the fossil record. Not all species are equally likely to be preserved, and differences in preservation potential are closely related to species ecology, with larger, more aquatic species having a higher preservation probability. The bird (=Pygostylia here) fossil record is strongly biased by taphonomy, with much of the ecological diversity known in the fossil record coming from a few spectacular windows. To facilitate comparison between these individual Lagerstätten, I built a framework for teasing apart the relative contributions of taphonomic bias and true ecological differences. I compared the ecomorphological disparity of extant North American avifaunas with young fossil and subfossil deposits (late Pleistocene fossils through late Holocene live-dead assemblages and archeological middens) from the same region to quantify how preservation bias is related to ecology. A consistent signal is found using principal coordinates analysis (PCo) which shows that both waterbirds, such as loons, and highly abundant birds, such as columbiforms, are more likely to be fossilized. Conversely, small, aerial hunters like swifts and swallows have a strong bias against their preservation, as expected. Using this framework, I also compared the Early Cretaceous (~125myr old) Jehol and Eocene Green River bird assemblages with the modern. Although both show signs of taphonomic biasing, actual ecological differences are discernible. Both the Green River and the Jehol bird assemblages include a much larger proportion of small-bodied birds than expected if all their differences were due to taphonomic biases. The Jehol, further, includes a much lower proportion of aquatic foraging birds than expected. Despite having fewer bird fossils in terms of both species and specimens, the Green River bird assemblage is nevertheless more disparate than the Early Cretaceous, most markedly in terms of size and richness of aquatic foraging forms. Although comparing very young fossil deposits to extant systems is not ideal, as some biological differences do exist, the directionality of the taphonomic biases are consistent across space and time. Further, using birds as a proxy for overall taphonomic bias in places of exceptional preservation provides a method for more holistically reconstructing ancient ecosystems.

Technical Session IX (Friday, November 1, 2013, 9:15 AM)

A NEW SPECIES OF *DASPLETOSAURUS* (THEROPODA: TYRANNOSAURIDAE) FROM THE CAMPANIAN OF SOUTHERN ALBERTA REPRESENTED BY A GROWTH SERIES OF WELL-PRESERVED SKULLS AND SKELETONS

MIYASHITA, Tetsuto, University of Alberta, Edmonton, AB, Canada, T6G 2E9; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada; PAULINA-CARABAJAL, Ariana, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina

Many of the tyrannosaurines collected from the Campanian of western North America were identified as *Daspletosaurus* in the last four decades. In particular, discoveries of nearly a dozen well-preserved skulls and skeletons of *Daspletosaurus* from the Dinosaur Park and Oldman formations of Alberta led to the realization that these specimens represent a species distinct from the type *Daspletosaurus torosus*. The new species of *Daspletosaurus* can be defined on the basis of a nearly complete, three-dimensionally preserved, disarticulated skull (only missing the vomer) and an associated postcranial skeleton of an adult (Royal Tyrrell Museum of Palaeontology TMP 2001.36.1). The description is supplemented by information from juvenile and adult skulls and skeletons of the same species. The new species is distinguished from *Daspletosaurus torosus* by characters that include the supranarial process of the premaxilla extending posteriorly for more than half the diameter of the external naris, a lacrimal that is 1.5 times anteroposteriorly longer than dorsoventrally tall, a pronounced temporal margin of the postorbital, and a maxillary tooth count greater than 15. The new species is from the Dinosaur Park Formation and the chronologically equivalent part of the Oldman Formation, and lived more recently than *Daspletosaurus torosus*. Together with *Daspletosaurus* sp. from the Two Medicine Formation of Montana, these putative species of *Daspletosaurus* form a more derived assemblage of tyrannosaurines in a phylogenetic analysis than the Campanian tyrannosaurines from Utah and, possibly, New Mexico. The identification of multiple species of *Daspletosaurus* favors the generic separation of derived tyrannosaurines into *Daspletosaurus*, *Tarbosaurus* and *Tyrannosaurus*.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

FIRST RECORD OF A PRIMITIVE RHINOCEROTOID *HYRACHYUS* FROM THE MIDDLE EOCENE OF JAPAN

MIYATA, Kazunori, Fukui Prefectural Dinosaur Museum, Fukui, Japan; OKAZAKI, Yoshihiko, c/o Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan; SAKAI, Harutaka, Division of Earth and Planetary Sciences, Kyoto University, Kyoto, Japan; OHASHI, Tomoyuki, Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan; TOMIDA, Yukimitsu, National Museum of Nature and Science, Tsukuba, Japan

A new specimen of the most primitive known rhinocerotoid, *Hyrachyus*, was recently discovered from the basal part of the middle Eocene Oyake (Ooyake) Formation, Yoshidome, Munakata City, Fukuoka Prefecture (northern Kyushu), Japan. This is the first discovery of this genus from Japan and also represents the oldest known Japanese rhinocerotid being at least 44.2 (± 3.4) million years old based on a fission-track age obtained from the conformably overlying formation. The *Hyrachyus* specimen was recovered from coarse-grained sandstone blocks bearing several remains of a coryphodontid pantodont, which were previously discovered and collected by one of us (H. S.) and the Fossil Research Group, Society of Natural History, Kitakyushu, in 1992. The co-occurrence of these taxa from Japan is a significant paleozoogeographical record of middle Eocene land mammals in East Asia. The *Hyrachyus* specimen includes a nearly complete left dentary with a canine and p2-m3, a symphyseal region of the right dentary with a canine and three incisors, a right calcaneus, and a possible femoral fragment, probably derived from a single individual. The nearly complete lower dentition, described from Asia for the first time, shows small spatulate incisors, a moderately long diastema anterior to a single rooted p1 (represented by its alveolus), developed meta- and hypolophids on molars, and the loss of m3 hypoconulid; these characters support the inclusion of the specimen in *Hyrachyus*. The length of tooth series (59 mm in m1-3; 100 mm in p1-m3) is long but fits within the range of the cosmopolitan species, *Hyrachyus modestus* documented from the early Bridgerian NALMA, rather than being comparable to that of a larger Bridgerian species, *H. eximius*. The Japanese form possesses relatively molariform p3 and p4, compared to the Bridgerian species. In Asia, excluding questionably referred specimens, six species of *Hyrachyus* are recognized in the middle Eocene of China based mainly on the upper dentitions. Although making direct comparison with the previously known Asian species is difficult because of the paucity of material preserving lower dentition, the Japanese form is distinct from smaller *H. lunanensis* and *H. minor* and from larger *H. metalophus* and *H. neimogoliensis* from China in size.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

VARIATION IN SAUROPOD (DINOSAURIA: SAUROPODA) CERVICAL CENTRUM LENGTH

MOACDIEH, Emile, Univ of Michigan, Ann Arbor, MI, United States, 48104

Sauropod cervical vertebrae are highly variable in number and proportion, and follow predictable, consistent trends in centrum length within the cervical series. Vertebral profiles, which plot centrum length for each position along the column, can be used to capture variation in vertebral length and count, and allow for comparisons amongst disparate sauropod clades. Several generalized neck morphotypes are hypothetically possible; those include necks with vertebrae of approximately homogeneous size (isomacran), and necks with the most elongate vertebrae positioned anteriorly, posteriorly, or in the middle of the series (referred to as distomacran, proximomacran, and mesomacran, respectively). Sauropods with complete necks used in this study include representatives from basal Eusauropoda, Diplodocoidea, and Macronaria, and cover a broad range of neck morphologies, sizes, and spatiotemporal distributions. Plotting cervical profiles for those morphotypes reveals that basal sauropods typically have similarly-sized cervical vertebrae, whereas more derived sauropods evolved comparatively longer vertebrae towards the end of the cervical series, forming a proximally-shifted mesomacran curve. Intraclade similarities in vertebral profiles were observed in mamenchisaurs, diplodocids, and macronarians. Basal sauropodomorphs, basal short-necked sauropods and dicraeosaurs show far less variation in cervical centrum length than seen in elongate-necked forms such as mamenchisaurs and diplodocids. The cervical profiles of sauropods are compared to those of extant tetrapods, which exhibit their own patterns of variation in centrum lengths ranging from mesomacran curves in birds to distomacran curves in mammals. A greater degree of cervical centrum length variation is strongly correlated with increasing neck length. This understanding of sauropod neck proportions is imperative for a better understanding of neck elongation, mechanics, and structure in tetrapods.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

MACRONARIAN RECORD FROM THE UPPER JURASSIC OF PORTUGAL

MOCHO, Pedro, Universidade Autónoma de Madrid, Madrid, Spain; ROYO-TORRES, Rafael, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; ORTEGA, Francisco, UNED, Madrid, Spain; SILVA, Bruno, Sociedade de História Natural, Torres Vedras, Portugal

New macronarian remains from the Portuguese Upper Jurassic are discussed. Some of those were found in Cambelas (Freixial Formation, Torres Vedras), Baleal (Praia da Amoreira-Porto Novo Formation, Peniche) and Peralta (Sobral Formation, Lourinhã) consisting of cranial (teeth) and postcranial material that could be assigned to basal macronarians. The study of several Portuguese classical remains also increases our knowledge of this group during Upper Jurassic. The reassessment of type specimens of *Lourinhasaurus alenquerensis* (Sobral Formation, Alenquer) and *Lusotitan atalaiensis* (Sobral Formation, Peralta) with the description of several unpublished and still undescribed elements allows us to refer these two taxa to Macronaria (also supported by cladistic analysis).

The presence of fully opisthocoelus condition up to the sacral vertebrae, horizontally projected diapophysis, and "plank"-like cranial dorsal ribs, which are common synapomorphies of basal macronarians, are used to relate these specimens with this group. At present, it is possible to identify one basal macronarian form close related to *Camarasaurus*. On the other hand, there are various specimens bearing several basal titanosauriform features, such as the camellate presacral bone, a lateral bulge on the femur, dorsal and caudal centra dorsoventrally compressed, cone-chisel-like teeth and a gracile humerus. Further analyses will discriminate if they represent one or two different taxa.

Recent works suggested that the Upper Jurassic-Lower Cretaceous (upper Oxfordian–lower Berriasian) sauropod faunas of Iberian Peninsula are composed by exclusive taxa (*Lourinhasaurus*, *Lusotitan*, *Dinheirosaurus*, *Aragosaurus*, *Galveosaurus*, *Losillasaurus* and *Turiasaurus*) although some of them are related to sauropod groups represented in Upper Jurassic strata of other continents such as brachiosaurids, diplodocids and camarasaurids. This situation is opposite to what is suggested by other groups of dinosaurs (such as stegosaurs or theropods) with a proposed North American-European Upper Jurassic distribution, putting forward a vicariance model to explain their diversity in this territory.

Technical Session XVI (Saturday, November 2, 2013, 3:45 PM)

RE-APPRAISAL OF THE CAPTORHINID REPTILE *CAPTORHINIKOS VALENSIS* FROM THE LOWER PERMIAN OF TEXAS

MODESTO, Sean, Cape Breton University, Sydney, NS, Canada, B1P6L2; LAMB, Amy, Cape Breton University, Sydney, NS, Canada; REISZ, Robert, Univ of Toronto at Mississauga, Mississauga, ON, Canada

Captorhinikos valensis is a poorly known, captorhinid reptile with multiple tooth rows from the Lower Permian of Texas. Our reappraisal of *C. valensis* reveals it to be a small moradisaurine captorhinid, exhibiting a maximum of five rows of bullet-shaped teeth in the multiple-rowed region of both the maxilla and the dentary. The slightly radiating organization of the tooth rows distinguish *C. valensis* from the parallel arrangement of the tooth rows exhibited by all other moradisaurines. *Captorhinikos valensis* is also distinguishable from the coeval moradisaurine *Labidosaurus meachami* by a more conspicuously denticulated, broader, U-shaped transverse flange of the pterygoid, a plesiomorphic morphology shared with the large, single-rowed captorhinid *Labidosaurus hamatus*. Postcranial information is limited to two short series of presacral vertebrae not associated with the cranial materials; open neurocentral sutures are present in one specimen, indicating immaturity at death. A branch-and-bound analysis in the software package PAUP of a data matrix consisting of 16 captorhinid taxa (plus 3 outgroups) and 75 characters discovered a single optimal tree. Whereas a previous analysis of captorhinid interrelationships found the (undifferentiated) genus *Captorhinikos* to fall outside of a clade composed of *L. hamatus* and the large moradisaurines, our analysis recovered *C. valensis* in a clade with the genera *Labidosaurikos*, *Gansurhinus*, *Moradisaurus*, and *Rothianiscus* (i.e., Moradisaurinae sensu stricto), and *Captorhinikos chozaensis* as the sister species of a clade that includes *L. hamatus* and Moradisaurinae s.s. Stratigraphic calibration of our captorhinid phylogeny indicates that moradisaurines evolved by the middle Kungurian (middle Leonardian).

Technical Sesssion XII (Friday, November 1, 2013, 2:45 PM)

AN ADVANCED NEOSUCHIAN FROM THE JURASSIC OF BRAZIL

MONTEFELTRO, Felipe, FFCLRP-USP, Ribeirão Preto, Brazil; LARSSON, Hans, McGill University, Montreal, QC, Canada; LANGER, Max, FFCLRP-USP, Ribeirão Preto, Brazil

Brazilian Mesozoic deposits retrieved one of the most well known crocodyliform fauna worldwide. However, this diversity is concentrated in basal mesoeucrocodylian groups, such as Notosuchia and Peirosauridae, collected from Cretaceous localities in the southeastern part of the country. We present here a new taxon composed by a nearly complete skull from the unexplored Pastos Bons Formation (Late Jurassic) of Maranhão state, northeastern Brazil. The uniqueness of the taxon is supported by autapomorphies such as a scalloped lateral margin of the rostrum in dorsal view, unsculpted alveolar margin at the caudalmost portion of the maxilla, blunt lateral prongs on the jugal at the base of the postorbital bar, hour-glass shaped choanae, and pterygoid choanal septum extended between the palatal shelves of the palatines. We critically revised and combined a series of recent phylogenetic studies of fossil Crocodyliformes and also expanded the taxon and character samplings to investigate the affinities of the new taxon. The resulting matrix, composed of 90 taxa and 484 characters, was analyzed using equally weighted parsimony, based on a heuristic search with 5,000 replicates (random seed 0, hold= 20 and tree bisection and reconnection [TBR]). The consensus topology is not fully congruent with any of the previously published hypotheses, but most of the recovered clades have been formerly identified. The new taxon is deeply nested within Neosuchia, as the sister-group of the Asian Paralligatoridae (*Shamosuchus djadochtaensis* + *Rugosuchus nonganensis*). In this context, paralligatorid synapomorphies include the articular facet for the anterior palpebral forming a shallow hemispherical depression bordered by elevated rims and an interfenestralis bar that is flared at both ends. The evolutionary history of Neosuchia in the southern hemisphere remains inadequately understood, partly due to a poor fossil record. Considering its provenance and phylogenetic position, the new taxon fills an important gap in the studies of Crocodyliformes. It indicates that paralligatorids are older than previously known and that the group either expanded its range of occurrence across the Turgai and Tethys seaways or was present in the related landmasses prior to the formation of those barriers. In addition, tetrapods in general are not well sampled in the Jurassic of Gondwana, hampering the proposal of robust paleobiogeographic scenarios. The discovery of this new taxon suggests that an important diversity of fossils may still be found with further field investigations in Late Jurassic deposits of Brazil.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

SPECIES COMPOSITION OF THE LATE CRETACEOUS EUTHERIAN MAMMAL *PARANYCTOIDES* FOX

MONTELLANO, Marisol, Instituto de Geologia, UNAM, Mexico City, Mexico; FOX, Richard, University of Alberta, Edmonton, AB, Canada; SCOTT, Craig, Royal Tyrrell Museum of Paleontology, Drumheller, AB, Canada

Although the known record of Mesozoic eutherian mammals has been significantly enriched in recent years, early eutherian evolution is still not well understood. Among the more controversial of Mesozoic eutherians is *Paranyctoides* Fox, which was described in 1979 from the Judithian Dinosaur Park Formation, Alberta, Canada. It is a rare taxon that has been identified in only a few other North American Late Cretaceous local faunas since. Within the past decade, dental and gnathic remains discovered in Central Asia have also been referred to *Paranyctoides*, thereby expanding the geographic range of the genus substantially and making it the only Late Cretaceous eutherian ostensibly occurring in both continents. As a result of our detailed study of *Paranyctoides*, however, we find that the Central Asia species lack the diagnostic characters of *Paranyctoides* and must be referred to other taxa. We conclude that this genus was limited to North America, ranging from Aquilan to ?Lancian time, and accordingly we recognized as valid only the following species: *Paranyctoides sternbergi* (Judithian, Alberta), *P. maleficus* (Aquilan, Alberta), *Paranyctoides* Wahweap sp. A and sp. B (Judithian,Utah), *Paranyctoides* Kaiparowits sp. A and sp. B (Judithian, Utah). Another purported species of *Paranyctoides*, *P. megakeros*, from the Lancian of Wyoming, is a junior synonym of *Alostera saskatchewanensis*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

INVESTIGATING THE INFLUENCE OF TAXON AND ECOLOGY ON TAPHONOMIC MODIFICATION

MOORE, Jason, Dartmouth College, Hanover, NH, United States, 03755

A number of physical characteristics have been associated with the likelihood and style of taphonomic modification that vertebrate bones undergo, including density, shape, and surface area to volume ratio. Examining the distribution of these characteristics with respect to metrics of taphonomic biasing can provide insight into the predominant taphonomic pathways a fossil assemblage has experienced, and so facilitate palaeofaunal comparisons among assemblages. One important further consideration for such comparisons, however, is the impact of taxon-specific biasing, relating to properties other than the physical characteristics of preserved bones. Such biasing has the potential to further obfuscate palaeoecological patterns of interest.

Here I examine the influence of such taxon-specific biasing using nine assemblages sampled from the Paleogene White River Group of South Dakota and Nebraska. These assemblages, totalling over 5000 identified specimens, consist of a wide range of mammal species, spanning a significant range of body sizes, morphologies and ecologies. Using a standard range of statistical techniques (ANOVA/MANOVA, regression, ordination), it is possible to compare the patterns of taphonomic modification (measured by weathering, abrasion, fracture type, element completeness, evidence of carnivore modification, etc.) on similar elements among taxa and so ascertain the presence and magnitude of any taxon, or ecology specific biases.

These analyses demonstrate that significant size-related bias is present in taxa smaller than ≈15 kg body mass in the White River Group assemblages. Beyond this result, which echoes that seen in many modern bone assemblages, little evidence of strong taxon-related bias is present in these assemblages. This suggests that, with the exception of size-bias, taphonomic modification is taxon-blind. This is of importance for the assessment of palaeofaunal dynamics, as it implies that rare taxa over 15 kg in body mass likely experience a similar taphonomic regime to common taxa, and, as such, their rarity represents true ecological rarity, rather than a taphonomic artifact.

Technical Sesssion XII (Friday, November 1, 2013, 3:30 PM)

FOSSIL CROCODYLIANS FROM THE MIOCENE-PLIOCENE OF THE HIGH GUAJIRA PENINSULA, COLOMBIA

MORENO-BERNAL, Jorge, Univ of Nebraska Lincoln, Lincoln, NE, United States, 68588-0340; HEAD, Jason, Univ of Nebraska, Lincoln, NE, United States; JARAMILLO, Carlos, Smithsonian Tropical Reseach Institute, Panama, Panama

The greatest diversity of Cenozoic crocodylians occurred during the Neogene in South America. However, the origin of this high diversity and its relationship to the environment are poorly understood. Most described species come from the late Miocene localities of La Venta, Urumaco, and Acre, whereas the record is sparse in the early to middle Miocene and after the latest Miocene and Pliocene. Field research in the Castilletes (Middle-Late Miocene) and Waré (Pliocene) Formations in the High Guajira Peninsula of Colombia provides new fossil data on the origin of Neotropical crocodylian diversity. The Castilletes and Waré Formations crop out most extensively in the Cocinetas Basin, and represent depositional environments consisting of deltaic and shallow marine systems in the Castilletes and predominately fluvial environments in the unconformably overlying Waré Formation. Vertebrate localities in both formations include abundant remains of sharks, rays, actinopterygians, turtles, crocodylians and mammals from several localities. Crocodilian fossils from the Castilletes Formation include gavialoids represented by a nearly complete skull as well as fragmentary longirostrine remains comparable with gavialoids from marine deposits, and cranial, mandibular, and postcranial remains of a giant taxon likely referable to the caimanine *Purussaurus* from a single middle Miocene coastal plain deposit. Fossils from the Waré Formation include cranial and postcranial elements preliminarily assigned to *Crocodylus*. The arrival of this genus to the Americas is the most recent continental-scale biogeographic event among crocodylians, and required transoceanic dispersal from Africa. The Miocene-Pliocene crocodilian record from the Guajira Peninsula indicates high diversity throughout the Neogene, consistent with hypotheses of both warmer climates and greater habitat availability relative to the modern Neotropics.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

EXPLORING THE RELATIONSHIPS OF THE NORTH AMERICAN DIMINUTIVE SKUNK GENERA *SPILOGALE* AND *BUISNICTIS*

MORETTI, John, Museum of Texas Tech University, Lubbock, TX, United States, 79401; JOHNSON, Eileen, Museum of Texas Tech University, Lubbock, TX, United States; ARROYO-CABRALES, Joaquin, INAH, Mexico City, Mexico; LEWIS, Patrick, SHSU, Huntsville, TX, United States

The diminutive New World extinct short-jawed skunk *Buisnictis breviramus* has been found at an early Pleistocene locality in western Texas (Roland Springs Ranch). As *Buisnictis* was known previously only from the Pliocene, the question raised is whether the specimens are *Buisnictis* or *Spilogale* and how to demonstrate it. This initial question is within the larger framework of understanding the broader issue of the nature of the relationship between *Buisnictis* and *Spilogale* that currently is unclear. Furthermore, understanding this relationship would aid in determining whether the appearance of *Spilogale* is the result of endemic North American developments or the product of a separate Old World immigration event. Exhibiting both primitive and derived traits, *Buisnictis* was suggested as a transitional form between base taxa of North American skunks and *Spilogale*, perhaps the most primitive of extant forms. Dental similarities between the genera suggest an alliance in a morphological lineage and cranial characters of a Hemphillian species of *Buisnictis* were proposed as directly linking the two genera. *Buisnictis breviramus* occurs in Blancan faunas from Washington to Texas and is advanced among early North American mephitines. The earliest known species of *Spilogale*, *S. rexroadi*, is found in Blancan faunas, although in a more limited range. Both genera occur together in the Rexroad (Kansas) and Beck Ranch (Texas) Blancan faunas. The extant Mexican endemic *S. pygmaea* is the smallest, most primitive living species of the genus and closest morphologically to the Blancan forms. In examining the nature of the *Buisnictis*-*Spilogale* relationship, a morphometric analysis is being undertaken using high resolution, measurable stereo light microscope images. *Buisnictis breviramus* is compared with modern *S. pygmaea* and *S. rexroadi*, an extinct primitive form. Initially, characters of the lower teeth and mandible are being analyzed in order to identify those characters capable of distinguishing or uniting *Buisnictis* and *Spilogale*. ANOVA and PCA have been run on p4/m1 measurements. Preliminary results indicate a distinction between *S. pygmaea* and *B. breviramus* driven largely by shape (p4 length and m1 width); *S. rexroadi* appears at the very edge of *S. pygmaea* variability and suggests it is quite similar in shape to *B. breviramus*; and two potential morphotypes appear within *S. pygmaea* and *B. breviramus* suggesting the possible presence of dimorphism in modern spotted skunks as seen in the extinct *Buisnictis*.

Technical Session IV (Wednesday, October 30, 2013, 3:15 PM)

AN EARLY MIOCENE BAT (CHIROPTERA: PHYLLOSTOMIDAE) FROM PANAMA AND MID CENOZOIC CHIROPTERAN DISPERSALS BETWEEN THE AMERICAS

MORGAN, Gary, New Mexico Museum of Natural History and Science, Albuquerque, NM, United States, 87104; CZAPLEWSKI, Nicholas, Oklahoma Museum of Natural History, Norman, OK, United States; RINCON, Aldo, Florida Museum of Natural History , Gainesville, FL, United States; WOOD, Aaron, Florida Museum of Natural History , Gainesville, FL, United States; MACFADDEN, Bruce, Florida Museum of Natural History , Gainesville, FL, United States

Two partial mandibles of large insectivorous bats from the early Miocene of Panama represent an undescribed genus and species in the endemic neotropical family Phyllostomidae (Chiroptera: Noctilionoidea). The bat jaws occur in two different faunas derived from volcaniclastic sediments along the Panama Canal at about 9° North latitude. A partial chiropteran dentary with p1 from the Lirio Norte Local Fauna (Las Cascadas Formation) occurs in a mammalian assemblage typical of the late Arikareean (~21 Ma) North American Land Mammal Age (NALMA). A partial bat dentary with p4-m1 from the somewhat younger (~19 Ma) Centenario Fauna (Cucaracha Formation) is associated with mammals found in the latest Arikareean or early Hemingfordian NALMAs. The oldest previously known fossil of the Phyllostomidae is an isolated m3 from the early Miocene of Argentina (Colhuehuapian South American Land Mammal Age; ~20 Ma). The early Miocene bats from Panama and Argentina both belong to the subfamily Phyllostominae and are similar in size to the living greater spear-nosed bat *Phyllostomus hastatus*, one of the largest known New World bats. A tropical North American origin for the Phyllostomidae is indicated by the oldest known member of this family from the early Miocene of Panama, together with an early radiation of noctilionoids in the Oligocene of Florida, including the recently described †*Speonycteris* (†Speonycteridae) and an undescribed genus and species in the Mormoopidae. The fossil record suggests overwater dispersal of phyllostomids to South America across the Central American Seaway (CAS) in the late Oligocene or early Miocene, with rapid diversification of the family in South America beginning in the early to medial Miocene. The presence of early Miocene phyllostomines in Panama and Argentina is one of the earliest examples of dispersal of terrestrial mammals across the CAS before the onset of the Great American Biotic Interchange (GABI) that began in the late Miocene and reached its peak in the late Pliocene following the formation of the Panamanian isthmus. Phyllostomids and three other chiropteran families (Emballonuridae, Molossidae, Vespertilionidae) occurred in both North America and South America prior to the late Miocene, suggesting an earlier unrecognized phase of the GABI. Early Miocene fossils from Panama representing several other vertebrate groups, including boid snakes and caimans, as well as plants, provide further evidence for pre-late Miocene biotic interchange between the Americas.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

TIME SLICE ANALYSIS OF MAMMALIAN FAUNAL STABILITY AND CHANGE IN THE LATE MIDDLE AND EARLY LATE MIOCENE SIWALIKS OF PAKISTAN

MORGAN, Michele, Harvard University, Cambridge, MA, United States, 02138; BARRY, John, Harvard University, Cambridge, MA, United States; FLYNN, Lawrence, Harvard University, Cambridge, MA, United States; PILBEAM, David, Harvard University, Cambridge, MA, United States

The Chinji Formation of northern Pakistan, spanning approximately three and a half million years from 14 to 10.5 Ma, is richly fossiliferous. It has previously been proposed that a core chronofauna inhabiting sub-tropical forests and woodlands existed for several million years during this time. Here we analyze the mammalian faunal record from four well-sampled 100 ky time slices to assess the degree of faunal stability and change between three Chinji Fm. intervals (13.6 Ma, 12.3 Ma, 11.4 Ma) and the Nagri Fm. (10.1 Ma). Taxonomic identifications for more than 10000 fossil specimens identified to nearly 150 species were reviewed and confidence in first and last occurrence data was assessed. Species were assigned to one of three body-size categories, small (< 1 kg; fossils primarily recovered from screening sediment), large (1 – 800 kg) and mega (>800 kg), to test if faunal change occurs similarly across differently sized mammals. The mammalian fauna is quite stable across all size categories between 12.3 and 11.4 Ma, a period of global climatic stability. Most of the faunal change during the Chinji Fm. occurs between 13.6 and 12.3 Ma. A major faunal turnover is recorded between 11.4 and 10.1 Ma; less than 50% of taxa present at 11.4 Ma persist at 10.1 Ma. This late Miocene faunal turnover accords with previous ecomorphological studies of body-size distribution within guilds and stable isotope analyses of enamel apatite. In the Siwaliks, the consumption of C4 grasses is first detected in equids at 10.1 Ma. Within these general trends, the faunal responses of small mammals, large mammals, and megaherbivores differ across the four time slices. Small mammals show the greatest variation in species richness, while large mammals show the greatest variation in faunal turnover. Megaherbivores show the least variation in both diversity and faunal composition. Together these patterns highlight the complexity of mammalian faunal change. Although there is no support for an enduring Chinji chronofauna, there is a million year period of relative faunal stability in the middle of the Chinji Fm. that is followed by a major faunal turnover in the early late Miocene.

Technical Session IX (Friday, November 1, 2013, 10:30 AM)

NEW STUDIES OF BRAINCASE ANATOMY, BRAIN SIZE, AND BRAIN STRUCTURE IN THE LATE CRETACEOUS THEROPOD *TROODON FORMOSUS* (DINOSAURIA: SAURISCHIA) BASED ON CT SCANNING AND 3D VISUALIZATION

MORHARDT, Ashley, Ohio University, Athens, OH, United States, 45701; RIDGELY, Ryan, Ohio University, Athens, OH, United States; VARRICCHIO, David, Montana State Univ, Bozeman, MT, United States; WITMER, Lawrence, Ohio University, Athens, OH, United States

The Late Cretaceous theropod dinosaur *Troodon formosus* has often been considered the 'smartest' dinosaur due to its large brain-to-body size ratio. Digital cranial endocasts of partial *Troodon* braincases from the Dinosaur Park Formation (Alberta) and the Two Medicine Formation (Montana) were examined using CT scanning and 3D visualization. This technique allows for nondestructive observation of internal cranial anatomy otherwise obscured by bone and/or matrix. Features readily associated with the endocast of *Troodon* (e.g., large and discrete cerebral hemispheres, cranial nerve canal locations for CN V-XII, ventrolaterally placed optic lobes, prominent cerebellum, relatively large floccular recess, and overall relatively large size) are apparent. Comparison of study endocasts shows two distinct morphologies associated with the occipital sinus, in one case being 'peaked' (dorsally extended, mediolaterally compressed) and the other case being 'rounded' (dorsal surface gently curves, shows no dorsal extension, and is not mediolaterally compressed). Peaked morphology corresponds more closely with that of the related Mongolian troodontid *Zanabazar*, which also was analyzed for this study. This variability may have implications for the caudal morphology of the cerebellum in both taxa. Similar to previously described material, vascular impressions can be seen on the medial surface of the laterosphenoids of *Troodon*, allowing assessment of the rostroventral extent of the optic lobes and cerebral hemispheres. Additionally, composite brain models were constructed for *Troodon* in the modeling software Maya, using Gross Anatomical Brain Region Approximation (GABRA) wherein 3D ellipsoids were modeled to represent major brain regions (olfactory lobes and tracts, cerebral hemispheres, optic lobes, pituitary, cerebellum, brainstem). Thus, brain regions underlying the digital endocast are modeled as ellipsoids, the limits of which are based on the osteological correlates of soft-tissue structures visible on endocasts, as identified by comparison with extant taxa. Brain models offer a new brain size-range estimate and new insights into cerebellar form and function for the brain of *Troodon*. Reconstructed brain structure in these troodontids is indeed very birdlike, and is consistent with that of other paravian taxa such as dromaeosaurids and basal birds, but assessments of the 'smartest dinosaur' claim await broader-scale analyses of relative brain size and brain-region evolution, which are currently underway.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

CRANIAL ONTOGENY OF *EDMONTOSAURUS*: IMPLICATIONS FOR THE TAXONOMIC STATUS OF THE PRINCE CREEK FORMATION SPECIES (LOWER MAASTRICHTIAN, NORTHERN ALASKA)

MORI, Hirotsugu, University of Alaska Fairbanks, Fairbanks, AK, United States, 99709; DRUCKENMILLER, Patrick, Univ. of Alaska Museum, Fairbanks, AK, United States; ERICKSON, Gregory, Florida State University, Tallahassee, FL, United States; PRIETO-MÁRQUEZ, Albert, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

Dinosaur diversity at high paleolatitudes is poorly understood but has important implications for resolving questions regarding fauna provinces in Laramidia. The temporally and geographically wide-ranging *Edmontosaurus* is an important case in point. The Liscomb Bonebed, in the lower Maastrichtian Prince Creek Formation of northern Alaska, has produced thousands of isolated elements of a single species of hadrosaurid referable to *Edmontosaurus*. However, the vast majority of the remains come from young juveniles, approximately one-fourth to one-third of the adult size, making a species-level assignment challenging. We attempt to address the taxonomic status of the Alaskan material by first characterizing the morphological changes that occur during ontogeny in *Edmontosaurus*. We conducted a morphometric analysis of *Edmontosaurus* using a three dimensional composite reconstruction of the skull of the Alaskan material and compared this to 19 nearly complete skulls of adult *E. regalis* (late Campanian) and *E. annectens* (late Maastrichtian). For shape changes that are difficult to visualize in this morphometric analysis, we applied simple bivariate plots and comparative morphological analysis, referring both complete and incomplete *Edmontosaurus* specimens. We found that skull height, prenarial length, widening of the postorbital bar, orbit morphology, shape of the infratemporal fenestra, jugal robustness, quadrate curvature, posterior shift of the opisthotic relative to the exoccipital, ventral deflection of the dentary, and excavation of the postnarial fossa are ontogenetically variable characters in *Edmontosaurus*.

With these results in mind, we then attempted to resolve the taxonomic status of the Alaskan *Edmontosaurus* by using landmark-based morphometrics, comparative morphology, and cladistics. When the influence of size on morphology is removed by regression, morphometric analysis clustered the Alaskan *Edmontosaurus* with *E. annectens*. The results of the comparative analysis indicate that the Alaskan *Edmontosaurus* has a complex mosaic of differences with both of the species. Finally, when the ontogenetically variable characters are excluded, our cladistic analysis recovered the Alaskan material as the sister taxon of *E. regalis*. These results indicate that the Alaskan *Edmontosaurus* cannot be readily referred to either species of the genus and appears to be a new taxon. This finding provides evidence supporting a distinct early Maastrichtian polar faunal province.

Symposium 1 (Wednesday, October 30, 2013, 9:30 AM)

DEVELOPMENTAL VARIATION COMPLICATES RECONSTRUCTIONS OF SKELETAL ONTOGENY OF EXTINCT VERTEBRATES: A LESSON FROM *TRICERATOPS* AND *TOROSAURUS*

MORRIS, Zachary, The University of Texas at Austin, Austin, TX, United States, 78705; BURROUGHS, Robert, The University of Texas at Austin, Austin, TX, United States; COLBERT, Matthew, Univ of Texas at Austin, Austin, TX, United States

Studying the biology of extinct organisms can be complicated by many factors, but one critically important consideration is development. When not properly assessed, ontogenetic variation can lead to difficulties in phylogenetic analyses and taxonomic assignments. However, quantifying developmental variation can be tremendously difficult given a limited number of specimens and the completeness of those specimens. A recent debate about whether or not *Torosaurus* and *Triceratops* are synonymous provides a useful example to highlight these issues. Ontogenetic transformations in osteological characters have been suggested with evidence from histological data, but the potential for multiple developmental sequences has not been previously assessed. In this analysis we assess the potential for sequence polymorphism in species of *Triceratops* and *Torosaurus* to evaluate ontogenetic data and how those data affect the hypothesis that these two taxa represent a single species. Ontogenetic Sequence Analysis (OSA) was used to assess developmental variation and variability in the relative order of 24 developmental events in *Triceratops horridus* (12 individuals), *T. prorsus* (10 individuals) and *Torosaurus latus* (6 individuals) separately and in a combined analysis based on a previously published dataset. The sequences reconstructed using OSA are broadly congruent with the previously reconstructed developmental sequence when treating all specimens as a single taxon. This study finds evidence in favor of both hypotheses because *Torosaurus* specimens are not exclusively the most mature individuals based on these developmental events and overlap in terms of event scoring with some specimens of *Triceratops*, but there is considerable overlap in developmental sequences among all three species. In all of our analyses, missing data and small sample sizes considerably limit the number of developmental events whose position can be fully resolved relative to all other events in the sequence. However, we find meaningful levels of sequence polymorphism for all taxa individually and when combined. This demonstrates the utility of OSA and the importance of assessing the amount of developmental variation present for a species and not assuming a priori whether an event occurs early or late in ontogeny.

Symposium 4 (Saturday, November 2, 2013, 11:15 AM)

THE OLDEST KNOWN (EARLY EOCENE) MAMMAL FROM ANTARCTICA

MÖRS, Thomas, Swedish Museum of Natural History, Stockholm, Sweden; GELFO, Javier N., Museo de La Plata, Buenos Aires, Argentina; REGUERO, Marcelo, Museo de La Plata, La Plata, Argentina; LORENTE, Malena, Museo de La Plata, La Plata, Argentina; LÓPEZ, Guillermo M., Museo de La Plata, La Plata, Argentina

An isolated tooth and an intermediate phalanx of terrestrial mammals were exhumed in Seymour/Marambio Island from a basal marine horizon of the Acantilados Allomember (TELM 2) of the La Meseta Formation. The bearing horizon is stratigraphically lower than any other terrestrial mammal locality known in the unit. It is well exposed along the sea cliffs facing the López de Bertodano Bay and extends inland toward the east by its high mud content, a paucity of shell beds, and well-preserved fine stratification. Small wood fragments are often concentrated in the muds or at thin ferruginous, concretionary seams. The depositional setting is interpreted to be an estuary and the microplankton, Sr^{86}/Sr^{87} and paleomagnetic datations at the levels where the remains were recovered indicate an early Eocene age. So these two fossils represent the earliest records of terrestrial mammals from Antarctica.

The tooth is a left talonid fragment of m2? without roots identified as *Notiolofos* cf. *N. arquinotiensis* (Litopterna: Sparnotheriodontidae). The labial side of the talonid shows a wrinkled surface not seen in the sharper lingual side. A large hypoconid fill the distolabial side as part of a lophid which continues mesially in the cristid obliqua. Hypoconulid is small and is connected to the entoconid by a faint postcristid. An ?entonconulid mesial to the entoconid probably close the talonid valley lingually. The talonid basin is not so wide but is particularly deep.

The intermediate phalanx is wider than long. The processus extensorius is well marked and there are two tuberositas flexoria? on the palmar side below the articular fossae for the proximal phalanges. There are two dorsal foramina in the diaphysis, four foramina below the processus extensorius on the proximal left border (in proximal view). Considering the already known terrestrial mammals from Antarctica, the phalanx more closely resembles those present in Litopterna such as *Megadolodus* in its proportions, with a wider proximal epiphysis than the distal one. It also differs from astrapotherians like *Astrapotherium* since the only preserved intermediate phalanx is longer than wide.

These new records highlight the importance of South American native ungulates in Paleogene Antarctic faunas, raising new questions about paleobiogeographic relations and the time of the break of the South America-Antarctica land connection.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A REEVALUATION OF THE OSSIFIED HYOID APPARATUS OF *PROTOCERATOPS ANDREWSI* (ORNITHISCHIA: CERATOPSIA) AND A REVIEW OF HYOID ELEMENTS IN ORNITHISCHIAN DINOSAURS

MORSCHHAUSER, Eric, Drexel University, Philadelphia, PA, United States, 19104; LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA, United States

The basal coronosaurian ceratopsian *Protoceratops andrewsi* is one of the best-represented species of dinosaurs, with over 80 specimens recovered to date. The ossified hyoid apparatus of this taxon was described in 1945 based on the subadult individual Carnegie Museum (CM) 9185/9186, and was interpreted to consist of a pair of large, plate-like second ceratobranchials; a third, tetraradiate bone was tentatively identified as a first ceratobranchial. Recent study of this specimen determined that these elements do not closely resemble the unambiguous hyoid bones that are known for other ornithischian taxa, including other ceratopsians.

We present a reinterpretation of the bones previously identified as hyoid elements in *Protoceratops*. Comparisons with other ceratopsian skeletons support the conclusion that the tetraradiate element originally regarded as a first ceratobranchial is actually an incomplete middle cervical rib. In several basal neoceratopsian species, including *P. andrewsi*, the middle cervical ribs bear a low caudodorsal process that lends them a tetraradiate contour in medial or lateral view. The larger, flattened elements originally identified as second ceratobranchials are here reinterpreted as partial sternal plates. Their somewhat atypical outline in comparison to those of other basal neoceratopsian sternals appears to be due to some combination of breakage, incorrect restoration, and (possibly) incomplete ossification. The pattern of breakage seen in these sternal plates is fairly common among small-bodied ceratopsian specimens.

In nearly all other ornithischian dinosaurs for which the ossified hyoid apparatus has been described, this part of the skeleton has been found to consist solely of a pair of rod-like first ceratobranchials. A few ornithischians also possess a second pair of splint-like or sheet-like bones that are most frequently interpreted as ceratohyals or second ceratobranchials. We predict that, if eventually recovered, any ossified hyoid elements of *Protoceratops* will conform to this arrangement.

Technical Session XI (Friday, November 1, 2013, 2:45 PM)

CHANGES IN DENTAL DEVELOPMENT IN TWO HERBIVOROUS MAMMAL TAXA FOLLOWING THE PALEOCENE-EOCENE THERMAL MAXIMUM IN THE BIGHORN BASIN, WYOMING

MORSE, Paul, Florida Museum of Natural History, Gainesville, FL, United States, 32611; WOOD, Aaron, Florida Museum of Natural History, Gainesville, FL, United States; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, United States

The Paleocene-Eocene Thermal Maximum (PETM) was a brief period of significant global climate change that occurred ~56 Ma, with an increase in global temperatures of ~5–10° C. Among the biotic effects documented during the PETM, one of the most dramatic has been dwarfing of several mammalian lineages that subsequently increased in size during the cooling trend following the PETM. An increase in body size is expected to result in an allometric increase in tooth size, but under a null hypothesis of dental development the relative size of tooth positions are expected to remain constant. Here we show relative tooth sizes were also altered among post-PETM taxa, indicating evolutionary change in dental developmental processes. We measured molar dimensions in dentary fragments of two mammalian lineages that experienced increase in size following the PETM: the phenacodontid condylarth *Ectocion parvus* (n = 22) to *Ectocion osbornianus* (n = 103), and the equid lineage *Sifrhippus sandrae* (n = 11) to *Arenahippus grangeri* (n=83). Bootstrap analyses and ANCOVA of log-corrected molar areas were used to detect statistically significant differences in relative tooth sizes. *A. grangeri* showed a disproportionately larger ratio of M_2/M_1 area and M_3/M_2 area, but no change in slope from *S. sandrae*. Under an inhibitory cascade model of dental development, these findings are consistent with an increase in the growth activator/inhibitor molecule ratio expanding posterior dentition in *A. grangeri*. *E. osbornianus* showed no change in the ratio or slope of M_2/M_1, consistent with our null hypothesis. However, the M_3/M_2 ratio was dramatically increased, with a significantly different slope than in *E. parvus*, indicating that tooth development in the most posterior portion of the jaw was highly altered without a concurrent effect on the anterior molars. An increase in the activator/inhibitor ratio is insufficient to explain the proportional changes in the *Ectocion* lineage, suggesting an additional alteration to molar developmental integration. Dietary correlates to relative molar proportions in modern taxa suggest that feeding ecology may be an important control on the activator/inhibitor molecule ratio during dental development. We conclude that post-PETM taxa experienced evolutionary modifications to tooth developmental processes in response to climate-induced changes in feeding ecology.

Technical Session XVI (Saturday, November 2, 2013, 2:15 PM)

HIGH DIVERSITY OF EARLY TRIASSIC ICHTHYOPTERYGIANS REVEALED THROUGH DETAILED EXCAVATION IN CHAOHU, ANHUI, CHINA

MOTANI, Ryosuke, University of California, Davis, Davis, CA, United States, 95616; JIANG, Da-yong, Peking Univ, Beijing, China; TINTORI, Andrea, UniversitÃ degli Studi di Milano, Milano, Italy; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States; CHEN, Guan-bao, Anhui Palaeontological Museum, Hefei, China

The Early Triassic saw the emergence of multiple lineages of marine reptiles during the recovery from the end-Permian extinction. Ichthyopterygians were the most common marine reptile group during this time period but even their diversity was traditionally considered low. The prevailing view holds that four monotypic genera of ichthyopterygians scattered along the margin of Northern Panthalassa, each being endemic to a particular locality. We report a recognition of at least four species of small ichthyopterygians from one of the localities, namely Majiashan in Chaohu, Anhui, China, as a result of our field excavation in 2010-2011.

It was believed that only one species of ichthyopterygian, *Chaohusaurus geishanensis*, inhabited this region in the Early Triassic. The species was represented by several specimens that were interpreted as a growth series because their carpal growth fitted an allometric equation. We collected more than 70 new specimens of small ichthyopterygians from the Middle and Upper Members of the Olenekian Nanlinghu Formation (Lower Triassic), of which about 30 have been prepared to date. These

additional specimens revealed a much broader scatter of morphology than known before, and a single allometric equation can no longer fit all samples.

Four distinctive morphotypes are found in our collection. By far the most common is *Chaohusaurus chaoxianensis*, resurrected because it can now be clearly distinguished from the type species, *C. geishanensis*. This latter species is extremely rare, with only two specimens known to date. In addition, we have two new species, a robust form and an extremely short-snouted form, but these two are also rare, being represented by 4 and 1 specimens, respectively. The four species are distinguished based on suites of cranial and postcranial characters but forelimb characters alone can readily delineate among the four. A linear discriminant analysis of the forelimb measurements allowed 100% correct reclassification.

We also collected parts of a significantly larger ichthyosaur but the specimens are too fragmentary to diagnose a new species. Overall, at least four and probably more species of ichthyopterygian inhabited Chaohu in the Early Triassic. Given that rare species are difficult to recover, it is possible that we are vastly underestimating the global diversity of ichthyopterygians in the Early Triassic. Suggestions have been made in the past that other Lower Triassic localities may have had more than one species although such has not been established based on well-preserved skeletons.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A PROXIMAL RADIUS OF *BARBERAPITHECUS HUERZELERI* (PRIMATES, PLIOPITHECIDAE) FROM THE MIOCENE SITE OF CASTELL DE BARBERÀ (NE IBERIAN PENINSULA)

MOYÀ-SOLÀ, Salvador, ICREA at Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Barcelona, Spain; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Barcelona, Spain; ALMÉCIJA, Sergio, Stony Brook University, Stony Brook, NY, United States

Barberapithecus huerzeleri (Primates, Pliopithecidae) was described in 2012 on the basis of dental remains from the Late Miocene of Castell de Barberà (Vallès-Penedès Basin, NE Iberian Peninsula). Despite some similarities with the pliopithecine *Pliopithecus*, *Barberapithecus* displays a set of dental derived features supporting its inclusion in the crouzeliine tribe Anapithecini. Whereas the postcranial anatomy of the Pliopithecinae is well known based on partial skeletons of *Epipliopithecus vindobonensis*, the postcranials of crouzeliines are very scarce, thus precluding locomotor inferences. We report the first postcranial remains of *B. hurzeleri*, namely a proximal fragment of a right radius (IPS66267), which was recently found among the classical collections from the type locality housed at the Institut Català de Paleontologia Miquel Crusafont.

Based on proximal articular measurements of the radius, a body mass of 4.3 kg (95% confidence interval 3.9–4.8 kg) is estimated for IPS66267, which fits well with estimates around 4–5 kg based on the teeth of the holotype (female) individual. This supports an attribution of IPS66267 to *Barberapithecus*, and discounts an alternative attribution to the large-bodied hominoid primate that is also recorded at this site. This proximal radius displays a similar morphology to that observed in non-hominoid anthropoids (other than atelines) as well as *Epipliopithecus* and extinct East African primitive catarrhines (*Simiolus* and *Dendropithecus*). The radius of *Barberapithecus* displays a relatively short and robust neck that is strongly compressed anteroposteriorly; a proximodistally expanded proximal radioulnar joint on the anteromedial portion of the head; a pronounced lateral lip; a restricted articular surface area for articulation with the humeral capitulum; and a tilted and oval radial head. *Barberapithecus* therefore lacks the functional features that, in hominoids and atelines, are functionally related to suspensory behaviors, and in contrast displays a proximal radioulnar joint that is particularly stable in pronated hand positions. The results of a Principal Components Analysis, based on proximal radial proportions, indicate that *Barberapithecus* clusters with fossil pliopithecines and dendropithecids, being closer to extant quadrupedal monkeys than to atelines or hominoids. Although other anatomical regions should be inspected when available, our results suggest that pronograde arboreal quadrupedalism was a major component of the locomotor repertoire of *Barberapithecus*.

Symposium 3 (Friday, November 1, 2013, 8:30 AM)

THE INS AND OUTS OF HIGH-RESOLUTION GEOCHRONOLOGY APPLIED TO STRATIGRAPHIC PROBLEMS

MUNDIL, Roland, Berkeley Geochronology Center, Berkeley, CA, United States, 94709; IRMIS, Randall, Univ of California Museum of Paleontology, Salt Lake City, UT, United States

Biostratigraphy combined with high-resolution geochronology has become a powerful tool to construct chronostratigraphic frameworks that constrain evolutionary processes as well as correlation of fossil-bearing strata. The most widely applied chronometers are zircon U-Pb and $^{40}Ar/^{39}Ar$ on K-bearing minerals, respectively. Recent advances in measuring minute samples allow analytical uncertainty below the 0.1 permil level (i.e., 10 ka uncertainty on Mesozoic rocks). In many cases the dated minerals are from volcanic rocks that are interspersed with fossil bearing sediments. The ages of the dated minerals are assumed to be depositional ages that are equal to an eruption age of a volcanic events and the age of the formation of the dated mineral. This assumption is likely to valid for minerals with closure temperatures significantly below magmatic temperatures (at or below the 600°C level). Hence $^{40}Ar/^{39}Ar$ ages for K-bearing minerals with low closure temperature can be interpreted as true depositional ages. U-Pb zircon ages, however, can be affected by protracted crystallization (in excess of the achievable analytical precision) that significantly predates eruption and deposition. The interpretation of such ages can be problematic and is compounded when redeposition of the dated horizon imposes an additional complication. In such cases the ages must be considered maximum depositional ages. For redeposited horizons which comprise several age suites of volcanic zircon, often relatively close in time, it is important to apply an analytical technique that allows maximum age resolution such that averaging effects can be avoided or minimized. Microbeam techniques (U-Pb laser ablation inductively coupled plasma mass spectrometry [LA-ICPMS], secondary ion mass spectrometry [SIMS]) allow for high throughput but have limited analytical precision whereas U-Pb thermal ionization mass spectrometry [TIMS] is time consuming but superior when such age resolution is needed. It is desirable to apply several geochronometers based on different isotopic systems such that discrepancies, if present, can be recognized and a robust chronostratigraphic framework can be constructed.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A NEW DOLPHIN (CETACEA, ODONTOCETI, DELPHINIDAE) FROM THE PLIOCENE OF IBARAKI, CENTRAL JAPAN

MURAKAMI, Mizuki, Waseda University, Tokyo, Japan; KODA, Yoshiki, Ibaraki Nature Museum, Bando Ibaraki, Japan

The fossil record of true dolphins (Cetacea, Delphinidae) goes back to the late Miocene of both the eastern and western North Pacific Ocean. Delphinidae diversified in the Mediterranean Sea during the Pliocene. On the other hand, only two species (*Hemisyntrachelus oligodon* and *Protoglobicephala mexicana*) are known from the Pliocene of the Pacific Ocean. Consequently, we hardly know what really goes on in the early evolution of Delphinidae. A new genus and species of true dolphin (INM-4-005772 housed in Ibaraki Nature Museum) from the Pliocene Kume Formation (3.9±0.4 Ma) of Ibaraki, central Japan, is reported here. The new species has a relative large-sized skull (CBL>606 mm). The new species has following unique morphology in Delphinidae: developed premaxillary eminences in the lateral part of the premaxillary sac fossae and deep premaxillary sac fossae; and a very small and circular premaxillary foramen (5.8 mm in the major axis) relative to its skull size. *Grampus griseus* is the only species having premaxillary eminences among Delphinidae, except the new species. However, the premaxillary eminence of *Grampus* is wide and extends entire of the premaxillary sac fossa, unlike the new species. The overall morphology of the new species is similar to several globicephalines, which have long and relatively narrow rostrum among the subfamily, rather than *Grampus* (e.g., *Hemisyntrachelus* spp. and *Peponocephala*. To compare with *Hemisyntrachelus* spp., the new species has a wider and short facial plane. The new species differs from *Peponocephala* by having a large skull, a narrow rostrum at the antorbital notch, and large teeth inferred from alveoli (16.7 mm in the major axis). In comparison with *Protoglobicephala*, the new species has a large skull and narrow maxillae and premaxillae at the rostrum. A new comprehensive morphological cladistic analysis including the new species would be a clue to understanding the early evolution of Delphinidae.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ELASMOBRANCHS OF THE LOWER JBEL QATRANI FORMATION, FAYUM, EGYPT

MURRAY, Alison, University of Alberta, Edmonton, AB, Canada, T6E 2G9; ARGYRIOU, Thodoris, University of Alberta, Edmonton, AB, Canada; COOK, Todd, University of Alberta, Edmonton, AB, Canada

Several recent studies have documented elasmobranch faunas in late Eocene deposits of Egypt, encompassing both marine and freshwater influenced faunas. These studies have brought renewed interest to the elasmobranch faunas of Egypt, and the interpretation of paleoenvironments. A somewhat younger fauna is known from the Jbel Qatrani Formation. This formation is usually interpreted, partly based on the fishes, as representing freshwater sediments deposited in lowland areas with swamps, marshes and meandering rivers with abundant vegetation but also with areas of open water and deeper rivers. A particular locality of the formation, Quarry E, previously dated as latest Eocene but now considered to be earliest Oligocene, has produced the majority of elasmobranch taxa found in the formation. Additional elasmobranch material from the formation are three specimens from Quarry A, and one each from quarries I, R, and L-51, but most of these represent taxa also found in Quarry E. The elasmobranchs of the Jbel Qatrani include stingrays and eagle rays (Myliobatiformes: Dasyatidae, Myliobatidae), requiem sharks (Carcharhiniformes: Carcharinidae), and a goblin shark (Lamniformes: Mitsukurinidae) as well as *Odontorhytis*, an extinct fish of uncertain relationships. Although some of the living relatives of these animals, such as the rays and ground sharks, can frequent brackish or fresh waters, the goblin shark would not be expected in shallow coastal areas with a freshwater influence, as its extant relatives inhabit waters more than 100 m in depth. The associated osteichthyan fauna from Quarry E comprises taxa most likely to inhabit fresh waters (a polypterid, lungfish, characiforms, a latid, cichlids). The fish faunas indicate a depositional environment with a freshwater influence, but with some marine influence as well. The Jbel Qatrani Formation records sea levels that are much lower than those indicated in the underlying formations. The lowering eustatic levels were likely associated with the onset of Antarctic glaciation about 34 million years ago, near the Eocene–Oligocene boundary. Although Quarry E has been suggested to be near to the paleocoastline, the drop in sea level corresponding to the increased glaciation may have caused the coastline to retreat from the area during deposition of these sediments, leaving behind an area influenced more by fresh waters. If so, it may be that the marine and freshwater elements in Quarry E represent to some degree time-averaged deposits, with the marine elements being slightly older than the freshwater elements.

Technical Session III (Wednesday, October 30, 2013, 1:45 PM)

JAW MECHANICS IN ORNITHISCHIAN DINOSAURS AND THE EVOLUTIONARY RELATIONSHIP BETWEEN MORPHOLOGY AND BITE FORCE

NABAVIZADEH, Ali, Johns Hopkins University School of Medicine, Baltimore, MD, United States, 21205

The success and diversification of ornithischian dinosaurs is due to a substantial array of phylogenetically distinguishing characters, including important functional adaptations. Previous studies have addressed cranial musculoskeletal function; specifically, ornithischians have considerable morphological diversity in jaw structure, especially among subclades, but also among genera within a given subclade. In this study, relative muscle forces among genera within ornithischian subclades as well as among these clades were calculated using 2D lever arm methods. Such lever arm mechanics estimate relative adductor muscle force for one side of the mandible independently, focusing on the effect of jaw shape and muscle angle difference on bite forces throughout the jaw. As expected, bite force was greatest at bite points nearest the jaw joint, or fulcrum, in all species. There are major instances of overlap, however, in the positions in which there was a greater mechanical advantage. Notable trends are a transition from a more evenly distributed bite force throughout the jaw in basal ornithopods and marginocephalians to a strong caudal bite force in hadrosaurids and ceratopsids. A relatively low bite force is also shown among thyreophorans, especially ankylosaurs, as well as a transition from a distal bite force in basal stegosaurs to a more mesial bite force in advanced stegosaurs. Perturbation analyses constructing hypothetical jaw morphologies with coronoid processes removed, as well as the jaw joint raised to the level of the tooth row, and a combination of both alterations were also analyzed to explore the effect of these jaw morphologies on the mandibular mechanical advantages for each taxon. In all taxa, both the coronoid process and lowered jaw joint increase moment arm length and therefore increase the mechanical advantage of the jaw apparatus. In more basal ornithischian taxa, lowering the jaw joint increased mechanical advantage to a higher degree than the presence of a coronoid eminence. However, throughout the evolutionary transition to genera that are independently derived in each subclade, the presence of a more prominent coronoid process was far more influential in increased mechanical advantage than the lowered jaw joint, a trend unseen in previous studies. These analyses help elucidate overall evolutionary trends in mandibular mechanical advantages across ornithischian taxa and show that these dinosaurs evolved more complex feeding apparatuses within different clades as well as morphological convergences between clades.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A BASAL THUNNOSAURIAN FROM IRAQ REVEALS DISPARATE PHYLOGENETIC ORIGINS FOR CRETACEOUS ICHTHYOSAURS

NAISH, Darren, University of Southampton, Southampton, United Kingdom; FISCHER, Valentin, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; LISTON, Jeff, National Museums Scotland, Edinburgh, United Kingdom; GODEFROIT, Pascal, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

A new thunnosaurian from the Kurdistan region of Iraq represents the first post-Triassic ichthyosaur from the Middle East. The specimen is an articulated partial skeleton that includes a partial skull, complete left forefin, partial ribcage and anterior section of the vertebral column. Associated palynomorphs uncontroversially date the specimen (preserved on a loose slab of matrix) to the late Hauterivian-Barremian interval of the Early Cretaceous. A posterior projection on the humerus, short and trapezoidal humerus, enlarged intermedium, and trapezoidal cervical and anterior dorsal neural spines represent autapomorphies. Forefin morphology is archaic: the carpals, metacarpals and phalanges form a mosaic similar to that of Triassic–Early Jurassic parvipelvians, accessory digits are absent, and notching is present on the leading edge of the first digit. These and other characters indicate exclusion of the Iraq ichthyosaur from Ophthalmosauridae, the only ichthyosaur clade currently known from the Cretaceous. A phylogenetic analysis of Parvipelvia – the largest yet produced – recovers the new taxon as the sister-taxon of *Ichthyosaurus communis*, thereby invoking a ghost-lineage of over 60 million years. Inclusion of the new taxon in analyses produced by other authors also resulted in exclusion from Ophthalmosauridae, though relationships with other neoichthyosaurians are less resolved than in our analysis. We conclude that the new taxon represents a highly conservative relict – a member of the *Ichthyosaurus* lineage – that retained an 'Early Jurassic' grade of pectoral anatomy into the Cretaceous. Ophthalmosauridae and members of the *Ichthyosaurus* lineage therefore both persisted beyond the Jurassic. Clearly, both have highly contrasting evolutionary histories and Cretaceous ichthyosaurs do not all represent members of the same evolutionary radiation. The Iraq ichthyosaur is one of several new taxa originally worked on by the late Robert M. Appleby. An inability to resolve conflicting views on the age of the specimen, combined with other issues, derailed his plans to publish on this specimen during the 1970s.

Romer Prize Session (Thursday, October 31, 2013, 11:00 AM)

ESTIMATION OF THE BONE GROWTH CENTER USING INNER BONE STRUCTURAL FEATURES AND ITS APPLICATION FOR PALEOHISTOLOGY

NAKAJIMA, Yasuhisa, Steinmann Institute for Geology, Mineralogy and Paleontology, University of Bonn, Bonn, Germany

Recent studies have made remarkable progress in knowledge of bone histology of fossil and recent tetrapods. However, despite the three-dimensional nature of internal limb bone structure, two-dimensional comparison of single transverse thin sections as a convenient standard has been performed. Sections were most often sampled from mid-diaphyseal level, or mid-shaft, which is defined as the most constricted region of the diaphysis. Since the transverse section from this level is likely to pass the center of ossification of a bone, it is believed that such section yields the strongest ecological signals and the best preservation of ontogenetic records such as lines of arrested growth.

The nutrient canal, or the pathway of major blood vessel penetrating compact bone wall in a long bone develops during embryogenesis, and continues to connect internal and external bone spaces throughout ontogeny. Therefore, if nutrient canals do not drift within compact bone, growth center of a bone can be estimated by tracing the path of nutrient canal internally.

Here the author validates the utility of the three-dimensional structure of nutrient canals for determination of the ontogenetic center or true mid-shaft using micro-focus CT scanner and thin sections.

Stylopodial and zeugopodial limb bone specimens of various mammals, birds and reptiles were scanned using high-resolution CT scanner and visualization of nutrient canals were performed. Several thin sections were taken from a bone so that they pass through the nutrient canals. As the result, the inner surface of nutrient canal is surrounded by periosteal bone, but not endosteal bone. This indicates that the nutrient canal does not drift within compact bone, and that the center of ossification is located at the intersection point of the extension of nutrient canal and the longitudinal axis. The validity of this model is well supported by 3D data from bones without medullary cavity where the center of ossification is also identified by the structural center of encochondral cancellous bone. The center of ossification is not always located in the morphological mid-shaft but in far proximally or distally to that in case of bones with complex geometry. CT scanning tests for fossilized bones of various eras also show the structure of nutrient canals and the center of ossification. In conclusion, three-dimensional inner bone structures including nutrient canal are useful in conjunction with comparative osteohistological studies for estimating ontogenetic pattern from a single bone of an extinct animal.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEAR-COMPLETE SKULL OF *EQUUS* (EQUIDAE, PERISSODACTYLA, MAMMALIA) FROM THE EARLY PLEISTOCENE KONSO FORMATION, SOUTHERN ETHIOPIA.

NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan; SUWA, Gen, University of Tokyo, Tokyo, Japan; ODE, Satoru, Kagoshima University, Kagoshima, Japan; ASFAW, Berhane, R. V. R. S. , Addis Ababa, Ethiopia; BEYENE, Yonas, A. R. C. C., Addis Ababa, Ethiopia

The early Pleistocene Konso Formation crops out in the Konso area at the southern end of the Main Ethiopian Rift. The Konso Formation has yielded a number of vertebrate fossils, including hominids. The age of the Konso Formation range from 1.95 to 0.85 Ma. The faunal assemblage consists mainly of mammals, with abundant bovids, suids and equids. Equid fossils from the Konso Formation are represented by *Hipparion* and *Equus*. We performed phylogenetic analysis on an almost complete skull of *Equus* from the ~1.4 Ma horizon of the Konso Formation. Well-preserved skulls of *Equus* from the Late Cenozoic of Africa are very rare, known only from *E. koobiforensis* from east of Lake Turkana and a few skulls from North and South Africa. Previous researchers mentioned some similarities of these fossil *Equus* with *E. stenonis* from Europe or extant *E. Quagga burchelli* from Sub-Saharan Africa. This Konso skull shows similarities with the skull of *E. Asinus africanus* in the ratio diagram pattern of metric data that compare extant and fossil *Equus* skulls. However, the size of the Konso skull is lager than the size of *E. A. africanus* skulls. One possibilty is that this Konso skull represents a new species of genus *Equus*, perhaps the first fossil record of subgenus *Asinus* from Sub-Saharan Africa.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DELIMITING THE FORELIMB MORPHOLOGY AMONG PLEISTOCENE (ENSENADEAN-LUJANIAN) MYLODONTIDS SLOTHS (MAMMALIA, PILOSA) AND THE IMPLICATIONS FOR FUNCTIONALITY

NAPLES, Virginia, Northern Illinois Univ, DeKalb, IL, United States, 60115-2861; MCAFEE, Robert, Ohio Northern University, Ada, OH, United States

Extinct sloths of the family Mylodontidae were numerous and varied during the Pleistocene (Ensenadan-Lujanian) Land Mammal Ages in both North and South America. While cranial characters distinguish them, the postcrania of some genera (e.g. *Mylodon*) are less well known (i.e. cranial collecting biases), leading to questionable diagnoses and a lesser understanding of these animals' functional capabilities and habits. Recent association of postcranial elements to an identifiable cranium of *Mylodon darwinii* from the Lujanian (late Pleistocene) of Argentina provides a new basis for assessing the morphology of the forelimbs of the Mylodontinae triumvirate (*Glossotherium*, *Mylodon* and *Paramylodon*) and for exploring their biomechanical implications. Quantitative and qualitative characters from humeri, ulnae, radii, and some manual elements belonging to these three genera were studied. The cumulative morphological differences of the humerus provide two unique perspectives as to the functional differences between *Paramylodon* and *Glossotherium*, with the first emphasizing lateral rotation and forearm flexion by way of the greater development of the pectoral crest and medial epicondyle. The lesser development of these features and the increased angle of the shaft away from the body in *Glossotherium* lend itself toward potential digging habits, whereas those for *Paramylodon* promote a greater grasping ability when the features of the radius are also considered. The posterior surface of all three taxa differs distally in the area for attachment of abductor and extensor muscles with *Mylodon* and *Paramylodon*, respectively, exhibiting the largest scar areas. The carpals of all three genera show differences but the metacarpals are more significant, with the fourth and fifth of *Glossotherium* being more slender, suggesting a lesser degree of manual rotation such that less of the lateral surface of the manus is in contact with the ground during locomotion. Despite the relative morphological similarity between these animals, the combined features portray different ecological habits. *Glossotherium* is regarded as having greater potential for habits related to digging behaviors, whereas Paramylodon was more suited to reaching and grasping, which is an activity useful to a browsing lifestyle. The lack of a definitively known humerus for *Mylodon* hampers our ability to make further inferences about the forelimb's functionality, but the radial characters imply a greater manual dexterity than that of *Paramylodon*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC AND FUNCTIONAL CUES IN MICROMAMMAL TARSAL BONES FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF SOUTHWESTERN TANZANIA

NAYLOR, Emily, Ohio University, Athens, OH, United States, 45701; KRAUSE, Cornelia, Ohio University, Athens, OH, United States; STEVENS, Nancy, Ohio University, Athens, OH, United States

The late Oligocene Nsungwe Formation, situated within the Rukwa Rift Basin in the Western Branch of the East African Rift System in southwestern Tanzania, offers a unique window into Paleogene mammalian evolutionary history. Micromammal fossils are abundant in the fauna, and represented by macroscelidean, rodent, hyracoid, and primate craniodental specimens. Postcranial elements, such as tarsal bones, also preserve well in Nsungwe Formation localities; particularly well-represented by the central element of the tarsal complex, the astragalus, offering important insights into micromammal locomotor behavior and paleoecology. This study used apomorphy-based and morphometric approaches to characterize 19 fossil specimens, placing them within the context of a morphologically and phylogenetically diverse extant sample of small mammals that exhibit a broad range of locomotor modes (generalized terrestrial, arboreal, saltatorial, semi-aquatic, glissant, fossorial). Astragalar morphology was assessed quantitatively using 27 linear and angular measurements taken from digital reconstructions of μCT-scanned specimens and performed in Avizo (version 6.0), then analyzed using analyses of covariance and multivariate statistical approaches. Results document several parameters useful for distinguishing phylogenetic and/or functional groupings among the extant sample. Nearly 70% of fossil specimens were categorized within distinct morphological groups, each with a closely approximated extant morphological representative. Detailed examination of tarsal elements provides an important additional line of evidence for exploring the phylogenetic and ecomorphological affinities of micromammals from the first late Oligocene terrestrial fauna from sub-equatorial Africa.

Romer Prize Session (Thursday, October 31, 2013, 11:15 AM)

ORIGINS, SYSTEMATICS AND PALEOECOLOGY OF PLACODONT MARINE REPTILES (SAUROPTERYGIA, PLACODONTIA)

NEENAN, James, University of Zurich, Zurich, Switzerland

Placodonts are a clade of durophagous sauropterygians that inhabited the eastern and western margins of the Tethys Ocean from the lower Middle to the end Triassic. The group consists of two morphotypes: the plesiomorphic, paraphyletic, and unarmored 'placodontoids', which are known only from the Middle Triassic, and the heavily armored Cyamodontoidea, which span the entire Middle and Late Triassic. However, the evolutionary relationships and origins of the Placodontia have remained unclear until now, particularly in the light of new taxa described from China, the majority of which are yet to be included in a phylogeny and described in detail.

In order to resolve the systematic relationships of placodonts, micro-computed tomography was used on several crania from both European and Chinese taxa. This method not only allows accurate reconstruction of external osteology, but also of obscured structures such as the braincase and inner ear. For the first time, a comprehensive phylogeny including all eastern and western placodont taxa is thus presented. Among the Chinese forms the basal placodont *Placodus inexpectatus* clusters with European 'placodontoid' taxa, while *Glyphoderma* and *Psephochelys* form a clade with the highly nested Placochelyidae, thus pulling this node back into the Late Middle Triassic. This indicates that all placodont clades originated during a period of intense speciation during the Middle Triassic, with cyamodontoid taxa diversifying into the Late Triassic on both sides of the Tethys.

Additionally, a new, exquisitely preserved skull of a juvenile placodontiform from Winterswijk, the Netherlands has provided a wealth of evidence concerning both the paleogeographic and evolutionary origins of crown group Placodontia. Characters such as a single row of teeth on the palatine place the new taxon on the stem to Placodontia, indicating an origin of the clade in the western Tethys, which then radiated eastwards. Furthermore, the dentition is not adapted for durophagy, indicating the unusual dental arrangement of palatine teeth in placodonts did not initially evolve as a result of consuming hard-shelled prey.

As the most plesiomorphic clade of the most successful and diverse marine reptile radiation known, the placodonts are essential for understanding the origins and diversification of Sauropterygia. The new data are therefore of great significance, providing insight into the paleobiogeographic and paleoecological changes that occurred on the stem leading to the more derived sauropterygians.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

RELATIONSHIPS AMONG THE BIZARRE: THE ANATOMY OF *AZENDOHSAURUS MADAGASKARENSIS* AND ITS IMPLICATIONS FOR RESOLVING EARLY ARCHOSAURMORPH PHYLOGENY

NESBITT, Sterling, Field Museum of Natural History, Chicago, IL, United States, 60605-2496; FLYNN, John, American Museum of Natural History, New York, NY, United States; RANIVOHARIMANINA, Lovasoa, Université d'Antananarivo, Antananarivo, Madagascar; PRITCHARD, Adam, Stony Brook University, Stony Brook, NY, United States; WYSS, Andre, Univ of California Santa Barbara, Santa Barbara, CA, United States

During the Triassic, a number of highly disparate archosauromorphs populated both terrestrial (e.g., *Trilophosaurus*, rhynchosaurs) and marine ecosystems (e.g., tanystropheids) across Pangea. Unfortunately, the unique and sometimes utterly bizarre body plans of these reptiles (e.g., specialized feeding adaptations) create a major challenge in understanding early archosauromorph relationships and patterns of diversification, as teasing apart homology from homoplasy has been difficult with the current sample of taxa. Here we present the postcranial anatomy of *Azendohsaurus madagaskarensis*, an early archosauromorph from the Middle-Late Triassic of Madagascar. *Azendohsaurus madagaskarensis* comes from a monotypic bonebed containing an ontogenetically variable sample, with preservation ranging from whole, disarticulated bones, to articulated partial skeletons. From this bonebed, the entire anatomy of the taxon is represented. *Azendohsaurus madagaskarensis* possessed an elongated neck, short tail, and stocky limbs. The manus and pes have unexpectedly short digits, terminating in large, recurved ungual phalanges. Together with the skull, knowledge of the postcranial skeleton elevates *A. madagaskarensis* to another highly apomorphic and bizarre Triassic archosauromorph. Even so, recovery, description and analysis of the full anatomy of *A. madagaskarensis* provides clues to understanding the relationships of this species and other problematic and anatomically specialized taxa, including the North American Late Triassic archosauromorphs *Trilophosaurus* and *Teraterpeton*. For example, *A. madagaskarensis*, *Trilophosaurus*, and *Teraterpeton* share a dorsally hooked quadrate and enlarged, trenchant unguals, whereas *Trilophosaurus* and *Teraterpeton* alone share a number of other character states (e.g., restricted scapular blade, premaxillary beak). We tested these observations in a newly constructed phylogenetic analysis centered on Triassic archosauromorphs and archosauriforms. We find that *A. madagaskarensis*, *Trilophosaurus*, *Spinosuchus*, and *Teraterpeton* form a clade within Archosauromorpha, but the relationships of this clade to other groups of Triassic archosauromorphs (e.g., archosauriforms, rhynchosaurs, tanystropheids) remains poorly supported. The newly recognized clade containing *A. madagaskarensis*, *Trilophosaurus*, and *Teraterpeton* demonstrates high disparity of feeding adaptations even within a closely related group of basal archosauromorphs.

Technical Sesssion XII (Friday, November 1, 2013, 3:45 PM)

MODELING THE HISTORICAL RANGE OF *ALLIGATOR* AND ITS IMPLICATIONS FOR CROCODYLIANS AS PALEOCLIMATE PROXIES

NESTLER, Jennifer, Stony Brook University, Stony Brook, NY, United States, 11794; AIELLO-LAMMENS, Matthew, Stony Brook University, Stony Brook, NY, United States

Crocodylians and their fossil relatives are regarded as climate-sensitive and their spatial distributions are often used to reconstruct, or act as proxy for, paleoclimate. However, crocodylian tolerances are not universal to the group and we know very little about which climate variables drive changes in crocodylian species distributions. The genus *Alligator* contains two extant species, *A. mississippiensis* and *A. sinensis*, and several fossil species. Unlike other crocodylians, *Alligator* is able to tolerate freezing temperatures for extended periods, allowing them to live in temperate climates. *Alligator mississippiensis* has a broad range across the southeastern United States, while *A. sinensis* is a critically endangered species found in a handful of localities in the Anhui Province of eastern China. To test which climate variables drive *Alligator* range evolution and to provide rigorous estimate of past distributions, we compiled a large database of individual extant occurrences and 19 bioclimatic variables for the Recent. Using the software package Maxent and five bioclimatic variables, we modeled the distribution of *Alligator* at the present, the last glacial maximum (~21 ka), and last interglacial period (~120-140 ka) to track its expansion and contraction with climate change. The results show that the range of *A. mississippiensis* expanded northward during the last interglacial period and severely contracted during the last glacial maximum. The range contraction is supported by low mitochondrial DNA diversity, which is thought to indicate a population bottleneck in the Late Pleistocene. Additionally, the modern range of *A. mississippiensis* extends farther north than is currently recognized. This is corroborated by both historical and modern data, indicating that this range extension is not due to current climate change. Despite the expansion and contraction of the range with climate, the model indicates that the minimum annual temperature and the mean temperature for the coldest quarter of the year may not be the most limiting factors in their range. This has biogeographic implications for the dispersal of the genus from North America into Asia and indicates that more research is required to fully understand the limiting factors of their range.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ANACORACID VERTEBRAL MORPHOLOGY AND COMPARISON TO LAMNIFORMES AND CARCHARHINIFORMES SUGGEST AN ORDINAL ASSIGNMENT

NEWBREY, Michael, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada, T0J 0Y0; COOK, Todd, University of Alberta, Edmonton, AB, Canada; SIVERSON, Mikael, Western Australian Museum, Perth, Australia; WILSON, Mark, Univ of Alberta, Edmonton, AB, Canada; NEUMAN, Andrew, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Squalicorax represents a diverse group of Cretaceous sharks with a global distribution. Based primarily on isolated teeth, over 40 nominal species have been assigned to the family Anacoracidae, many of which are nomina dubia. Despite being a common and abundant component of many marine assemblages, particularly in the Cretaceous Western Interior Seaway of North America, this family has been the subject of a long debate as to its ordinal affinity. Based strictly on tooth morphology, some authors included this group within Hexanchiformes; however, the perceived hexanchid affinity of anacoracids was based largely on the labiolingually compressed root in highly derived Maastrichtian species. Others included *Squalicorax* within Carcharhiniformes, but tooth histology and the juxtaposed dentition of the former indicates a placement outside of that order. Presently, the anacoracids are typically assigned to Lamniformes based on characters including osteodont tooth histology, bilobate root morphology, and the presence of an independent or juxtaposed dentition. However, anacoracids lack a dental bulla that is present in most lamniforms. To date, no studies have surveyed the morphology of centra associated with teeth and skeletons in detail. Herein, we review the

available material for study and compare the vertebral morphology of *Squalicorax* to that of extinct and extant lamniform species.

Seven partial skeletons from *Squalicorax* (Anacoracidae) with associated sets of teeth and centra were examined. Centra were hemisected (n = 7) and/or transversly (n = 3) sectioned. The prepared centra are round to subcircular, short, taller than long, and have a thin corpus calcareum. In addition, the corpus calcareum shows growth bands and centra bear thin circular lamellae with small radial canals adjacent to the corpus calcareum; however, they lack radial or diagonal lamellae and septae. The centrum morphology of *Squalicorax* differs from that of extinct and extant lamniform species in lacking a thick corpus calcareum and radial lamellae. Based on these differences, we do not suggest broadening the definition of the Lamniformes to accommodate the anacoracids. While the centra of anacoracids are very similar to those of the Carcharhiniformes, characteristics of the teeth exclude their taxonomic assignment to the order. Our findings suggest the Anacoracidae should be classified either as incertae ordinis or assigned to a new order.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

TAXONOMIC, MORPHOLOGICAL, AND PALEOENVIRONMENTAL REVISIONS ON FOSSIL BOVIDS (ARTIODACTYLA) FROM CONTINENTAL SOUTHEAST ASIA

NISHIOKA, Yuichiro, Primate Research Institute, Kyoto University, Aichi, Japan; TAKAI, Masanaru, Primate Research Institute, Kyoto University, Aichi, Japan; VIDTHAYANON, Chavalit, Mekong River Commission, Vientiane, Laos; HANTA, Rattanaphorn, Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, Thailand; JINTASAKUL, Pratueng, Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, Thailand

Bovid artiodactyls are much diversified in the late Neogene fauna of southern Asia. Previous studies suggest that fossil bovids in northern South Asia are correlated taxonomically with those in continental Southeast Asia. However, we recognize that the bovid fossil assemblage in Southeast Asia shows less diversity and higher levels of endemics than that in northern South Asia. In order to revise taxonomical positions of fossil bovids, cranial and dental specimens collected from the Irrawaddy sediments of Myanmar and from the Tha Chang sand pits of Thailand were used. The Irrawaddy sediments are biostratigraphically divided into two horizons, the Lower Irrawaddy sediments (upper Miocene/lower Pliocene) and the Upper Irrawaddy sediments (upper Pliocene/lower Pleistocene). The geological age of the Tha Chang sand pits is correlated with that of the Irrawaddy sediments. Morphological comparisons classified the fossil bovids from the Irrawaddy sediments and the Tha Chang sand pits into six species (*Sivaportax dolabella*, *Proleptobos birmanicus*, *Pachyportax latidens*, *Pachyportax giganteus*, cf. *Proamphibos* sp., and cf. *Hemibos* sp.) and two species (*Pachyportax latidens* and *Selenoportax* sp.), respectively. Among these genera, *Sivaportax* and *Proleptobos* are endemic to Myanmar and continuously occurred in the Lower and Upper Irrawaddy sediments. Although the other genera are common with those from the Siwalik Group of northern South Asia, cf. *Proamphibos* sp. and cf. *Hemibos* sp. have never been found from the Siwalik Group. The paleoenvironment during the Pliocene of central Myanmar was a transitional stage from forest to grassland on the basis of stable isotope and mesowear analyses using fossil bovid teeth. The aridification of central Myanmar is considered to be caused by seasonal monsoon winds and the uplift of the Indo-Burma ranges related to the Himalaya-Tibetan Plateau orogeny. The faunal difference between South Asia and Southeast Asia may be correlated with these climate and geographical changes.

Preparators' Session (Thursday, October 31, 2013, 11:00 AM)

MOVING MARSH'S DINOSAURS INTO THE 21ST CENTURY

NORRIS, Christopher, Yale Peabody Museum of Natural History, New Haven, CT, United States, 06511; YARBOROUGH-FITZGERALD, Vicki, Yale Peabody Museum of Natural History, New Haven, CT, United States; FOX, Marilyn, Yale Peabody Museum of Natural History, New Haven, CT, United States

In 1926, the Peabody Museum constructed what was then a state-of-the-art storage facility to house the dinosaur collections of Othniel Charles Marsh, including type specimens of such iconic taxa as *Apatosaurus*, *Stegosaurus*, *Camarasaurus*, and *Triceratops*. The hand-made metal storage featured an innovative design of adjustable, wire mesh pullout shelves. Though advanced for its time, this storage system was far from ideal, being subject to corrosion and exposing specimens to mechanical damage through vibration. The storeroom itself was dungeon dark and had no climate control; fluctuations in temperature and humidity added stress to already failing 1870's hide glue joints. In 2000 the Museum was able to deal with specimen-level issues, but the larger problem of the storage area itself remained. In 2011, the Museum made a successful application to the Save America's Treasures program, based on the significance of Marsh and his discoveries to the history of the United States. Recently the Peabody Museum has been able to move these important specimens into new compactorized storage, in a newly renovated, climate-controlled space in an adjacent building, with access controlled by a new security system. The renovation of this space called for complete removal of the existing floor and installation of a new floor that would withstand the weight of the bones and the compactors. The new well-lit, white Delta Designs compactors feature pullout shelving that extends to its full depth, smoothly, with the touch of a finger, making it easy for researchers to study any specimen on the shelf. This move has enabled us to reorganize the collection, reuniting elements from specimens that were formerly dispersed around the original room. Specimens are now arranged taxonomically and within taxon by catalog number. As the specimens are moved into the new storage facility their condition is checked, any needed repairs made, specimens are digitally imaged, and both the original location and the new location are databased. This presentation describes the long process through which, step-by-step, we have been able to improve the accessibility and stability of these specimens.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC AND BIOSTRATIGRAPHIC IMPLICATIONS OF NEW POSTCRANIAL MATERIAL OF *PROTOHADROS* (ORNITHOPODA, HADROSAUROIDEA) FROM THE WOODBINE FORMATION OF TEXAS

NOTO, Christopher, University of Wisconsin-Parkside, Kenosha, WI, United States, 53141-2000; MAIN, Derek, Univ of Texas at Arlington, Irving, TX, United States; POOLE, Karen, The George Washington University, Washington, DC, United States

Protohadros was originally described as the most basal member of the Hadrosauridae, based on a reasonably complete skull but scant postcrania from the Arlington Member of the Woodbine Formation (Cenomanian). Subsequent analyses place it outside Hadrosauridae as a stem taxon among a series of increasingly derived hadrosauroids, although some ambiguity in its position exists. Furthermore, recent work has demonstrated the complicated and mosaic nature of hadrosauroid evolution leading up to the emergence of the Hadrosauridae, especially within the postcranial skeleton, suggesting more postcrania are needed to better resolve relationships within stem hadrosauroids.

Skeletal material excavated from the Arlington Archosaur Site (AAS) in Dallas, TX, represents previously unknown postcranial elements attributed to *Protohadros*. Material comes from multiple individuals and growth stages including a scapula, coracoid, humerus, ulna, ilium, ischium, pubis, femur, tibia, fibula, ribs, axis, and vertebrae. Cranial material includes teeth and a near complete dentary. The material displays a unique mix of basal iguanodontian and derived hadrosaurid features not seen in other taxa. The AAS is located in the Lewisville Member, which underlies the Arlington Member, and consists of coastal delta plain deposits. Lithostratigraphy, biostratigraphy, and GPS data suggest that the *Protohadros* type locality is part of the Lewisville Member, making it older than originally reported. Similar isolated ornithopod remains from Lewisville Member exposures in the area suggests *Protohadros* was a relatively common taxon in these environments.

Both cranial and postcranial characters were scored for *Protohadros* in a matrix of 35 taxa and 218 characters. A preliminary parsimony analysis was performed using the software package TNT 1.1 using the defaults of the xmult command. This runs multiple searches using a combination of algorithms and was followed by symmetric resampling and decay analyses. Eight most parsimonious trees were recovered. The strict consensus found *Telmatosaurus*, *Eolambia*, and *Protohadros* to be the successive sister taxa to the Hadrosauridae. However, the node containing these three genera plus Hadrosauridae is not well supported. Addition of characters and taxa to the matrix may improve resolution in this region of the tree, but it is also possible that character conflict makes this problem intractable. This new material fills numerous gaps in our knowledge of *Protohadros* skeletal anatomy and ontogeny, and provides insight into hadrosauroid evolution.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

RECONSTRUCTING AN ANCIENT PLAYA MUDFLAT USING HIGH-DYNAMIC-RANGE IMAGING ALONG AN EXPOSED SECTION OF THE FLUVIAL-LACUSTRINE DEPOSITS OF THE COPPER CANYON FORMATION, DEATH VALLEY NATIONAL PARK, CALIFORNIA

NYBORG, Torrey, Loma Linda University, Loma Linda, CA, United States, 92354; NURMI, Neal, Resources Management, Death Valley National Park, Death Valley, CA, United States; JANSEN, Birgitta, Resources Management, Death Valley National Park, Death Valley, CA, United States

Extremely well preserved fossil tracks and trackways of mammals and birds are preserved in playa mudflat deposits of the Copper Canyon Formation. Twenty-six ichnospecies of cat, camel, horse, mastodon, and bird tracks have been identified from 60+ localities spanning over 1800 m of fluvial-lacustrine deposits. The Formation is exposed within Copper and Coffin Canyons on the west side of the Black Mountains in southern Death Valley National Park, California in a tectonic basin associated with right steps within a low angle normal fault system that extended Death Valley and uplifted the Black Mountains. Uplift has deformed the basin into a large syncline. Detailed measured sections within the Copper and Coffin Canyons reveal that the distribution of the tracks is widespread and is only limited to the degree to which the rocks crop out. Most rock exposures are very limited. However, along the limbs of the syncline the deposits dip up to 70 degrees exposing large areas of the ancient playa mudflat deposits. At one of these limbs we used high-dynamic-range imaging to capture multiple standard photographs using exposure bracketing. This process produces an image of greater dynamic range and thusly greater definition. Stitch software was then used to reconstruct a portion of the playa mudflat. Using this technique a plethora of mammal and bird tracks and associated sedimentary structures can be clearly seen, which allows insight into the potential number and distribution of tracks still buried within the 1800 m fluvial-lacustrine deposits of the Copper Canyon Formation.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

LIZARDS FROM THE JUDITH RIVER FORMATION (UPPER CRETACEOUS), HILL COUNTY, MONTANA

NYDAM, Randall, Midwestern University, Glendale, AZ, United States, 85383

Newly recovered microvertebrate specimens from three closely spaced localities (Makela-French, Put's Plunder, Boremys Butte; all University of California Museum of Paleontology localities) in the Judith River Formation include numerous jaws, osteoderms, and vertebrae of lizards. The most common lizards recovered are chamopsiids with specimens referable to *Chamops*, *Leptochamops*, *Meniscognathus*,

Socognathus, and several indeterminate chamopsiid specimens. Most of the chamopsiid specimens are too fragmentary for specific identification. Additional scincomorphan specimens include cordyliform and paramacellodid-cordylid-grade jaw fragments. Anguimorphans include a few platynotan vertebrae and numerous platynotan jaw fragments. Some of the jaw fragments are tentatively referable to *Parasaniwa*, but most are too fragmentary for further identification. Additional anguimorphan remains include a jaw fragment comparable to the glyptosaurine *Odaxosaurus*, anguid osteoderms, and osteoderms with a pronounced pustulate ornamentation similar to that known for both monstersaurian-grade platynotans and xenosaurids. There are also two partial dentaries referable to Iguania (?Iguanidae) based on the presence of high-crowned, narrow-shafted, tricuspid teeth with flaring accessory cusps.

The localities in Hill County, Montana are approximately 90 km north of the classic American Museum of Natural History Clayball Hill and Clambake Hollow localities in Chouteau County from which the only other lizard fossils (*Chamops segnis*, *Leptochamops denticulatus*, *Odaxosaurus piger*, *Exostinus lancensis*, *Parasaniwa wyomingensis*, *Paraderma bogerti*) of the Judith River Formation have been reported. These original localities produced some relatively well-preserved jaws, but most specimens are fragmentary and the species-level taxonomic precision of the original identifications requires re-evaluation.

Among the relatively well-sampled lizard faunas from the Judithian, the Judith River fauna is one of the lowest in taxonomic diversity. As with most other known Judithian faunas (ranging from northern Mexico to southern Alberta) the Judith River Formation shares the presence of platynotans, *Odaxosaurus*, and non-chamopsiid scincomorphans. The high diversity of chamopsiids is most similar to the nearby faunas of southern Alberta. If confirmed, the presence of iguanians in the Judith River Formation would be an important addition to a meager record currently restricted in the Upper Cretaceous to northern latitude localities.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE EVOLUTIONARY HISTORY OF CRANIAL VASCULATURE IN BASAL RUMINANTS

O'BRIEN, Haley, Ohio University, Athens, OH, United States, 45701

Artiodactyls possess a highly specialized cranial vascular structure known as the carotid rete. The carotid rete is an intracranial thermoregulatory arterial meshwork that replaces the internal carotid artery. Sitting within a sinus of cooled venous blood, this structure is capable of selectively cooling the brain and delaying hydrologically costly responses to heat stress, such as panting and sweating. As such, the carotid rete is hypothesized to be selectively advantageous for artiodactyls as climate has changed across the Cenozoic. Within Artiodactyla, the most speciose clade is the Ruminantia. All currently sampled ruminants possess a carotid rete except for *Tragulus javanicus*. Because this species belongs to the most primitive ruminant family, it is not clear whether this aberrant lack of a rete is the plesiomorphic condition within Ruminantia or apomorphic for *T. javanicus*.

This study combines neontology and paleontology to elucidate the evolutionary history of the carotid rete within the Tragulidae. Arterial patterns were confirmed in additional tragulid taxa first by radiopaque latex vascular injection, CT scanning, and digital dissection of a *Moschiola memmina*. Next, osteological correlates for cranial vascular patterns, including external cranial foramina and intracranial impressions (i.e. carotid canal), were scored for all extant species of tragulids. It was determined that all contemporary tragulids lack a carotid rete. Osteological correlates were then sought in extinct, primitive ruminants, including *Leptomeryx* and *Hypisodus*. Osteological correlates in fossil ruminants indicate that the most primitive members of this group possessed thermoregulatory cranial vasculature. Finally, parsimony and likelihood ancestral state character reconstruction reveal a secondary loss of the carotid rete within Tragulidae. These results suggest that basal ruminants likely possessed this evolutionarily advantageous cranial vascular pattern.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ANATOMY OF A NEONATE SKULL OF *DOLICHORHYNCHOPS* (PLESIOSAURIA)

O'KEEFE, F. Robin, Marshall University, Huntington, WV, United States, 25755; BYRD, Christina, Marshall Univ, Suffolk, VA, United States

We describe a neonate polycotylid plesiosaur skull from the Sharon Springs member of the Pierre Shale (Campanian). The skull is respresented by most of a dermal palate, with the basisphenoid adhering to it. Other elements include the dermal pterygoid, parasphenoid, and ectopterygoid, and the endochondral basisphenoid, exoccipital, and prootic. The suspensorium is complete on the left side, although the quadrate has dropped out. The rostrum, consisting of the right maxilla and fused premaxillae, is complete back to near the level of the frontal suture. Both hemimandibles are present.

The endochondral elements of the skull are poorly ossified and the braincase is completely disarticulated, including the exoccipital. The parasphenoid has a significant anterior rostrum, a character diagnostic for *Dolichorhynchops*, as is the articulation of the ectopterygoid; however, the pterygoid plates are very narrow, more so than in *Trinacromerum*. The entire skull was surprisingly narrow, with a high, arched suspensorium and a well-developed sagittal crest. This character is also diagnostic to the genus *Dolichorhynchops*, and we therefore refer the neonate to that taxon. Reconstruction of the orbital region is not possible, but given the proportions of the skull the eye would have been large. Of the hemimandibles, the left is better preserved, and allows a confident estimate of skull length. The mandibular symphysis appears to have been entirely cartilaginous, and completely enclosed the anterior ends of the coronoid and splenial. Twenty-three teeth are preserved, 10 of them still residing in alveoli. The teeth are small, but similar to adult *Dolichorhynchops* teeth. In summary, the skull of the neonate is relatively high and narrow, with a relatively short, gracile snout and large eyes. The dermal skeleton is delicate, and the endochondral elements are poorly ossified. A reconstruction based on the skull displays the proportional differences with adult *Dolichorhynchops*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE PLEISTOCENE HERPETOFAUNA FROM ROOM 2 OF CATHEDRAL CAVE, WHITE PINE COUNTY, NEVADA

OLORI, Jennifer, SUNY Oswego, Oswego, NY, United States, 13126; BELL, Christopher, The University of Texas at Austin, Austin, TX, United States; JASS, Christopher, Royal Alberta Museum, Edmonton, AB, Canada

Herpetofaunas are known from a number of Quaternary cave deposits throughout the Great Basin of the western United States, but most are restricted chronologically to the terminal Pleistocene through Holocene. Excavations in Room 2 at Cathedral Cave, Nevada, resulted in the recovery of more than 900 specimens of reptiles and amphibians. Given current maximum age estimates for faunal remains from Room 2 (146.02 ± 2.584 to 153.7 ± 6.4 ka), reptile and amphibian fossils from Cathedral Cave represent one of the earliest-known, species-rich Pleistocene herpetofaunas in western North America. Squamate remains include representatives of *Aspidoscelis*, *Crotaphytus*, *Gambelia*, and *Phrynosoma*. Additionally, remains of both gracile and robust forms of other phrynosomatids are present, as are representatives of colubrid and viperid snakes, and two species of turtle (*Gopherus agassizii* and an unidentified species of Emydidae). Amphibians are represented only by anuran material. Much of the identified squamate and amphibian fauna is similar to what might be expected in terminal Pleistocene or Holocene faunal assemblages from the region, although the records of turtles are notable. The presence of *Gopherus* particularly is anomalous given climate estimates for the Pleistocene of the Great Basin. The Cathedral Cave record indicates a resident population of *Gopherus*, and forces reconsideration of a nearby record previously disregarded as a case of transportation by humans. At the least, the presence of turtles in the Room 2 faunal assemblage is indicative of substantial biogeographic change in the distribution of those taxa in western North America during earlier portions of the Pleistocene that are not otherwise represented in the Great Basin.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

VARIATION THROUGH TOOTH WEAR OBSCURES THE DIFFERENTIAL DIAGNOSES OF THE HEMPHILLIAN CASTORIDS *DIPOIDES STIRTONI* AND *DIPOIDES SMITHI*

OLROYD, Savannah, University of Oregon, Gresham, OR, United States, 97030; HOPKINS, Samantha, Univ of Oregon, Eugene, OR, United States

Diagnostic features that show excessive variation can be problematic when their variation interferes with clear distinction between taxa. Species identification can be further confounded when such highly variable supposedly diagnostic dental characters change with tooth wear. The Hemphillian castorids *Dipoides stirtoni* and *Dipoides smithi* are distinguished from one another by the presence or absence of striations on the fourth premolars. *D. stirtoni* has a parastria running down the buccal side of the upper P4 and a parastriid on the lingual side of the lower p4 in all wear stages. *D. smithi* lacks the parastria and only occasionally has a parastriid in later wear stages. We have reviewed this diagnosis by examining over 200 toothrows and isolated cheek teeth of both species from the Mckay Reservoir and Juniper Creek local faunas in Oregon. No well-worn P4s of *D. smithi* have a parastria, but the parastria is present in the earlier wear stages of all upper cheek teeth. Approximately 25% of the p4s of *D. smithi* studied have a parastriid in later wear stages, and one *D. stirtoni* p4 had no parastriid. We investigated other dental characters to see if other features were diagnostic to these species. The two taxa are indistinguishable in tooth size, molar shape, and wear stages (with the exception of the persistence of parastriae and parastriids into later wear stages). The current diagnosis makes identification difficult, as any new isolated specimens cannot be confidently identified as either of these species unless the specimen includes a well-worn P4. Complex wear series can produce a large amount of apparent dental variation in hypsodont mammals. Caution should be taken when using dental characters to assign diagnoses to such highly-hypodont taxa.

Technical Session XVIII (Saturday, November 2, 2013, 4:00 PM)

ADAPTING MODERN COMMUNITY ECOLOGY TECHNIQUES FOR TERRESTRIAL PALEOECOLOGY: INSIGHTS FROM THE EARLY CRETACEOUS CLOVERLY FORMATION

ORESKA, Matthew, University of Virginia, Charlottesville, VA, United States, 22904; CARRANO, Matthew, Smithsonian Institution National Museum of Natural History, Washington, DC, United States

The relatively poor fossil record for most terrestrial vertebrate communities often constrains paleoecologists. As a result, much of the work in terrestrial paleoecology has focused on evolutionary paleoecology within lineages, leaving community and population-level questions open to speculation. In many cases, paleocommunity-level hypotheses are based on autecological inferences but cannot be tested against actual community-level data sets. However, the paucity of community-level samples is attributable both to poor preservation and to traditional prospecting methods. Recent efforts to identify and quantify vertebrate microfossil bonebeds (VMBs) are yielding large, diverse, terrestrial fossil assemblages that may be conducive to population and community ecology statistical approaches.

We analyzed relative species abundances between different sites in the Early Cretaceous Cloverly Formation, a terrestrial deposit with a historically poor non-dinosaur vertebrate fossil record. Fieldwork conducted for this study identified 29 fossil-bearing sites, including VMBs, which together yielded almost 12 000 taxonomically informative specimens. We compared different strategies for analyzing species composition and

abundances by site, including analysis of variance, correlation analysis, and ordination, while attempting to control for differences in site-level taphonomy and stratigraphy.

Our results highlight a degree of spatial heterogeneity in the Cloverly metacommunity. The two richest sites exhibited significantly different osteichthyan and amniote (i.e. lizard and mammal) relative abundances, which we interpret as a paleoenvironmental signal. Other taxa were both common and widespread, including turtles and a large crocodylian. However, the distinctive distributions and taxonomic co-occurrences of certain taxa, including the three turtles, suggest different life habits. Other common taxa (e.g., albanerpetontids, atoposaurids) possibly bridged the aquatic and terrestrial paleocommunities. Among dinosaurs, several taxa occurred with significantly greater frequency than others; we recovered numerous sauropod and *Deinonychus* teeth but comparatively few ornithopod and large theropod remains.

Similar insights can be drawn for other terrestrial formations, even those with relatively poor fossil preservation potential. However, these techniques will likely yield the greatest insight when applied to VMB-rich formations, such as those from the Late Cretaceous Western Interior.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW FOSSIL EGGS, EGGSHELL, AND PERINATAL OSTEOLOGICAL REMAINS FROM THE EGG MOUNTAIN LOCALITY, UPPER CRETACEOUS TWO MEDICINE FORMATION, MONTANA, USA

OSER, Sara, Montana State University, Bozeman, MT, United States, 59715

Egg Mountain is one of several dinosaur nesting sites at the Willow Creek Anticline (WCA) in the Upper Cretaceous Two Medicine Formation of Montana. Two unidentified egg clutches (Type I eggshell), fragmentary eggshell (Type II), and osteological remains were recently discovered on the south side of Egg Mountain in homogenous siliciclastic grey mudstone. Micritic limestone above the egg-bearing strata contains insect cocoons with helical ridges (*Rebuffichnus*) and burrows consistent with the *Celliforma* ichnofacies, indicating a well-drained paleosol. The objectives of this study are to 1) describe the eggs and eggshell, 2) determine nesting environment, and 3) assign the osteological remains to taxon. Analytical methods including petrographic microscopy, cathodoluminescence imaging, and scanning electron microscopy permit identification of egg microstructure, calculation of gas conductance, and assessment of diagenetic alteration.

The two clutches of Type I eggshell contain 7-12 eggs randomly distributed in elliptical areas. The highly compressed 12x12 cm eggs are 1-2 cm thick and lack ornamentation. The 0.5 mm thick eggshell shows diagenetic alteration that obscures eggshell microstructure, inhibiting ootaxonomical assignment. Type II eggshell is 0.8-1.3 mm thick and is dispersed throughout a 0.7 m interval of mudstone, overlapping with the egg clutches. In thin section, shell units lack delineation and are comprised of radiating wedges with sweeping columnar extinction. These features, sagenotuberculate ornamentation, and prolatocanaliculate pores allow assignment to *Spheroolithus*. *Spheroolithus* and Type I eggs respectively have gas conductance values 17-34 times and 30 times higher than avian eggs of the same mass, suggesting incubation occurred in a high humidity and low oxygen environment. Osteological remains occur at and below the clutches. The small size of the bones and lack of fusion between the dorsal centra and neural arches indicate an embryonic or early hatchling developmental stage. Articulation of the dorsal vertebrae with ribs and the close association of the maxillae and premaxilla suggest little or no transport prior to burial. The morphology of the humerus and skull elements is consistent with the Hadrosauridae, however, the developmental stage and incomplete nature of the specimen inhibits further assignment. Although *Spheroolithus* eggshells are associated with nests containing juvenile hadrosaurs elsewhere at the WCA, they are rare at Egg Mountain and further document the presence hadrosaurs at this site.

Technical Session VIII (Thursday, October 31, 2013, 3:15 PM)

EFFECTIVE COUNTERCURRENT EXCHANGE AT THE RESPIRATORY TURBINATES REQUIRED A STIFF THORAX IN SYNAPSIDS

OWERKOWICZ, TOMASZ, California State University, San Bernardino, CA, United States, 92407; CROMPTON, A. W., Harvard University, Cambridge, MA, United States

Temporal countercurrent exchange (CCE) of heat and water, which occurs at the respiratory turbinates, allows for considerable energy conservation in extant endotherms. Scaling of respiratory turbinate surface area correlates with field metabolic rate in mammals, but not birds. This suggests nasal cavity dimensions can potentially serve as a proxy in determining metabolic rates of extinct synapsids. Temporal CCE depends on cooling and warming of the turbinate mucosa by the inspiratory and expiratory airflows, respectively. This mechanism is effective only when inspiration is followed by expiration before the nasal mucosa can be reperfused and rewarmed. Such a breathing pattern – inspiration before expiration (I/E) – is observed in extant mammals at rest. Extant reptiles show the opposite pattern – expiration precedes inspiration (E/I), with an apnoeic period of variable duration thereafter. This dichotomy of breathing patterns is determined by the divergent lung structures and thoracic morphologies of mammals and reptiles. Reptilian faveolar lungs have a low surface area-to-volume (SA:V) ratio, low surface tension and weak elastic recoil. Reptiles, therefore, do not need a stiff ribcage to counteract elastic lung recoil. Mammalian bronchoalveolar lungs have a high SA:V ratio, high surface tension and strong elastic recoil. Lung collapse in mammals is prevented by subatmospheric pleural pressure inside a stiff thorax. Thoracic stiffness in mammals depends on a suite of characters: a muscular diaphragm, a long ossified sternum and short costal cartilages. In contrast, most reptiles (with the obvious exception of turtles) retain relatively compliant ribcages comprised of a short cartilaginous sternum and long costal cartilages. We propose that the breathing pattern of synapsids could have changed from reptilian (E/I) to mammalian (I/E) only when thoracic stiffness was sufficiently high to oppose elastic lung recoil. Although single sternal elements are found in various therapsids, an ossified segmented sternum (manubrium+sternebrae) is lacking for most synapsid taxa. The earliest record of sternebrae comes from Jurassic tritylodontids, even though gradual expansion of the nasal cavity is evident in Triassic therapsids. This suggests that the temporal CCE associated with modern endothermy may not have been operational in earlier synapsids. Prior to the origin of a stiff thorax, morphology of respiratory turbinates may have been shaped by factors other than heat and water conservation.

Technical Session VI (Thursday, October 31, 2013, 8:45 AM)

NEW MORPHOLOGICAL DATA ILLUMINATE HINDLIMB FUNCTION AND THE ECOLOGICAL CONTEXT OF FLIGHT IN THE EARLIEST BATS

PADIAN, Kevin, Univ of California Berkeley, Berkeley, CA, United States, 94720-4780; DIAL, Kenneth P., University of Montana, Missoula, MT, United States

Reconstructing ancestral character states in the evolution of chiropteran flight is challenging because, whereas the earliest bats are clearly capable of flight, their immediate laurasiatherian outgroups provide no useful information about intermediate states between fully volant bats and their terrestrial ancestors. To date, the postcrania of early bats have received less attention than the skull and teeth, and the principal problem addressed has been whether flight preceded echolocation. New preparation of the postcrania of the most basal bat *Onychonycteris* and comparative character analysis of other basal fossil bats (*Icaronycteris, Palaeochiropteryx*) reveal a variety of unusual morphological features that shed light on the functional and ecological origin of bats. Newly revealed anatomical features of *Onychonycteris* and comparative re-examination of other basal bat postcrania demonstrates that the trochanters of the proximal ends of the femur in *Onychonycteris* were not typically mammalian but subequal, and the head was offset laterally, as in crown-group bats, indicating a relatively "modern" hip flexure and a lateral orientation of the hindlimb. However, details of the tarsus and the claws, both manual and pedal, in these basal bats suggest a different ecological context than would be evident from the basal conditions of living crown-group bats. The functional morphology of the forelimb and hindlimb indicate scansorial habits that imply climbing tree trunks and rock faces. Phylogenetic analysis, integrated with analysis of functional traits, suggests a sequence of simplification and reduction of claws, coupled with increase in wing size, and an eventual shift from generalized scansorial habits to inverted perching on substrates that led to the unusual pedal claw morphology seen in most living bats today.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW PERSPECTIVES ON THE DIVERSITY OF THE CANIDAE IN THE UPPER POLESLIDE MEMBER (WHITNEYAN), BRULE FORMATION, BADLANDS NATIONAL PARK, SOUTH DAKOTA

PAGNAC, Darrin, South Dakota School of Mines, Rapid City, SD, United States, 57701; WELSH, Ed, SWCA Environmental Consultants, Rapid City, SD, United States

The Cedar Pass fauna from Badlands National Park, restricted to the upper Poleslide Member of the Brule Formation, contains representatives of most vertebrate families found in the White River Group. The paleofauna of the Poleslide Member is generally interpreted as exclusively Whitneyan in age, while Arikareean assemblages are typically restricted to the overlying Sharps Formation. Historically, the dominant canid representative in the White River Chronofauna has been *Hesperocyon*, but increased hesperocyonine diversity is recorded in the Whitneyan of South Dakota and Nebraska with the genera *Mesocyon*, *Cynodesmus*, *Sunkahetanka*, and *Osbornodon* represented. *Hesperocyon gregarious* occurs in the Cedar Pass fauna but is the only hesperocyonine representative and abundance is notably low. Borophagine diversity and abundance is exceptionally high, with *Archaeocyon*, *Cynarctoides*, *Phlaocyon*, *Oxetocyon*, and *Otarocyon* represented. The Whitneyan has generally been typified by the first substantial canid diversification event, with hesperocyonines in higher abundance than borophagines. Based on our sample, the Cedar Pass fauna demonstrates a reversal of this trend with the Borophaginae dominating canid ecology. The abundance and diversity of borophagine canids suggests a greater affinity with early Arikareean faunas than the previously interpreted Whitneyan categorization for the upper Poleslide Member. Only two Orellan holdover taxa are represented. Cluster analyses utilizing Dice, Jaccard, Kulczynski and Ochiai similarity indices were utilized to compare the Cedar Pass canid fauna with that of Orellan, Whitneyan and early Arikareean faunas across the western United States. Three of these analyses cluster the Cedar Pass fauna with early Arikareean faunas from South Dakota and Nebraska, whereas one, the Kulczynski index, clusters Cedar Pass with early Arikareean sites of North Dakota and Nebraska. The Arikareean affinity of the Cedar Pass fauna suggests an earlier diversification of borophagine canids in the Great Plains than previously interpreted.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

TAPHONOMY OF CARNIVOROUS AND HERBIVOROUS MAMMALS PRESERVED IN RANCHO LA BREA TAR PITS: SHIPS THAT PASS IN THE NIGHT?

PALMQVIST, Paul, University of Malaga, Malaga, Spain; ESPIGARES, M. Patrocinio, University of Malaga, Malaga, Spain; PÉREZ-CLAROS, Juan A., University of Malaga, Malaga, Spain; MARTÍN-SERRA, Alberto, University of Malaga, Málaga, Spain; JANIS, Christine, Brown Univ, Providence, RI, United States

The Rancho La Brea tar pits are a "Fossil-Lagerstätte" of plant and animal life in California during the late Pleistocene. The sediments, sands and clays deposited as alluvial fans of ephemeral currents, were permeated by the petroleum of the underlying Tertiary sandstones. According to current consensus, herbivorous mammals would wander into this sedimentary environment, become trapped in asphalt and eventually die, attracting predators that would also become stuck. Later, the carcasses would be covered by alluvial deposits. This scenario is in agreement with the abundance of carnivores (90%

of the assemblage), but does not explain the lack of articulated skeletons, nor the role played by fluvial transport in the accumulation of bones. The only detailed taphonomic study, performed on a single tar pit, showed that most bones were not subject to a significant degree of fluvial transport, but were buried shortly after death. Here we test these data with contingency tables for differences between carnivores and herbivores. Results showed that the proportion of bones without evidence of transport or showing a minimum degree of fluvial abrasion is 51.2% (8007/15649) for carnivores and 28.5% (721/2526) for herbivores ($t = 21.97$; $p < 0.001$). Similarly, the frequency of bones with advanced weathering (weathering stages 2 to 5) is 16.2% (2528/15650) for carnivores and 32.5% (814/2507) for herbivores ($t = 41.21$; $p < 0.001$). This suggests that the skeletal remains of carnivores were exposed during a shorter period of time before burial than those of herbivores. The proportion of bones with gnaw marks is 1.8% (275/15501) for carnivores and 5.9% (152/2559) for herbivores ($t = 82.57$; $p < 0.001$). The frequency of young individuals with deciduous teeth is 29.1% (44/151) for carnivores and 51.6% (16/31) for herbivores ($t = 3.46$, $p < 0.001$). This could explain in part the differences of weathering and abrasion between both trophic groups, as the bones of juveniles are less mineralized than those of adults. Finally, the frequencies of vertebrae and ribs versus limb bones, which differ in hydrodynamic behavior and resistance to weathering, also show differences between carnivores and herbivores, which confirms that they experienced different taphonomic circumstances. Specifically, herbivores show a lower preservational completeness than carnivores, as their appendicular skeleton is biased to half of the original bone elements. This could suggest that, after the entrapment of ungulates, carnivores dismembered the exposed limbs of their carcasses.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

CRANIAL ANATOMY OF THE PROBLEMATIC CARBONIFEROUS-PERMIAN LEPOSPONDYL *BRACHYDECTES NEWBERRYI*: NEW INFORMATION FROM MICRO-CT

PARDO, Jason, Univ of Calgary, Calgary, AB, Canada, T2N 1N4; Anderson, Jason, Univ of Calgary, Calgary, AB, Canada

Lepospondyli is a highly diverse group of small-bodied anamniotes from the late Paleozoic of North America, Europe, and North Africa. Phylogenetic analyses have repeatedly divided lepospondyl diversity between two major clades: the Recumbirostra and Microbrachomorpha. Recent work has made major progress in clarifing the anatomy and relationships of the Recumbirostra (a clade which encompasses the majority of "microsaurs'), but the relationships of the remaining lepospondyl taxa (especially the Aïstopoda, Nectridea, Adelospondyli, and Lysorophia) remain considerably less well understood. The lysorophians are especially problematic; significant reductions in the dermal and postcranial skeleton make this group difficult to place within lepospondyl phylogeny, and have led some workers to suggest that lysorophians may be closely related to some or all modern lissamphibians. New studies employing x-ray computed tomography have unlocked the braincase as a source of phylogenetic information within lepospondyls, but only limited braincase data is available for lysorophians. In order to facilitate comparison between lysorophians and other lepospondyls, we scanned a partial ontogenetic sequence of the lysorophian *Brachydectes newberryi* from the Council Grove Group of Kansas and Nebraska, USA. The anterior braincase is robust and heavily-ossified, with an anterior ('sphenethmoid') ossification bracing the palate against the skull roof and a posterior ('orbitosphenoid') ossification contacting the parietal. The columella ethmoidalis is partially ossified in larger specimens. Dorsal projections of the basisphenoid ('pleurosphenoids') are robust and brace solidly against the skull roof. The pleurosphenoids are separated from the prootic by a fissure that encompasses foramina for both the maxillary branch of the trigeminal as well as a dorsal vein in a similar arrangement to that seen in the brachystelechid *Carrolla craddocki*. The otic capsule is well ossified ventrally but retains an unossified window dorsally between the prootic and opisthotic. The occiput is roofed by an ossification of the synotic tectum ('supraoccipital') with a well-ossified ascending process exposed dorsally between the postparietals. The occipital condyle is unpaired and concave. The anatomy of the neurocranium is distinct from other microbrachomorphs but shows numerous similarities with the braincase of recumbirostrans, especially brachystelechids.

Technical Session XVI (Saturday, November 2, 2013, 3:30 PM)

NEW ARTICULATED SPECIMENS OF LEATHERBACK SEA TURTLES FROM THE CENOZOIC OF NORTH AND SOUTH AMERICA ELUCIDATE THE PHYLOGENY, DIVERSITY, GLOBAL BIOGEOGRAPHY, AND MAJOR EVOLUTIONARY TRENDS OF DERMOCHELYIDS

PARHAM, James, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States, 92834; WOOD, Roger, Richard Stockton College of NJ, Pomona, NJ, United States; SALAS-GISMONDI, Rodolfo, Museo de Historia Natural-Universidad Nacional Mayor San Marcos, Lima, Peru; THOMAS, Howell, Natural History Museum of Los Angeles County, Los Angeles, CA, United States; PYENSON, Nicholas, Smithsonian Institution, Washington, DC, United States

Spectacular new specimens of fossil leatherback sea turtles (Dermochelyidae) from localities in North and South America provide the basis for a reassessment of dermochelyid systematics that reveals new patterns of diversity through time, paleobiogeography, and morphological evolution. Today, dermochelyids are represented by a single species, the critically endangered leatherback sea turtle, the sister group to all other extant sea turtles (Cheloniidae). Dermochelyids have some unusual specializations that correspond to an unusual ecology; they are deep diving cnidivores that occupy a niche similar to that of ocean sunfish (Molidae). Dermochelyids are gigantotherms with a more cartilaginous appendicular skeleton and skull than most other turtles. The dermochelyid shell is covered by skin instead of scales, and made up of thousands of interlocking bony ossicles (other turtle shells are made up of ~50 plates). Unfortunately, most fossil dermochelyids are recovered as isolated ossicles that provide limited data. Therefore, it is significant that the new specimens are from the Miocene of Peru (Pisco Basin), the Oligocene and Miocene of eastern USA (South Carolina and Maryland), and the late Miocene of Los Angeles County, California, include partial to complete articulated carapaces, some associated with skull and limb material. The new data help show how coeval lineages of dermochelyids, endemic to different areas, were replaced by a single cosmopolitan species in the Neogene. This change in dermochelyid diversity coincided with a major change in the morphology of the dermochelyid shell. Dermochelyids with thick shells with large ossicles were replaced by a species with a much thinner shell made of more, smaller ossicles. In addition to shedding new light on the transition from a diverse thick-shelled fauna to the single thin-shelled species, the evolutionary history of dermochelyids is now sufficiently dense, and temporally refined, to illustrate coincident evolutionary patterns with other marine vertebrates. Taken together, these patterns allow us to develop hypotheses about the role of broad scale physical drivers for the evolution of dermochelyids and other taxa.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE EFFECT OF PROXY 'HOLOTYPES' ON TAXONOMIC PRACTICES FOR VERTEBRATE FOSSILS

PARKER, William, The University of Texas at Austin, Austin, TX, United States, 78712; STOCKER, Michelle, The University of Texas at Austin, Austin, TX, United States

Holotype specimens, especially historic ones, are the basis for taxonomic and ultimately phylogenetic arguments, but often are fragmentary and may preserve few diagnostic character states. Frequently, better-preserved, referred specimens are used as proxy 'holotypes' for the purpose of additional specimen referrals as well as for comparisons among species and other taxonomic categories. That practice is problematic when utilizing apomorphy-based fossil identifications because the precise taxonomic affinities of the proxy materials with respect to the original type specimens may not be clearly identified with specific anatomical data or supported. In some instances, referrals were made using geographic or stratigraphic similarities, which is circular when examining the paleogeographic distributions or chronologic durations of those taxa. The problem of proxy 'holotypes' is not restricted to a particular clade or time period, and taxonomic practices involving the Late Triassic aetosaurian taxa *Typothorax coccinarum* and *Stagonolepis robertsoni* typify this issue. Those two taxa are established broadly in the paleontological literature, yet their utility is based entirely on referred, rather than type, specimens that may not represent single taxonomic entities. Our apomorphic examination of the holotype specimens of those aetosaurs designates those taxa as nomina dubia and such taxonomic instability has direct consequences for Late Triassic biostratigraphy and biochronology because these taxa were considered index taxa for proposed biozones. Designation of neotypes, renaming of the diagnostic material, or continued use of proxy 'holotypes' all provide some level of solution with respect to this problem. However, those each have further complications, and resolution is best determined on a case-by-case basis. It is crucial that taxonomic referrals be based solely on comparisons with a standard set of specimens (ideally type specimens) to ensure repeatability and consistency of specimen referrals. The use of apomorphic character states to refer new material to existing taxa provides a testable and repeatable evidentiary basis for referring new material to taxa, but only if those character states are reflected in the reference specimens. Referrals based on apomorphies present in the type materials avoid geographic and stratigraphic biases and allow type and referred materials to be precisely integrated into larger paleobiological studies exploring the spatial and temporal evolution of extinct taxa.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ONTOGENY OR PHYLOGENY? CLADISTIC PLACEMENT OF A JUVENILE DROMAEOSAURID FROM THE LOWER CRETACEOUS OF MONTANA

PARSONS, William, Buffalo Museum of Science, South Wales, NY, United States, 14139; PARSONS, Kristen, Buffalo Museum of Science, South Wales, NY, United States

Museum of Comparative Zoology (MCZ) 8791 is a small dromaeosaurid from the Lower Cretaceous Cloverly Formation of central Montana. The only other dromaeosaurid recovered from this formation is *Deinonychus antirrhopus*. One line of arrested growth in the radius indicates MCZ 8791 died between one and two years of age. Our cladistic analysis places MCZ 8791 basal to *Deinonychus antirrhopus* and as a sister taxon to *Bambiraptor feinbergorum*, but of the 66 characters coded for MCZ 8791, it shares all but one with *Deinonychus*. That single differing character is a pneumatic foramen in the articular. MCZ 8791 shares this character with *Bambiraptor*. In MCZ 8791, the edges of this foramen show evidence of continuing growth and thus are of a variable ontogenetic nature. Further data has been obtained through landmark shape graphing of the lateral profiles of the second pedal ungual of several dromaeosaurids. Comparisons of the measurements between similar landmark points increase the number of characters that confirm the taxonomic similarity of MCZ 8791 and *Deinonychus*. Also, the identical structure and number of denticles on the maxillary teeth further confirm this identification. Beyond the characters that have already been coded, some further differences have been observed; some are evidence of a juvenile growth status and thus are ontogenetic. The juvenile identification of those features is due to the possession of at least one element such as regions of bone/cartilaginous transitional growth; juvenile histological characters; and/or open, undeveloped cortical surfaces. Other differences are not as easily recognized as ontogenetic, but we propose there is sufficient evidence to argue that they are additional variable ontogenetic characters. Examples of these are the presence or absence of maxillary interdental plates, the elongate cranium, possible concave profile of the dorsal edge of the anterior portion of the skull, the slender mandibular ramus, the spacing between the maxillary teeth, the angle of raking of the maxillary teeth, the length of manual II-2 phalanx, the mid-shaft width of pedal II-1 phalanx, the distance between the ventral apex of the flexor tubercle and the ventral limit of the proximal articulating facet on pedal ungual 3, the ratio of the comparative

thicknesses of the bony wall to the medullary cavity of the fibula, and the thickness of the bony wall of the distal end of the femur. If MCZ 8791 is a juvenile *Deinonychus*, then the identification of these further ontogenetic features contributes to our knowledge of dromaeosaurid ontogeny.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW CERCOPITHECOID PRIMATE POSTCRANIAL FOSSILS FROM COOPER'S D, SOUTH AFRICA

PATEL, Biren, University of Southern California, Los Angeles, CA, United States, 90033; DESILVA, Jeremy, Boston University, Boston, MA, United States; STEININGER, Christine, University of the Witwatersrand, Johannesburg, South Africa

There are several highly fossiliferous localities in the Bloubank Valley, Gauteng, South Africa. The Cooper's Cave System has been known since 1938 and has produced a rich fossil assemblage, including some remains of the early hominin *Paranthropus robustus*. In 2001, excavations began at a new locality, Cooper's D, which dates to approximately 1.4–1.5 Ma. Although hominins are relatively rare in the assemblage, remains of cercopithecoid primates are much more common. Craniodental fossils currently indicate the possible presence of at least three large bodied cercopithecoid primate genera at Cooper's D: *Gorgopithecus*, *Papio*, and *Theropithecus*. In this study, we identify and describe >100 cercopithecoid postcranial fossils representing all regions of the appendicular skeleton. The specimens come from several ages classes and size morphs. More than one-third of the fossils described here are from sub-adult and juvenile individuals. The adult postcranial fossils reported here vary substantially in size with body masses estimated between 30–60 kg (from 16 of the better preserved specimens). The functional morphology of the postcranial remains indicate that these elements come from animals that likely utilized terrestrial substrates, but they are difficult to definitively attribute to *Gorgopithecus*, *Papio*, or *Theropithecus* given the absence of associated skeletons; the smaller specimens likely belong to *Papio* while the larger ones can be attributed with the other two genera. Because Cooper's D has also yielded fossils of the early hominin *Paranthropus robustus*, this raises the question of how these four large-bodied, mostly terrestrial, primates sympatrically utilized this landscape.

Technical Session X (Friday, November 1, 2013, 9:45 AM)

A COMPARISON OF THE FOSSIL EVIDENCE OF THREE MAMMALIAN FAMILIES FROM EAST AND SOUTHERN AFRICA OVER THE PAST 3 MILLION YEARS: THE EFFECTS OF SAMPLING BIAS

PATTERSON, David , The George Washington University, Washington , DC, United States, 20052; FAITH, Tyler, University of Queensland, Queensland, Australia; BOBE, Rene, The George Washington University, Washington, DC, United States; WOOD, Bernard, The George Washington University, Washington, DC, United States

The history of faunal exchange between East and southern Africa in the Plio-Pleistocene has proved to be a challenge to elucidate. Differing geological contexts, taphonomic histories and collection methodologies, as well as a lack of precise chronologies have all contributed to complicate the record in ways that make commonalities and disparities between the two regions difficult to decipher. However, access to new comprehensive datasets has provided encouragement to researchers trying to generate a better understanding of this critical time period in the African paleontological record. In this study, we examine the biogeographic history of three terrestrial mammalian families spanning the past 3 million years to test hypotheses related to faunal exchange. We used presence/absence data for 106 species from 44 genera within the family Bovidae and 34 species from 15 genera within the families Hyaenidae and Felidae from 48 East African and 40 southern African fossil localities. These assemblages were placed into 500,000-year time slices and compared at both the genus and species level using the Sørenson-Dice index of faunal similarity. Starting from the present and working back in time, our findings indicate that East and southern African bovid, hyaenid and felid species are most similar from 0 – 0.5 million years ago (Ma) and hyaenid and felid species are more similar than are bovid species between 0.5 – 3.0 Ma. At the level of genus, whereas East and southern African bovid assemblages are more similar than at the species level, indicating differential species representation between the two regions, the carnivoran taxa included in our analysis show consistently less disparity between species- and genus-level similarity indices. This suggests that levels of carnivoran exchange between East and southern Africa during this time period were higher than those for bovids. Within bovid taxa, the number of genera shared in East and southern African assemblages is highly correlated (r^2= .971) with the minimum number of species sampled, whereas in felids and hyaenids this is not the case (r^2= .292). The underlying biogeographic patterns highlighted in our analysis suggest that mammalian groups can have very different histories of exchange between East and southern Africa over the past 3 million years. However, before invoking ecological dynamics as the primary driver of these different patterns, it is paramount to consider the effects of sampling bias.

Technical Sesssion XII (Friday, November 1, 2013, 2:15 PM)

BONE HISTOLOGY IN NEW, EARLY SILESAURIDS (DINOSAURIFORMES) FROM ZAMBIA: IMPLICATIONS FOR THE ORIGIN OF DINOSAURIAN GROWTH PATTERNS

PEECOOK, Brandon, University of Washington, Seattle, WA, United States, 98195; HUTTENLOCKER, Adam K., University of Washington, Seattle, WA, United States; SIDOR, Christian, University of Washington, Seattle, WA, United States

Several early divergences within crown Archosauria are known to have occurred by the late Early Triassic, less than five million years after the end-Permian extinction (252 Ma). Recently, three genera of dinosauriforms, two silesaurids and possibly the oldest member of Dinosauria (*Nyasasaurus parringtoni*), have been described from the early Middle Triassic (Anisian) of Tanzania and Zambia as the oldest known avemetatarsalians, or bird-line archosaurs. In 2011, a bonebed was discovered in the upper Ntawere Formation of Zambia. It preserved cynodont material and at least nine silesaurids of the same size class (femur length ~150 mm). A giant silesaurid femur (~370 mm) was recovered from a nearby locality. Though not assignable to a previously known genus, the silesaurid specimens are numerous enough to permit destructive osteohistological study. Comparison to Late Triassic silesaurids and true dinosaurs permits evaluation of the early evolution of dinosauriform traits, such as the origins of rapid, dinosaur-like growth rates. In the Zambian silesaurids, the thin cortex is almost completely composed of parallel-fibered bone, though regions of fibrolamellar bone are present in areas of rapid growth, such as the fourth trochanter. This is in contrast to the predominantly fibrolamellar bone of *Nyasasaurus*, early dinosaurs, and possibly the Late Triassic silesaurid *Silesaurus opolensis*, though the latter shares the presence of small vascular canals with the Zambian specimens. Most vascular canals are primary osteons in the smaller specimens whereas in the giant femur primary osteons are restricted to the interior cortex and simple canals dominate the subperiosteal bone, indicating a reduced growth rate at larger size if all the femora belong to the same taxon. Vascular canal diameter generally decreases toward the periosteal margin and the canals are mostly longitudinal, although regions of subreticular to weak radial anastomoses are present and extend to the periosteal margin. *Nyasasaurus* and early dinosaurs are characterized by much higher levels of vascular connectivity. There are no traces of growth marks in any specimen. The Zambian specimens are important because they pertain to only the second non-dinosaurian dinosauriform sampled histologically and because they may represent a growth series from an Anisian-aged bird-line archosaur.

Technical Session XIV (Saturday, November 2, 2013, 8:15 AM)

EXCELLENTLY PRESERVED NEW SPECIMENS OF *ANCHIORNIS* AND THE IMPLICATION OF EARLY EVOLUTION IN PARAVES

PEI, Rui, American Museum of Natural History, New York, NY, United States, 10025; LI, Quanguo, China University of Geosciences, Beijing, China; MENG, Qingjin, Beijing Museum of Natural History, Beijing, China; NORELL, Mark A., American Museum of Natural History, New York, NY, United States; GAO, Ke-Qin, Peking Univ, Beijing, China

Anchiornis huxleyi is a primitive paravian dinosaur reported from the beds of Tiaojishan Formation, western Liaoning, China, at the age of the Middle Jurassic. It was regarded as a pre-*Archaeopteryx* coelurosaurian that is among the earliest members of Paraves. With extremely well preserved feathers, *Anchiornis* is also the first non-avian dinosaur whose plumage coloration is revealed. *Anchiornis* plays an important role in understanding the early evolution of Paraves and the origin of birds. However, the phylogenetic position of this taxon is hotly debated. Based on five new specimens, the current study of *Anchiornis* provides additional information on the morphology and phylogeny of this taxon. All new specimens are well preserved with complete and well-exposed skeletons, revealing new and detailed anatomical information on the skull and the postcranial skeleton. Although all new specimens can be referred to as *Anchiornis*, they show a small degree of variation in body sizes and some morphological traits such as the humerus/femur proportions, which result from intraspecific and ontogenetic variation. As one of the earliest members of the Paraves, *Anchiornis* exhibits many primitive characters observed in *Archaeopteryx*, basal troodontids and basal dromaeosaurids. Preliminary phylogenetic analyses were conducted with the most updated information on maniraptorans, especially deinonychosaurians, under both maximum parsimony and maximum likelihood criteria. *Anchiornis* is recovered to form a monophyletic group with *Xiaotingia* based on characters such as enlarged maxillary fenestrae, and this group is placed at the basalmost position of the monophyletic Troodontidae. *Anchiornis* possesses typical troodontid features such as a groove on the lateral surface of the dentary, but it lacks some traditional troodontid traits such as a large number of cheek teeth and the subarctometatarsalian/arctometatarsalian pes. The placement of *Anchiornis* into the Troodontidae indicates some avian-like features are present at the earliest stage of the deinonychosaurian evolution, and it gives opportunities to revise the early character evolution within the clade of Paraves.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE DIVERSITY OF SMALL MAMMALIAN TARSALS FROM CASTLE GARDENS, EARLIEST EOCENE OF WYOMING

PENKROT, Tonya, Arizona State University, Phoenix, AZ, United States, 85004-0696; ZACK, Shawn, , Phoenix, AZ, United States; STRAIT, Suzanne, Marshall University, Huntington, WV, United States

Castle Gardens is an exceptionally rich microvertebrate locality in the Willwood Formation, southern part of the Bighorn Basin, Wyoming (Wa-0 biochron). The mammalian fauna from Castle Gardens documents an earliest Eocene assemblage and includes both dental material, which constitutes the bulk of the material preserved at the locality, and a substantial amount of postcrania. Among the latter, proximal tarsals are the most abundant elements, with a total of 384 small tarsals (under 5 mm in length for astragali and 8 mm for calcanei) currently known, including 168 astragali and 216 calcanei, which can be sorted into at least ten and nine morphs, respectively. Most of these morphs can be reassociated with each other and with taxa represented by dental remains based on size and on comparisons to more confidently identified tarsals from other localities. Among non-eutherian taxa, one multituberculate is represented, as are two marsupials, based on astragalar morphology. Eutherians include one archontan, likely referable to *Niptomomys*, and several morphs that likely pertain to "insectivores", including *Macrocranion*, a large and a small nyctithere, and at least three very small tarsal morphs. Tarsals of *Macrocranion* are the most abundant in the Castle Gardens sample, matching the dental abundance of this taxon, and are virtually identical to *Macrocranion* tarsals from Dormaal. The two nyctithere tarsal morphs show minor but

consistent morphological differences, but both closely resemble tarsals of *Cryptotopos*. Finally, many of the very smallest elements show substantial water wear which makes clear delineation of morphotypes difficult, but at least three astragalar and calcaneal morphologies are present. These very small tarsal morphs likely include tarsals pertaining to the diminutive "insectivores" known dentally from Castle Gardens, *Batodonoides* and *Parapternodus*. The presence of at least one additional morph may indicate the presence of a taxon at Castle Gardens that is not yet documented dentally. All of the very small elements differ substantially from tarsals of *Macrocranion* and Nyctitheriidae, indicating that the taxa they represent are unlikely to be closely allied to these forms.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

USING MESOWEAR AND MICROWEAR TO INFER THE DIET OF *ASTRAPOTHERIUM* FROM THE LATE EARLY MIOCENE OF SANTA CRUZ, ARGENTINA

PEREZ, Nicole M., Case Western Reserve University, Cleveland, OH, United States, 44106; CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States; KELLOWAY, Tara L., Case Western Reserve University, Cleveland, OH, United States; PRYBYLA, Alix, Hawken School, Gates Mills, OH, United States; TOWNSEND, K.E. Beth, Midwestern University, Glendale, AZ, United States

Astrapotheres are an extinct group of ungulates that lived in South America from the Paleocene to at least the middle Miocene. Neogene astrapotheres, which are placed in the family Astrapotheriidae, are characterized by their large size (one to several tons), retracted nasal bones (suggestive of a proboscis), canine tusks, and low-crowned, lophodont cheek teeth. Based on craniodental and postcranial morphology, ecological habits of astrapotheres have generally been compared to living tapirs (Tapiridae), rhinos (Rhinocerotidae), elephants (Elephantidae), and/or hippos (*Hippopotamus*). The goal of this study was to use dental mesowear and low-magnification enamel microwear to infer astrapothere feeding ecology relative to these possible modern analogs. Our study was based on 38 specimens of *Astrapotherium* from the late early Miocene (Burdigalian Age) Santa Cruz Formation of southern Argentina (Santacrucian SALMA).

Dental mesowear and low-magnification stereomicrowear are two well-established, taxon-independent methods of paleodietary reconstruction that have been used by many investigators to assess diet in ungulates. Mesowear uses tooth cusp shape to gauge accumulated dietary abrasion (food-on-tooth wear) relative to attrition (tooth-on-tooth wear). We used a mesowear "ruler" based on modern ungulate teeth to score mesowear of astrapothere upper molars on a scale from 0 (high, sharp cusps) to 3 (flat, blunt cusps). Microwear reflects small scars left on tooth enamel by food. We scored astrapothere microwear on clear epoxy casts using low magnification (35x) on a Leica MZ 12.5 stereomicroscope with an ocular reticle that delineated a standard measuring area (0.4 x 0.4 mm). The microwear variables scored included numbers of pits, scratches, and gouges. The size and depth of pits were assessed qualitatively as was the texture of scratches (i.e., fine, coarse, hypercoarse).

Our results indicate that *Astrapotherium* was most likely a leaf browser. *Astrapotherium* microwear is characterized by intermediate pit densities and few or no gouges or puncture pits. Scratch densities are low and scratches are mainly of fine texture. The low mesowear scores observed in *Astrapotherium* (average <0.5) fall outside the range of modern grazers and fruit browsers but are near the middle of the distribution of modern leaf browsers. These findings suggest that a browsing rhinoceros such as *Diceroryhinus* may be the most appropriate modern analog for *Astrapotherium* in terms of diet and body size.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A MORPHOMETRIC CHARACTERIZATION OF CRANIAL SHAPE IN TERRESTRIAL CARNIVORANS BASED ON FOURIER ANALYSIS

PEREZ-CLAROS, Juan, University of Malaga, Malaga, Spain; MARTIN-SERRA, Alberto, Universidad de Malaga, Malaga, Spain; FIGUEIRIDO, Borja, University of Malaga, Malaga, Spain; JANIS, Christine, Brown Univ, Providence, RI, United States; PALMQVIST, Paul, University of Malaga, Malaga, Spain

A number of studies have shown that skull morphology reflects the ecological adaptations of terrestrial carnivores as well as their phylogenetic legacy. Here we use Fourier shape analysis for describing the dorsal outline of the cranium in a number of extant and extinct species in the order Carnivora. To evaluate to what extent the shapes of the outlines analyzed reflect phylogeny and/or adaptation, a principal components analysis was performed with the harmonic amplitudes of the Fourier analyses. Results obtained show that cranial morphology is highly constrained by the phylogenetic legacy of each carnivoran family, as those species belonging to the same family tend to be placed in the same region of the morphospace. However, a functional signal is also present. In particular, after controlling for size effects, there is a weak but significant correlation between an axis of morphological variation and the estimates of bite force at the level of the upper canine, while another independent axis is related to bite force measurements at the carnassial. The wide distribution of canids in the empirical morphospace reflects their ecological disparity, while the restricted dispersal on the plot of saber-tooth predators probably results from biomechanical constraints posed by their highly specialized, hypertrophied upper canines. Moreover, there is a general allometric trend for all carnivoran families, which is associated with the lateral expansion of the zygomatic arches, and two different allometric trends exclusive to canids and felids, respectively, which are linked to snout length. Our results show that phylogeny constrains to a large extent the morphological adaptive zone which carnivoran species can inhabit.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW DATA ON THE PHYLOGENETIC POSITION AND EVOLUTION OF DORTOKIDAE, THE ONLY PAN-PLEURODIRAN CLADE OF TURTLES RECOGNIZED IN THE EARLY CRETACEOUS OF EUROPE

PÉREZ-GARCÍA, Adán, Universidad Complutense de Madrid, Madrid, Spain; ORTEGA, Francisco, UNED, Madrid, Spain; GASULLA, José Miguel, Universidad Autónoma de Madrid, Madrid, Spain

Pan-pleurodiran turtles are poorly represented in the European pre-Santonian record. *Proterochersis robusta*, from the Late Triassic of Germany, is considered by several authors to be a representative of that lineage, while others identify it as a member of Testudinata outside crown-group Testudines. Platychelyidae is represented in the European record by the shell taxon *Platychelys oberndorferi* from the Late Jurassic of Germany and Switzerland. At the end of the Mesozoic, two pan-pleurodiran groups coexisted in Europe: Pelomedusoides and Dortokidae. Pelomedusoides was a lineage of Gondwanic origin very abundant and diverse during the Campanian and Maastrichtian of Europe. Dortokidae was an endemic European group. The systematic position of Dortokidae is currently in discussion, having being identified as the sister taxon of Eupleurodira (Chelidae + Pelomedusoides) or as the sister taxon of Pelomedusoides.

Dortokidae are relatively abundant in Campano-Maastrichtian sites of southwestern Europe, where the type species, *Dortoka vasconica*, was described. Dortokidae are also represented in the Maastrichtian of Romania, where "*Muehlbachia nopcsai*" was defined; and in the late Paleocene of that country, represented by *Ronella botanica*. The presence of this group has been reported in the Santonian of Hungary and the Campanian of Austria. Despite that Late Cretaceous record, Dortokidae were preliminarily indentified, based on scarce and fragmentary plates, from the Barremian of Spain (Vallipón, Teruel, Castellote Sub-basin, Maestrazgo Basin, Iberian Range).

New material of turtles from the early Aptian of Spain (Arcillas de Morella Formation), from Morella (Castellón, Morella Sub-basin, Maestrazgo Basin), is presented. That formation is well-known due to the high diversity of vertebrates, corresponding to terrestrial, freshwater and marine taxa. Several turtle taxa have been hitherto identified there, corresponding to a member of Solemydidae (stem Testudines) closely related to the British *Helochelydra nopcsai*, the xinjiangchelyid *Brodiechelys royoi* (stem Cryptodira) and, at least, an indeterminate member of the crown Cryptodira. The new specimens share many of the synapomorphies of Dortokidae, allowing their assignment to that clade, and also present a unique combination of characters that will be further analyzed. Therefore, this finding allows confirming the presence of Pan-Pleurodira in the Early Cretaceous, and shed light on the early evolution of Dortokidae.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

RECONSTRUCTIONS OF THE CHEWING MUSCLES IN EUROPEAN ADAPIDS AND SUBFOSSIL LEMURS

PERRY, Jonathan, The Johns Hopkins University School of Medicine, Baltimore, MD, United States, 21205; MACNEILL, Kristen, Pennsylvania State University, University Park, PA, United States; HECKLER, Amanda, Pennsylvania State University, University Park, PA, United States; HARTSTONE-ROSE, Adam, University of South Carolina School of Medicine, Columbia, SC, United States

Osteological correlates of chewing muscle size in extant strepsirrhines provide an opportunity for reconstructing chewing muscle size in extinct primates. The most reliable osteological correlates are those that most accurately represent muscle attachment areas. Here we reconstruct physiological cross-sectional area (PCSA) of temporalis, masseter, and medial pterygoid muscles from their attachment areas – measured from the skulls of subfossil lemurs of Madagascar and European adapids. We use regressions of attachment area against muscle PCSA from dissections of extant lemurs to obtain these reconstructed values for the extinct taxa. PCSA is of value as a correlate of maximum potential muscle force. Some members of each of the two extinct groups likely possessed very great chewing muscle PCSA relative to skull size. Overall chewing muscle PCSA is great for both extinct groups compared to extant strepsirrhines. Relative temporalis PCSA is especially great only in European adapids, not in subfossil lemurs. Relative masseter and medial pterygoid PCSA are especially great in both extinct groups, but more so in subfossil lemurs. Increase in PCSA of masseter and medial pterygoid in subfossil lemurs follows a trend seen in folivorous extant strepsirrhines: these muscles are emphasized in folivores relative to the temporalis. Gape might explain patterns in division of labor among the chewing muscles. The masseter and medial pterygoid are less susceptible to loss of leverage at gape than is temporalis, but they are also more vulnerable to stretch. It is more likely that the increasing emphasis on masseter and medial pterygoid in folivorous strepsirrhines (extant and extinct) is related to the need for powerful horizontal mastication. These data are used to create estimates of bite force at different gape angles. Such estimates are useful for incorporating food properties into dietary inferences.

Technical Session IX (Friday, November 1, 2013, 10:45 AM)

NEW DIRECT AND MORPHOLOGICALLY-INFERRED EVIDENCE OF PISCIVORY IN *MICRORAPTOR*

PERSONS, Walter, University of Alberta, Edmonton, AB, Canada, T5B 4VP; XING, Lida, China University of Geosciences, Beijing, China; BELL, Phil, Pipestone Creek Dinosaur Initiative, Clairmont, AB, Canada; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada; MIYASHITA, Tetsuto, University of Alberta, Edmonton, AB, Canada

Since its original description, the four-winged dromaeosaur *Microraptor* has remained central to debates over the phylogenetic origins of modern Aves and the functional origins of avian flight. As such, the life habits of *Microraptor* have enticed much speculation, and this speculation has been frequently used to support broader theories. A new, fully articulated and nearly complete specimen of *Microraptor gui*

provides direct evidence that the feeding ecology of *Microraptor* differed from all previous interpretations. In addition to well preserved keratinous sheathes covering the manual and pedal unguals and traces of long contour feathers originating from the forelimbs, hind limbs, and tail, the new specimen includes gut contents. The gut contents consist almost entirely of teleost fish remains. *Microraptor* is characterized by an absence of anterior tooth serrations, and reexamination of the dentition of *Microraptor* shows that the first three teeth in the dentary are strongly procumbent. Reduced tooth serrations and procumbent dentition are both traits common to many piscivores. Combined with previous discoveries, this new evidence makes the diet of *Microraptor* the best sampled of any non-avian dinosaur. *Microraptor* appears to have been capable of successfully hunting the most common prey throughout the micro-habitats of the Jehol ecosystem and was not limited to arboreal predation. Additionally, the new specimen is the largest *M. gui* yet recorded, equaling the type specimen of the taxonomically controversial species "*M. hanqingi*" in femoral length. The new specimen thereby simultaneously demonstrates that "larger" size is non-diagnostic of "*M. hanqingi*" and rules out allometry as an explanation for the differences observed between the pelvises of "*M. hanqingi*" and *M. gui*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW CT-BASED ANALYTICAL APPROACH FOR EXPLORING TAPHONOMIC BIASES IN TERRESTRIAL VERTEBRATE ASSEMBLAGES

PETERMANN, Holger, Yale University, New Haven, CT, United States, 06511; FIELD, Daniel, Yale University, New Haven, CT, United States

Both extrinsic and intrinsic factors influence an animal's remains prior to fossilization. The application of quantitative, non-invasive methodologies such as CT scanning may be able to shed light on the influence of intrinsic mechanical controls on bone fossilization potential. Here, we investigated bone stiffness and its influence on preservation potential using a new CT-based analytical method, and a robust dataset of terrestrial squamate taphocoenoses. We quantified bone density, cross-sectional area, and rigidity non-invasively from CT data using a new analytical method, and correlated these parameters with a recently compiled dataset quantifying the frequency of recovery of squamate skeletal elements from a variety of terrestrial localities. This method enables discrimination amongst bone material properties (such as Young's Modulus), and geometrical factors (a bone's second moment of area) as primary controls on fossil preservation. This study has broad potential to shed light on the genesis of taphonomic biases in the fossil record of terrestrial vertebrates, and establishes a novel, non-invasive approach to the study of vertebrate taphonomy.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A FLIGHTLESS PTEROSAUR

PETERS, David, David Peters Studio, St Charles, MO, United States, 63303

Jura Museum Solnhofen Sammlung (SoS) 2428 is a largely complete, crushed, Solnhofen pterosaur. It was previously considered another specimen of *Ardeadactylus* (formerly *Pterodactylus*) *longicollum*, neotype: Staatliches Museum für Naturkunde, Stuttgart (SMNS) 56603. However, a closer look reveals important differences. The skull is longer than the cervical series in SoS 2428, but not in *Ardeadactylus*. The slender cervical ribs are each a centrum length in SoS 2428, but they are much shorter in *Ardeadactylus*. The parasagittally compressed dorsal vertebrae comprise only 40% of the torso length in SoS 2428, but 66% in the more typical pterosaur, *Ardeadactylus*. Conversely, in SoS 2428 the robust sacral series extends for 60% of the torso, 34% in *Ardeadactylus*. In SoS 2428 the dorsal ribs, sternal ribs and gastralia are relatively twice the lengths of those found in *Ardeadactylus*. The pectoral girdle is gracile in SoS 2428, with a scapula and a coracoid half the width of those same elements in *Ardeadactylus*. The forelimb (wing) elements are likewise less than half the length and width of those in *Ardeadactylus*. The wing finger (manual digit 4) is further reduced relative to the rest of the wing. When folded, the unreduced first wing phalanx extends back to the carpus. However, the second wing phalanx is half that length. The third phalanx is half the second and the fourth is less than half the third. Thus, when folded, the distal tip of the reduced wing finger extends just to the elbow. By comparison, in *Ardeadactylus* the elbow meets the middle of the second wing phalanx and the two distal phalanges nearly double that length. In SoS 2428, the free fingers, digits 1-3, are not reduced. Matching the elongated sacrum in SoS 2428, the hyperelongated ilium extends for 60% of the torso length. However, the much smaller pubis, prepubis, ischium and femur are similar in size to those same elements in *Ardeadactylus*. In SoS 2428 the distal tibia and pes are not preserved. When reconstructed, SoS 2428 has a relatively longer and wider torso than any other known pterosaur. It also has a reduced wing, half the length and half the chord of the wing of *Ardeadactylus* when scaled to the same torso length. Such a reduced wing and enlarged torso make the prospect of flight rather doubtful by comparison. Moreover, with such morphological differences, SoS 2428 is clearly a distinct genus.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

CHRONOCLINAL BODY SIZE INCREASE OF THE EXTINCT GIANT SHARK MEGALODON (*CARCHARCOLES MEGALODON*)

PIMIENTO, Catalina, Florida Museum of Natural History, Gainesville, FL, United States, 32611; BALK, Meghan, Univ of New Mexico, Albuquerque, NM, United States

Body size influences nearly every aspect of the biology of any organism, from their ecology to their evolution. One of the most prevalent patterns of body size is the tendency in many evolutionary lineages to become larger through time (i.e. Cope's Rule). Paradoxically, larger sizes can confer both ecological benefits and extinction susceptibility. Although Cope's Rule works at a macroevolutionary scale, microevolutionary trends in body size can help to better understand the causes and consequences of larger sizes. The extinct shark *Carcharocles megalodon* (Megalodon) is one of the largest marine top predators to have ever existed. Fossil evidence suggests that it lived from 16 to two million years ago, could reach up to 18 meters in length, and had a global distribution. Even though its maximum size is often reported, little is known about its body size trends through time. A previous qualitative study suggested a static tooth size over time in *C. megalodon*. Although tooth size has been considered a reasonable proxy for body size, this hypothesis was based on a limited sample size and likely missed subtle evolutionary changes that can only be detected using quantitative analyses. In this study, we rigorously assess changes in *C. megalodon* body size over time. Accordingly, we developed a series of tooth measurements of various museum collections encompassing a wide temporal and geographic range. In contrast to previous studies, we estimated the total length of each specimen, conducted high-resolution statistical analyses, and found an increase in size through time. This chronoclinal size pattern could have resulted in a number of ecological adaptations that are associated with higher fitness (e.g. defense against predation, predatory and mating success, resistance to climatic variations, greater range of acceptable foods, extended longevity, etc.). Nevertheless, in the long term, the ultimate gigantic size of *C. megalodon* could have resulted in a corresponding number of issues (e.g. increased development time, greater requirement for food, longer generation time, lower fecundity, etc.), making the species more susceptible to extinction. The eventual extinction of *C. megalodon* could have created new opportunities for other top marine predators to evolve, like the modern lamnids. Our results advance the understanding of the evolution of *C. megalodon* and can potentially explain macroevolutionary trends in the *Carcharocles* clade.

Technical Session II (Wednesday, October 30, 2013, 10:45 AM)

WHICH TOOTH BEST REPRESENTS WHOLE TOOTH ROW DENTAL COMPLEXITY IN MAMMALS?

PINEDA MUNOZ, Silvia, Macquarie University, Sydney, Australia; EVANS, Alistair, Monash University, Melbourne, Australia

Dental complexity analysis is a homology-free ecometric to infer the ecology and dietary specializations of extinct species. Most often, whole molar tooth rows are used to infer diet. However, well-preserved and complete tooth rows are rare in the fossil record, which makes performing morpho-functional analysis difficult. Thus, we investigated whether and which isolated teeth can be used as a proxy for the whole tooth row.

We used 3-D scans of upper and lower postcanine tooth rows of extant mammalian species, including Rodentia, Carnivora, Diprotodontia, Artiodactyla, and Primates, to measure the complexity of the whole tooth row and of each individual tooth using Orientation Patch Count (OPC). Simple regressions were used to investigate the correlations between single teeth and the overall complexity of the occlusal tooth row. Our results showed that lower and upper M2s have the highest correlation with general tooth row morphology (r2=0.817 and 0.678 respectively) for the dataset of all mammalian orders. More detailed analysis showed inter-order differences. For instance, rodent lower m1s display a similar correlation to lower m2s. In addition, carnivorans show strong intra-order variability due to differential tooth loss within the group. Thus, lower m2s are the most useful when present, as they display a strong correlation with overall molar complexity (r2=0.949); otherwise lower m1s are still highly correlated (r2=0.790). This study justifies the use of isolated molars for dietary reconstruction from dental complexity and indicates which molars are most informative.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE EVOLUTION OF TAIL JOINT STIFFNESS IN OVIRAPTOROSAUR DINOSAURS AND ITS CONSEQUENCES FOR TAIL FUNCTION

PITTMAN, Michael, The University of Hong Kong, Pokfulam, Hong Kong (CN); HUTCHINSON, John R., The Royal Veterinary College, Hatfield, United Kingdom

Oviraptorosaurs preserve distal tail fronds that are sometimes articulated with a fused pygostyle-like structure. This similarity with birds has led to speculation that they used their tails for display purposes, as in peacocks. The prezygapophyseal morphology and craniocaudally short centra of oviraptorosaur tails indicate a high degree of flexibility per unit of absolute tail length. Their prezygapophyses permitted a large range of motion per joint, which increased tail mobility because the craniocaudally shorter centra allowed the tail to accommodate more joints per unit length. The large muscle volumes reconstructed for oviraptorosaur tails presumably helped to actively stiffen or move them. We predict high passive joint stiffness in their tails because their great depth and breadth created longer moment arms for tissue to leverage its resistance against dorsally/ventrally or laterally directed joint rotation respectively. Shorter tails that evolved via craniocaudally shorter centra also lead to the same prediction because centrum length affects the length of muscle spanning the vertebrae, which inversely correlates with joint stiffness. But how did joint stiffness evolve and affect tail function?

From four taxa, we reconstructed the size-normalized changes in vertebral morphology between the unnamed node between Oviraptorosauria and Paraves (node A) and the oviraptorid node, and used this to reconstruct changes in passive joint stiffness. Increased dorsoventral height of the hypothetical vertebrae between node A and the oviraptorid node supports an increase in dorsoventral joint stiffness, although the latter decreased according to trends in centrum height and chevron depth. Between these nodes, lateral joint stiffness increased, as is evident from increased transverse length and vertebral width and decreased centrum length. Both joint stiffness trends coincide with tail shortening and reduced caudal count between node A and the oviraptorosaurian node, and increased caudal count between the latter and the oviraptorid node. These results show that oviraptorosaur tails were mechanically appropriate for holding themselves up, particularly as they were heavier compared to paravians despite being shorter. The lower caudal count in oviraptorosaurs compared to node A indicates a greater range of motion per joint in the former, if tail mobility was constant. Thus, increased dorsoventral and lateral joint stiffness may have helped them produce the range of muscular force vectors needed for complex tail display or behavior.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE FIRST THEROPOD TRACKWAYS FROM THE LOWER CRETACEOUS (ALBIAN) DE QUEEN FORMATION, SOUTHWEST ARKANSAS

PLATT, Brian, University of Mississippi, University, MS, United States, 38677; SHELL, Ryan, University of Arkansas, Benton, AR, United States; SUAREZ, Celina, University of Arkansas, Fayetteville, AR, United States; BOSS, Steve, University of Arkansas, Fayetteville, AR, United States; WILLIAMSON, Malcolm, University of Arkansas, Fayetteville, AR, United States

In June 2011, industrial excavations at a gypsum mine in Howard County, Arkansas, exposed a 4,200 m^2 dinosaur track-bearing bedding plane in a marly limestone bed in the De Queen Formation. A rapid salvage recovery of data from the site took place over a two-week period. These efforts revealed a variety of tracks and trackways, including the first known tridactyl trackways in Arkansas. At least two morphotypes of tridactyl tracks were present, as well as multiple sauropod trackways and associated dinoturbation. Recovery of data from the site included field mapping and measurements, plaster casts, and wide-field, ground-based LIDAR scanning (Z+F 5006i and Leica C10 laser scanners) of the entire track site. Eight tridactyl trackways, at least eleven sauropod trackways, and a large area of dinoturbation were preserved digitally and used to produce a shaded relief map of the site, from which additional data were extracted. Most tridactyl tracks are attributable to theropods and range between 36-61 cm in length and 22-54 cm in width. Length-width measurements taken from plaster casts from six theropod trackways fall along a linear growth trend when length is plotted versus width, suggesting they are tracks of various sized animals of the same species. The same measurements are compared to *Eubrontes* tracks attributed to *Acrocanthosaurus atokensis* from the Glen Rose Formation of Texas and the linear trend of the two are not statistically different, suggesting the Arkansas track-maker is likely *Acrocanthosaurus*. Two of the sauropod trackways are sinuous and closely parallel to each other for over 50 m, suggesting the two individuals were traveling as a pair. Rose diagrams of the trackways indicate a mean sauropod trackway orientation of 326.2° (northwest) and a mean theropod trackway orientation of 166.0° (southeast). Preliminary geochemical analyses of bulk organic carbon of sediment below, in, and above the site will help constrain the age of the bed via carbon isotope chemostratigraphy and petrographic and stable isotopic analysis will provide the isotopic composition of paleoprecipitation during the formation of the trackway.

Technical Session XVIII (Saturday, November 2, 2013, 1:45 PM)

BIOGEOGRAPHIC DISTRIBUTION PATTERNS OF TETRAPODS DURING THE JURASSIC: NEW INFORMATION FROM THE CAÑADÓN ASFALTO BASIN, PATAGONIA, ARGENTINA

POL, Diego, CONICET, MEF, Trelew, Argentina; CARBALLIDO, Jose Luis, CONICET, MEF, Trelew, Argentina; RAUHUT, Oliver, Bayerische Staatssammlung fur Palaontologie und Geologie, Munchen, Germany; ROUGIER, Guillermo, Univ of Louisville, Louisville, KY, United States; STERLI, Juliana, CONICET, MEF, Trelew, Argentina

The Jurassic vertebrate fauna of the Cañadón Asfalto Basin is one of the most diverse in the world, in particular due to the highly fossiliferous Cañadón Asfalto Formation (late Early – early Middle Jurassic). Described taxa from this unit include members of different clades of sauropod and theropod dinosaurs, heterodontosaurid ornithischians, sphenodontians, turtles, crocodylomorphs, and mammals. Recent studies on the phylogenetic affinities of these taxa have shed light on the evolutionary affinities of the taxa recorded in the Cañadón Asfalto Basin, allowing the evaluation of the biogeographic signal through quantitative methods. Several studies have suggested the existence of groups endemic to the southern hemisphere during the Jurassic whereas others have postulated a pangeic distribution as the null hypothesis for the distribution of tetrapods during this period. Here we present a series of quantitative analyses applying Dispersal Extinction Cladogenesis (DEC) in the software packages DIVA and VIP on phylogenetic hypotheses of all the above-mentioned groups in which fifteen taxa of the Cañadón Asfalto Basin (some of which have been recently published) have been included. The analyses indicate that eight eleven of the fifteen lineages recorded in the Cañadón Asfalto Basin belong to clades in which the ancestral reconstruction is restricted to the southern hemisphere, indicating the existence of a marked provincialism of these groups of vertebrates during Pangean times. Four of the taxa recorded in the Cañadón Asfalto Basin belong to lineages that, in contrast, have a non-gondwanan ancestral distribution. These results indicate the new records from the Jurassic of Patagonia are showing a previously undetected and regionalization of the distribution of continental vertebrates at least since the late Early Jurassic, before the effective separation of the northern and southern land masses. The common biogeographic pattern detected from this study suggests therefore the existence of biogeographic barriers that determined the distribution of continental vertebrates in Pangea during the Jurassic. These barriers likely were environmental or climatic, such as the postulated existence of the Central Gondwanan Desert.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

MORPHOLOGICAL ADAPTATION, RANGE SHIFTS, OR EXTINCTION? MODELING OF MORPHOLOGICAL RESPONSES OF SPECIES AND COMMUNITIES TO ENVIRONMENTAL CHANGE IN A GEOGRAPHICALLY AND TEMPORALLY EXPLICIT CONTEXT

POLLY, P. David, Indiana University, Bloomington, IN, United States, 47405; SCHNITZLER, Jan, Senckenberg Research Institute und Nature Museum, Frankfurt am Main, Germany; LAWING, A. Michelle, University of Tennessee, Knoxville, TN, United States; ERONEN, Jussi T., University of Helsinki, Helsinki, Finland

Organisms can respond to changes in climate and environment that exceed their tolerance limits in three ways. They can adapt to the change through natural selection and environmental plasticity, they can shift their geographic range to track their climatic or environmental optimum, or they can become extinct. While the third response is mutually exclusive, the first two are not. Factors governing evolutionary response include evolvability of the relevant traits and the rate at which the trait can evolve. Factors governing geographic response include the topography of physical barriers, ecological interactions with other species, and rate of migration. One of the strengths of the fossil record is that it can be used to document the past responses of vertebrates to changes in environments at many scales. However, the coarseness of temporal, geographic, and taxonomic sampling in the fossil record makes it difficult to compare these valuable empirical data to the responses observed in the modern world over ecological timescales.

We developed a geographically and temporally explicit model to study responses of vertebrates to changing environments. Our model focuses on ecometric traits, which are morphological features that have a direct functional relationship to the environment. Species and communities are geographically sorted based on such traits and these traits respond directly to environmental selection. Our model simulates local populations of an evolving species whose traits influence whether they can disperse into adjacent regions, whose traits respond to selection when they move into a new region with a different environment or when the environment changes, and whose geographic variance is governed by gene flow across the species meta population. We modeled locomotor traits in mammals that are related to habitat openness using the geography, climate, and vegetation cover of modern North America. When migration rates are high and evolvability is low, then species respond primarily by tracking the environment. When evolvability is high and migration rates are low, then species respond primarily by adapting to the changing environment.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

IS *OMNIVOROPTERYX SINOUSAORUM* A SAPEORNITHID BIRD?

POMEROY, Diana, Dinosaur Institute-Natural History Museum of Los Angeles County/CSU Long Beach, Los Angeles, CA, United States, 90007

The Early Cretaceous taxon *Omnivoropteryx sinousaorum*, from the Jehol Group in Liaoning Province (China), was named and described as a large bird with cranial morphology similar to the contemporaneous basal oviraptorid *Caudipteryx zoui*, and similar postcranial morphology to the contemporaneous basal pygostylian bird *Sapeornis chaoyangensis*. Despite these similarities, the validity and relationships of *O. sinousaorum* have remained a source of contention. I present the results of a quantitative and qualitative analysis comparing the holotype of *Omnivoropteryx sinousaorum* to fourteen sapeornithid specimens, including the holotypes of *Sapeornis chaoyangensis* and all of its junior synonyms—*Sapeornis angustis*, *Didactylornis jii*, and *Shenshiornis primita*. I obtained a series of regression lines and conducted a principal components analysis comparing limb elements in the statistical program Paleontological Statistics (PAST). I also performed a thorough re-examination of the characters used to diagnose *O. sinousaorum* as well as the junior synonyms of *S. chaoyangensis*. The compared limb elements of all species show a strong correlation, with the majority of the specimens fitting the regression lines. PC1, which represents the relative sizes of the limb elements, explains most of the variance, defining 92.2% of the variation in the sample. The re-examination of the diagnosis of *Omnivoropteryx sinousaorum*, in comparison to the other sapeornithids, reveals a diagnosis reliant upon characters influenced by taphonomic biases and/or ontogenetic variation. The regression models, in addition to the PCA, strongly indicate that the observed differences in size among the sapeornithids and *O. sinousaorum* are better interpreted as ontogenetic variation within a single growth series. Based on these observations, I argue that *Omnivoropteryx sinousaorum* is a junior synonym of *Sapeornis chaoyangensis*.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

FINITE ELEMENT ANALYSIS OF THE CARPUS OF *CAMPTOSAURUS* AND THE EVOLUTION OF CARPAL FUSION IN ANKYLOPOLLEXIA

POOLE, Karen, George Washington University, Washington, DC, United States, 20052

*The degree of fusion in the carpal elements of iguanodontian dinosaurs varies from separate elements in taxa such as *Tenontosaurus* and *Dryosaurus* to complete fusion of all carpal elements and the first metacarpal in *Barilium*. The genus *Camptosaurus* has an intermediate level of fusion in which the radiale is fused to the first and second distal carpals and the first metacarpal, and the intermedium fuses to the third distal carpal. This study aims to test two alternative hypotheses: that fusion of the carpals reduces strain when a force is applied along the axis of the limb, or that fusion of the carpals reduces strain when a force is applied along the axis of the first digit. That is, does this fusion have a functional purpose either for bearing weight or for supporting the first digit and its conical ungual?

To test this, two specimens of *Camptosaurus dispar* (US National Museum specimens USNM 5473 and USNM 4277) were CT scanned at the George Washington University Hospital's Imaging Center. The software Mimics was used to create three-dimensional meshes of each element, which were then exported to PreView where

boundary conditions and material properties were assigned. Analyses were carried out in the program FEBio. When a load was oriented along the axis of the limb, strain was present in the radiale, intermedium, and ulnare, but did not affect the first metacarpal. When a load was placed normal to the distal surface of the first metacarpal, very little strain was transferred to the radiale, but there was a sharp line of increased strain along the suture between the first metacarpal and the radiale. This indicates that the fusion of these elements may have occurred in response to high amounts of strain along this joint, thus supporting the digital, rather than the weight-bearing, hypothesis.

C. dispar has previously been described as having varying degrees of carpal fusion across individuals, as seen in the specimens USNM 5473 and USNM 4277. However, CT scans of these specimens show that the radiale and the intermedium of USNM 4277 are not fused as previously thought. Thus, the pattern of fusion is actually the same in these individuals. While more specimens of *Camptosaurus* carpi will be CT scanned for confirmation, carpal fusion in this taxon may have less individual variation than previously thought. This also shows an interesting pattern to the progression of carpal fusion in ankylopollexians starting from the medial side and progressing laterally in more derived taxa such as *Iguanodon* and *Barilium*.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PALEOBIOGEOGRAPHIC IMPLICATIONS OF AUSTRALIA'S CRETACEOUS SAUROPODS

POROPAT, Stephen, Uppsala University, Uppsala, Sweden; HOCKNULL, Scott, Queensland Museum, Brisbane, Australia; KEAR, Benjamin, Uppsala University, Uppsala, Sweden; ELLIOTT, David, Australian Age of Dinosaurs Natural History Museum, Winton, Australia

The middle Cretaceous sediments of central Queensland (northwestern Australia), deposited during and after the retreat of the Eromanga Sea, have yielded abundant sauropod remains. A basal titanosauriform from the upper Albian Toolebuc Formation near Richmond is similar to, but distinct from, *Wintonotitan wattsi*. The first named Cretaceous Australian sauropod, *Austrosaurus mckillopi* from the upper Albian Allaru Mudstone, also appears to represent a non-titanosaurian titanosauriform. Revisions of *Wintonotitan wattsi* and *Diamantinasaurus matildae*, both of which were derived from the overlying Winton Formation (uppermost Albian–Cenomanian / Cenomanian–Turonian), have shown that derived lithostrotian titanosaurs were present alongside more primitive somphospondylans by the early Late Cretaceous. That *Diamantinasaurus* shares close ties with the similarly-aged *Malawisaurus* and *Tapuiasaurus* suggests a Gondwanan origin for Lithostrotia during the Early Cretaceous, followed by a radiation into Australia in the earliest Late Cretaceous. A new titanosauriform taxon, the third from the Winton Formation, highlights the high diversity of sauropods in middle Cretaceous northeastern Australia, whilst a braincase from another site represents the first non-dental sauropod cranial material known from Australia.

Evidence of Australian Cretaceous sauropods is also preserved in the Broome Sandstone of Western Australia, and the Griman Creek Formation of southern Queensland and northern New South Wales, both of which were deposited in relatively high-latitude settings (50-60°S). However, the Eumerella and Wonthaggi Formations of coastal Victoria (southeastern Australia), which were deposited in even higher latitude settings (70-80°S), have not yielded any sauropod material to date, despite decades of collection and the recovery of vertebrate fossils from several sites. Southeastern Australia, which maintained a connection to Antarctica throughout the Cretaceous, has been interpreted to have been persistently cool and subjected to long, dark winters during the Aptian–Albian. This may have acted as a climatic barrier preventing lithostrotian titanosaurs, which first appear in the Early Cretaceous of South America and Africa, from reaching Australia through Antarctica. Only after the retreat of the Eromanga Sea, and the establishment of warmer conditions at the South Pole, were lithostrotians able to disperse into Australia, via Antarctica, from South America.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

COMPUTED TOMOGRAPHY, DIGITAL PREPARATION AND THREE-DIMENSIONAL RECONSTRUCTION OF THE EARLY TETRAPOD LOWER JAW

PORRO, Laura, University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom; CLACK, Jennifer, University of Cambridge, Cambridge, United Kingdom

The invasion of the land by vertebrates is one of the great transitions in the history of life, necessitating dramatic changes in skeletal morphology. Of particular interest is an explosive radiation during the Carboniferous in which tetrapods evolved into diverse forms that colonized and exploited terrestrial niches. Our study focuses on the morphological and mechanical evolution of the tetrapod lower jaw, which features an orderly and gradual series of shape changes across the fish-tetrapod transition. The skulls of eight early tetrapod genera were CT scanned; our study incorporates taxa from the Late Devonian to Early Triassic with most specimens dating from the Carboniferous. CT data was segmented using 3D visualization software to digitally separate bone from matrix and the individual bones of the skull from each other, revealing new anatomical details that were previously obscured. The medial aspect and symphyseal region of the lower jaw - including the extent and number of splenial and coronoid bones, and the presence or absence of a parasymphyseal – are visualized and described in *Eusthenopteron*, *Acanthostega*, *Crassigyrinus*, and *Eoherpeton*. CT data clarifies the position and extent of the bones of the anterior palate in *Greererpeton* and *Eoherpeton*, as well as their relationship to the choanae. The hyolingual apparatus of *Eusthenopteron* was revealed *in situ* within the articulated skull, and the braincase anatomy of several taxa was visualized. Damage to specimens was digitally repaired, missing elements duplicated across the sagittal midline, and bones from multiple specimens scaled appropriately; bones were then articulated to create a series of 'retrodeformed' computer models, many of which represent the first 3D reconstruction of several early tetrapod skulls. Finite element analysis will be applied to these models in order to understand the functional and ecological implications of shape changes in the lower jaw during the early evolution of tetrapods.

Technical Session VII (Thursday, October 31, 2013, 1:45 PM)

EVIDENCE FOR SITES OF PHYSIOLOGICAL HEAT EXCHANGE IN THE HEADS OF DINOSAURS

PORTER, William, Ohio University, Athens, OH, United States, 45701; WITMER, Lawrence, Ohio University, Athens, OH, United States

Dinosaurs likely used the same three sites of thermal exchange (oral, nasal, and orbital regions) for thermoregulation as do their extant outgroups. Extant taxa share basic vascular patterns with known roles in thermoregulation, but different clades emphasize different regions based on differing thermoregulatory strategies. We tested the hypothesis that dinosaurs used these same three sites for thermoregulation based on osteological correlates (OCs) for enhanced vascularity. Direct observation and CT scanning allowed dinosaur vascular anatomy to be reconstructed in Avizo and restored in Maya for *Stegosaurus, Euoplocephalus, Triceratops, Stegoceras, Hypsilophodon, Edmontosaurus, Maiasaura, Hypacrosaurus, Plateosaurus, Diplodocus, Camarasaurus, Majungasaurus*, and *Tyrannosaurus*. Small-bodied dinosaurs were compared with larger-bodied members of the same clade to assess the evolution of vascular networks associated with apomorphically enhanced heat-exchange regions. Dinosaurs with enlarged nasal regions show an emphasis on the blood vessels supplying them, as found in large-bodied ankylosaurs, sauropods, hadrosaurs, and ceratopsids. For example, the large subnarial foramen in sauropods indicates that the large oral and nasal regions were highly vascularized and likely sites of heat exchange. Smaller-bodied dinosaurs with plesiomorphically modest oral and nasal regions displayed conservative vascular patterns. The observed phylogenetic patterns are consistent with the hypothesis that larger-bodied forms, given their low surface-to-volume ratios, evolved anatomically expanded regions involved with evaporative cooling, mediated by enhanced blood flow. Smaller dinosaurs, given both their higher surface-to-volume ratios and better capacity to thermoregulate behaviorally, had less selective pressure to evolve elaborate heat-exchange structures. The interpretation of thermoregulatory strategy in large theropods is more complex. Theropods have relatively small nostrils and short nasal airways, but may have deployed the paranasal sinus system as another site of heat exchange by ventilating the sinuses similar to modern birds. Vascular evidence found within the antorbital fossa may offer some evidence for this hypothesis. Evidence for conserved vascular patterns allowed the interpretation of dinosaur vascular networks, giving us clues to thermal strategies and a broader understanding of dinosaur physiology.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

WERE HOMININ LIVING SITES FOR THE BIRDS? USING AVIFAUNA TO INTERPRET PLIOCENE HOMININ LAND USE AT OLDUVAI GORGE, TANZANIA

PRASSACK, Kari, Hagerman Fossil Beds NM, Hagerman, ID, United States, 83332

Concentrations of stone tools and associated butchered large mammal bones at Olduvai Gorge, Tanzania, provide evidence of Pliocene hominin activities. Once interpreted as living sites, subsequent studies have questioned hominin involvement as the primary bone collecting and modifying agents and suggest that these sites were unsuitable for prolonged hominin activity.

Subsistence activities and site utilization should vary with resource availability and predation risk. Such factors are dependent on landscape heterogeneity and construct. Here, data from Bed I and Lowermost Bed II (1.88-1.72Ma) avifaunal communities help to refine environmental reconstructions of the DK-3 (Lower Bed I), FLK-22 and FLKNN-1 (Middle Bed I), and HWKE-1 (Lowermost Bed II) living sites, and their associated landscapes, to better facilitate model testing and interpretation of hominin activities at Olduvai. Data come from Leakey and Olduvai Landscape Paleoanthropology Project (OLAPP) avifauna and from OLAPP's ongoing research.

Changes in the avifaunal communities at Olduvai reflect a shift from wetland (lower) to mixed (middle) to arid (upper) environments in Bed I; a wetland-dominated landscape returns in Lowermost Bed II. The birds support other environmental data in interpreting these sites as either drier, high points on the landscape abutting wetlands (FLK-22 and FLKNN-1) or low-lying wetland systems adjacent to drier grounds (DK-3 and HWKE-1). These data enable us to better identify specific habitat patches across Olduvai's landscapes and suggest hominin utilization of dry ground corridors to access wetland resources.

Large mammal carcasses are unpredictable and patchy in time and space, and their access is subject to increased predation risk. As with other taxa, carcasses were likely opportunistic or fallback foods for hominins. Large accumulations of butchered bones from moderately arid periods, like FLK-22, may artificially inflate the perceived importance of large mammals in Pliocene hominin subsistence. Butchered bones are a conspicuous trace in archaeological deposits, but increasingly, studies are suggesting that hominins primarily utilized a variety of wetland resources. The birds support this view.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

DIETARY BEHAVIOR AND HABITAT OF A MAMMAL ASSOCIATION FROM THE RANCHOLABREAN OF HIDALGO, CENTRAL MEXICO

PRIEGO-VARGAS, Jaime, Universidad Autónoma del Estado de Hidalgo, Pachuca, Mexico; BRAVO-CUEVAS, Victor, Universidad Autonoma del Estado de Hidalgo, Pachuca, Mexico

In the present study, we characterize the dietary behavior and habitat preferences of Pleistocene mammals, through isotopic analyses of carbonate in tooth enamel apatite

($\delta^{13}C$ and $\delta^{18}O$). The fossil material comes from a sedimentary sequence consisting of sands and conglomeratic lenses deposited in a fluvial setting located near San Agustín Tlaxiaca in southeastern Hidalgo, central Mexico. The samples were extracted from molars and tooth fragments belonging to the following taxa: *Equus conversidens* (n=5), *Bison* sp. (n=2), *Hemiauchenia gracilis* (n=2), *Camelops* sp. (n=1), *Stockoceros conklingi* (n=2), *Capromeryx mexicana* (n=1), *Odocoileus* cf. *virginianus* (n=3), *Mammuthus* sp. (n=2), and an unidentified gomphothere species (n=2); the presence of fossil remains belonging to *Bison* is indicative of a Rancholabrean age. The values of $\delta^{13}C$ (V-PDB) range from -1.06‰ to -12.23‰ whereas those of $\delta^{18}O$ (V-SMOW) range from 23.68‰ to 29.60‰. The mean value of $\delta^{13}C$ indicates that most taxa were mixed-feeders ($\delta^{13}C$ values between -1‰ and -10‰), although the deer *O.* cf. *virginianus* and the gomphothere are included within browsers ($\delta^{13}C$ values < -10‰). A Kruskal-Wallis test indicates differences ($p < 0.05$) between the $\delta^{13}C$ values of species considered, suggesting a distinctive dietary behavior for each taxon, consisting of a particular ratio of C3/C4 plants. The $\delta^{18}O$ average of small-sized antelopes, gomphothere, mammoths, and deer are similar (≈ 25‰), suggesting a comparable relatively high water dependency for these mammals and/or preference for humid habitats. The higher $\delta^{18}O$ values are those of the medium-sized antelopes, camelids, bison, and horses (≈ 28‰) that may be related to a lower water dependency. The record of $\delta^{13}C$ and $\delta^{18}O$ suggests a scenario of open areas covered by grasses and variable coverage of shrubs and trees of different sizes; furthermore, it seems that unsteady humid conditions occurred at the area, which in turn, would be related to seasonal rainfall patterns. This study provides evidence of the environmental conditions in Central Mexico during the second part of the Pleistocene.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

JUVENILE SAUROLOPHINE SPECIMENS (DINOSAURIA: HADROSAURIDAE) FROM THE LATE CAMPANIAN (CRETACEOUS) OF NORTHEASTERN MEXICO

PRIETO-MARQUEZ, Albert, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; SERRANO BRAÑAS, Claudia Inés, Instituto de Geología, Universidad Nacional Autónoma de México, Mexico DF, Mexico; TORRES RODRÍGUEZ, Esperanza, Instituto de Geología, Universidad Nacional Autónoma de México, Mexico DF, Mexico; REYES LUNA, Paola Carolina, Earth and Planetary Sciences, McGill University, Montreal, QC, Canada; ESPINOSA CHÁVEZ, Belinda, Benemérita Escuela Normal de Maestros de Coahuila, Saltillo, Mexico

We report new juvenile hadrosaurid specimens collected from upper Campanian (~72.5 Ma) strata of the Cerro del Pueblo Formation cropping out west of Saltillo (Coahuila, northeastern Mexico). Each of the bones was found isolated and surface collected in three localities; two of them (El Palmar and La Rosa) lie near the town of General Cepeda, whereas the third site (Presa San Antonio) lies 80 km away, near the town of Parras de la Fuente. The remains from La Rosa consist of a fragmentary dentary and maxilla; those from El Palmar include two dentaries, four maxillae, three dental battery fragments, two distal tibiae, and a pedal ungual; and those from Presa San Antonio consist of a nearly complete pubis and a partial femur. All the elements are comparable in size; based on the estimated length of 10 cm for the maxillae and the 25 cm long pubis, femoral length is estimated to be 35-45 cm. Their referral to the Hadrosauridae is supported by a horizontally oriented ectopterygoid shelf of the maxilla (El Palmar), maxillary occlusal plane with two teeth arranged labiolingually (El Palmar and La Rosa), and the prepubic morphology (see below) of the pubis (Presa San Antonio). Only the La Rosa dentary preserves teeth, corresponding to the caudal region of the dental battery. These are diamond-shaped, only twice as long as wide, and have a single median ridge; marginal denticles, if present at all, appear to have been eroded away. The lack of accessory ridges in the La Rosa dentary teeth suggests that they may belong to the Saurolophinae. The prepubic process of the Presa San Antonio pubis shows a long proximal constriction and a subrectangular, elongate, and ventrally deflected distal blade. This morphology characterizes members of the Kritosaurini-*Prosaurolophus* clade. Therefore, the Presa San Antonio pubis is referred here to this clade of saurolophines, which is consistent with the occurrence in that locality of *Kritosaurus navajovius*. However, the pubic morphology alone is insufficient for referring the specimen to *K. navajovius*, another kritosaurin, or a 'prosauroloph' saurolophine. From an ontogenetic standpoint, these remains document the presence in the juveniles of relatively short dentary tooth crowns (typically longer, i.e. height/width ratio greater than 2.5, in adult saurolophines with the exception of *G. latidens*) and a maxilla with a line of alveolar foramina located more ventrally than usually found in adult specimens of the Saurolophinae.

Technical Sesssion XII (Friday, November 1, 2013, 2:00 PM)

MORPHOLOGY AND SYSTEMATICS OF THE REPTILE CLADE TANYSTROPHEIDAE: IMPLICATIONS FOR LATE TRIASSIC BIOGEOGRAPHY AND EARLY ARCHOSAUROMORPH EVOLUTION

PRITCHARD, Adam, Stony Brook University, Stony Brook, NY, United States, 11794; NESBITT, Sterling, Field Museum of Natural History, Chicago, IL, United States; TURNER, Alan, Stony Brook University, Stony Brook, NY, United States; IRMIS, Randall, University of Utah, Salt Lake City, UT, United States; SMITH, Nathan, Howard University, Washington, DC, United States

Tanystropheids are a clade of long-necked archosauromorphs whose remains are largely restricted to marine deposits from the Triassic of Europe and Asia and almost entirely known from two-dimensionally crushed skeletons. Thus far, the occurrences of *Tanytrachelos* along the East Coast of the United States represent the westernmost confirmed record of tanystropheids, although unconfirmed isolated fragments have been referred tentatively to the group from localities in western North America. A large sample of well-preserved, three-dimensional tanystropheid fossils from the Hayden Quarry in the Upper Triassic Chinle Formation of New Mexico provides new insight into the anatomy, phylogeny, and paleoecology of Tanystropheidae. A newly constructed phylogenetic analysis of 200 characters and 45 diapsids, early archosauromorphs, and archosauriforms recovers a novel topology for basal Archosauromorpha. Tanystropheidae forms the sister taxon of a clade including *Trilophosaurus*, *Prolacerta*, and Archosauriformes. The analysis also recovers a novel subclade of small tanystropheids including *Langobardisaurus* and *Tanytrachelos*. Numerous apomorphies, including dorsoventrally flattened cervical centra and a number of tarsal characters, indicate that the Hayden Quarry tanystropheid materials belong to this subclade. *Protorosaurus* is recovered as the earliest diverging archosauromorph, outside of Tanystropheidae, and *Prolacerta* nests as the sister taxon to Archosauriformes. These results support the hypothesis that a long-necked "protorosaur" bauplan was ancestral for archosauromorphs. Tanystropheid apomorphies identified in this analysis were subsequently used to recognize additional Norian-aged fossils from other sites in New Mexico, Arizona, and Texas. Some of these fossils had previously been attributed to drepanosaurs. The estimated body size range of western tanystropheids based on comparison with *Tanytrachelos* (~0.3 meters–2.0 meters) indicates that the group was a taxonomically and ecologically diverse component of western North American ecosystems. The presence of tanystropheids throughout western North America, a region that was only seasonally wet during the Norian and Rhaetian suggests that tanystropheids could adapt to a far wider range of habitats than previous records indicate.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

SPECIES LONGEVITY IN NORTH AMERICAN FOSSIL MAMMALS

PROTHERO, Donald, Nat. Hist. Museum Los Angeles County, La Crescenta, CA, United States, 91214

Species longevity in the fossil record is related to many paleoecological variables and important to macroevolutionary studies, yet there are very few reliable data on average species durations in Cenozoic fossil mammals. Many of the online databases (such as the Paleobiology Database) use only genera in North American Cenozoic mammals, and there are severe problems because key groups (e.g., camels, oreodonts, peccaries, pronghorns, proboscideans) have no reliable updated taxonomy, with many invalid genera and species and/or many undescribed genera and species. Most of the estimates of species longevity have been mere guesses without sufficient data to back them up. The few published data sets yield species duration estimates of about 2.3-4.3 m.y. for larger mammals, with small mammals tending to have shorter species durations. My own compilation of all the valid species durations in families with updated taxonomy (39 families, containing 431 genera and 998 species, averaging 2.3 species per genus) yields a mean duration of 3.21 m.y. for larger mammals. This breaks down to 4.10-4.39 m.y. for artiodactyls, 3.14-3.31 m.y. for perissodactyls, and 2.63-2.95 m.y. for carnivorous mammals (carnivorans plus creodonts). These averages are based on a much larger, more robust data set than most previous estimates, so they should be more reliable for any studies that need species longevity to be accurately estimated.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PHALANGERIFORM MODELS FOR THE ESTIMATION OF BODY MASS IN STEM PRIMATES

PRUFROCK, Kristen, University of Toronto Scarborough, Scarborough, ON, Canada, M1C 1A4; SILCOX, Mary, University of Toronto Scarborough, Scarborough, ON, Canada

The Phalangeriformes, a suborder of marsupials, include small- to medium-bodied members in Australia, New Guinea, and Indonesia. Phalangeriforms may provide useful comparative models for reconstructing aspects of stem primate ("plesiadapiform") biology as some species display primate-like traits (e.g., convergent orbits and grasping extremities) suggesting convergence in ecological niche. Phalangeriforms and plesiadapiforms also share hypertrophied incisors, a condition that strongly impacts cranial morphology, missing in most living primates. As such, phalangeriforms may provide a relevant comparative population for cranial scaling in plesiadapiforms. Here, we report on a new set of body mass equations based on 15 cranial measurements from a broad sample of phalangeriforms including 33 species from four families (Burramyidae, Phalangeridae, Pseudocheridae, and Petauridae) ranging between 19.8-6803.9 g. These data were used to construct least squares regression equations. Pearson's r-values ranged from 0.79-0.94. Dental arcade width (0.94), dental arcade length (0.94), and maximum cranial length (prosthion-inion length; 0.94) had the closest relationship to body mass and are also measurements strongly influenced by the presence of hypertrophied incisors. These equations were used to calculate body mass estimates for *Palaechthon nacimienti*, *Ignacius graybullianus*, *Plesiadapis tricuspidens*, *Plesiadapis cookei*, and *Microsyops annectens*. In most cases the new equations produced estimates that closely resembled those based on dental measurements, and were more congruent with these values than estimates based on crania of living primate or lipotyphlan samples. For example, an equation derived from prosthion-inion length yielded a body mass estimate of 352 g for *Ignacius graybullianus*, comparable to a value of 375 g based on M1 area, and notably higher than previous estimates based on the cranium (231-286 g). The estimates that were least congruent with the values calculated from dental equations were generally based on measurements that were strongly influenced by brain size (e.g., width and height of foramen magnum, and bregma-opisthion), producing values that were substantially lower than those based on primate samples. This may reflect differences in scaling of the brain between marsupials and eutherians. In all, these new data provide a basis for reassessing body mass in stem primates, a variable critical to investigating issues such as the early evolution of the brain.

Technical Session XV (Saturday, November 2, 2013, 11:45 AM)

NEW MATERIAL OF *ODOBENOCETOPS* FROM THE LATE MIOCENE OF CHILE CLARIFIES THE SYSTEMATICS AND PALEOBIOLOGY OF WALRUS-CONVERGENT ODONTOCETES

PYENSON, Nicholas, Smithsonian Institution, Washington, DC, United States, 20013; GUTSTEIN, Carolina, Universidad de Chile, Santiago, Chile; COZZUOL, Mario, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil; VELEZ-JUARBE, Jorge, University of Florida , Gainesville, FL, United States; SUÁREZ, Mario, Universidad de Chile, Santiago, Chile

All living toothed whales (odontocetes) echolocate, using a complex arrangement of air sacs, muscles, and a melon on top of their head. Based on the similar arrangements of facial bones, it is likely that all fossil odontocetes also echolocated. However, this inference is dubious for *Odobenocetops*, the so-called walrus-whale. First described in 1993, the genus is known from two species, both recovered from Pliocene aged rocks in southern Peru. Unlike every other known odontocete, living or extinct, *Odobenocetops* has a down-turned rostrum with a vaulted palate, much like living walruses (*Odobenus*). *Odobenocetops* has only two upper teeth, which are asymmetrical in length and size. Its orbits also point dorsally, instead of laterally. Researchers have suggested that these features represent an example of convergent evolution with walruses, but this suggestion has not been fully tested using all available information. For example, *Odobenocetops* may have been an ecological generalist or a specialist; also, it may have modern analogs with walruses or dugongs. Here we report new material recovered from the late Miocene Cerro Ballena locality, in the Bahía Inglesa Formation of the Atacama Region in northern Chile to test such hypotheses. These fossils represent a single individual, collected in a 4 m^2 area, with two tusks, an incomplete cranium, associated postcrania, and an intact left tympano-periotic. They also represent the oldest record of this genus, and the first outside of Peru. Results from a new phylogenetic analysis indicate that *Odobenocetops* belongs near or within Delphinida, but that it is not close to monodontids, nor even a delphinoid, as previously suggested. For example, the Chilean specimen possesses a long, sharp parabullary ridge of the anterior process of the periotic, unlike any delphinoid. We propose that the putative delphinoid affinities of *Odobenocetops* are either misinterpretations or convergences. For example, narwhal (*Monodon*) tusks point anteriorly instead of ventrally, and they are frequently asymmetric, but they are located in the maxillae, not in the premaxillae as in *Odobenocetops*. Moreover, all tusks in *Monodon* spiral sinistrally, whereas *Odobenocetops* have longitudinal striae, similar to living walruses. Such morphological comparisons provide a basis for testing ecological hypotheses about the role of *Odobenocetops* in Neogene coastal marine food webs of South America.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC AND FUNCTIONAL IMPLICATIONS OF INNER EAR MORPHOLOGY IN FOSSIL AND EXTANT PORPOISES (CETACEA, PHOCOENIDAE)

RACICOT, Rachel, Yale University, New Haven, CT, United States, 06511

Porpoises (Phocoenidae) are some of the smallest odontocetes and produce some of the highest-frequency clicks and other sounds for biosonar and communication. The inner ear anatomy of odontocete cetaceans, now readily accessible by means of nondestructive high-resolution X-ray CT scanning, allows interpretation of their acoustic and locomotory abilities, and is also a potential source of morphological characters for phylogenetic analyses. This study compiles a dataset based on digital endocasts of inner ear labyrinths of fossil and extant porpoises to examine functional and phylogenetic variation in the shape of the vestibules, semicircular canals, and cochleae. Results demonstrate: (1) variation in the shapes of vestibules and semicircular canals is much higher than in the cochlear region; (2) fossil and later-diverging phocoenids have more tightly coiled cochleae than outgroup odontocetes; and (3) the fossil species studied have more broadly expanded semicircular canals than extant species. The similarities of the vestibular region among fossil species implies phylogenetic affinity, and could be related to lack of fused cervical vertebrae in the fossils allowing more head motility than in extant species. Allometric scaling relationships differ significantly among species, highlighting their potential as phylogenetic characters. The shapes and dimensions of all cochlear regions indicate that all studied specimens could hear high-frequency sounds, and thus had acquired high-frequency hearing capabilities by 7–11 Mya at the latest.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

EVIDENCE OF SEXUAL DIMORPHISM WITHIN CYSTOPHORINAE (CARNIVORA, PHOCIDAE) FROM NEW MIDDLE MIOCENE SEALS OF THE NORTHERN PARATETHYS

RAHMAT, Sulman, Howard University, Washington, DC, United States, 20059; KORETSKY, Irina, Howard University, Washington, DC, United States; GILLAND, Edwin, Howard University, Washington, DC, United States

The geographical distributions of some modern pinniped species often extend through several zoogeographical regions, likewise, fossil species are also widespread. Among numerous fossil true seals (Phocidae) found in the Black Sea Littoral region, representatives of Cystophorinae with heavy pachyosteosclerotic bones are particularly important for paleoecology, biostratigraphy and correlation of the coastal-marine faunas between North America and Western Europe. Cladistic, morphometric and morphological analyses of the new Cystophorine fossil material allow emended diagnoses and redescriptions to help clarify phylogenetic relationships within the Family Phocidae. Various characters shared with several Recent species of Cystophora and Mirounga confirm that the new genus (*Pachyphoca*), with two new species of extinct fossil true seals (*Pachyophoca ukrainica* and *P. chapskii*), belongs to the subfamily Cystophorinae. The new Miocene genus was from the Middle Sarmatian (11.2-12.3 Ma) in the Paratethyan Basin of southern Ukraine. Previous studies of sexual dimorphism covering cranial and postcranial elements in both fossil and Recent species have only been performed on members of the subfamily Phocinae. Sexual dimorphism in postcranial bones and mandibles in living members of Cystophorinae is more obvious than in other representatives of true seals. Therefore, this new fossil material (58 individual bones) provides a foundation for examining sexual dimorphism in fossil and Recent Cystophorinae. The analysis shows that the most reliable characters for sex determination in Cystophorinae are the width of the distal epiphysis on the humerus and the presence of the lesser trochanter on the femoral shaft. Examination of anatomical traits demonstrated that both new species show a mosaic of primitive characters and were better adapted for terrestrial locomotion than any living representatives of Cystophorinae. The new Miocene genus *Pachyphoca* shares primitive characters with other species of *Cystophora* and *Mirounga*, such as the middle of the humeral trochlear internal crest rising wave-like over the coronoid fossa, and the distal and proximal epiphyses of the humerus almost equal in width. These new findings imply that the subfamily Cystophorinae includes not only elephant and hooded seals, but also the two new Middle Sarmatian pachyosteoclerotic seals.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

POTENTIAL VERTEBRATE BURROWS IN THE SALT WASH MEMBER, UPPER JURASSIC MORRISON FORMATION

RAISANEN, Derek, University of Kansas, Lawrence, KS, United States, 66045-7594; HASIOTIS, Stephen, University of Kansas, Lawrence, KS, United States

Carbonate-preserved, large-diameter structures (LS) in the Salt Wash Member of the Upper Jurassic Morrison Formation near Ticaboo, Utah, USA, may represent burrows constructed by synapsids and/or reptiles. The depositional environment in which the LS are found was interpreted as a floodplain consisting of clay-rich mudstones 2-3 m thick interbedded with massive sheet sandstones 3-5 m thick. The mudstones were interpreted as paleosols and the sandstones were interpreted as overbank flooding or avulsion events. The LS were located in the third paleosol down from the top of the mid-Morrison unconformity in the study area. The LS have two main morphotypes. Morphotype 1 (M1) is most common with more than 100 complete or partial specimens. M1 is composed of two elements: (1) a vertical to subvertical helical shaft and (2) one or more horizontal tunnels. In two specimens the tunnels are helical. Longitudinal and transverse striations are visible on the top and sides of both M1 elements but appeared distorted by the carbonate preservation in some places. The bottom surfaces lack striations and are coated with smooth lumps of carbonate. Morphotype 2 (M2) has only three occurrences and is composed of a single, long (~2 m) subhorizontal tunnel. There were fewer longitudinal and transverse striations present on M2 than on M1 LS. These striations are also restricted to the top and sides and were distorted in some places. The bottom surfaces are coated with carbonate, as in M1. All LS appear to have undergone some architectural deformation during preservation, possibly due to compaction and recrystallization of carbonate.

Mammals were interpreted as the M1 tracemaker. The architecturally complex M1 LS fit into a continuum of helical ichnofossils attributed to synapsids. Prominent examples include Permian *Diictodon* burrows from South Africa and Miocene *Palaeocastor* burrows (*Daemonelix*) from the United States. The ovoid cross-section, slightly wider than tall, is more similar to Cenozoic mammal burrows than the kidney-shaped cross-section of earlier Permian and Triassic therapsid burrows. The simpler architecture of M2 closely resembled the burrows excavated by such extant reptiles as crocodilians or monitor lizards. The longitudinal and transverse striations on both morphotypes are interpreted as scratch marks from the manus and/or pes, or bite marks. The presence of vertebrate burrows in an area of the Morrison Formation not known for a wealth of small vertebrate body fossils reveals hidden biodiversity and enhances understanding of the paleoecosystem.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NICHE PARTITIONING AMONG PLESIADAPIFORMES: AN EXAMPLE FROM THE LATE PALEOCENE OF SOUTHWESTERN WYOMING

RAMDARSHAN, Anusha, Carnegie Museum of Natural History, Pittsburgh, PA, United States, 15213; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, United States

Plesiadapiformes were a group of primate-like mammals that were very diversified and abundant during the Paleocene, encompassing 11 families (i.e., Plesiadapidae, Carpolestidae, Saxonellidae, Paromomyidae, Micromomyidae, Purgatoridae, Palaechthonidae, Microsyopidae, Picrodontidae, Picromomyidae and Toliapinidae). Indeed, there are more than 50 genera and 120 species known in the fossil record, making this group as diversified as extant strepsirhines. However, few studies have considered the dietary ecology of this group of mammals, and fewer still have focused on niche partitioning among this group. The mammalian fauna of Big Multi Quarry, located in southwestern Wyoming, is the most diverse fauna known from a single Clarkforkian locality. This locality has yielded 11 plesiadapiform taxa (representing five families: Plesiadapidae, Carpolestidae, Paromomyidae, Micromomyidae and Microsyopidae), which also corresponds to the richest diversity for plesiadapiforms from a single locality. These taxa were apparently sympatric and offer a case study of niche partitioning in the fossil record. In order to better understand how resources were shared among this community, the diet of each taxon was assessed using low magnification dental microwear analysis. The comparative database for this study consists of 182 specimens and 15 species of living lemurs, lorises, galagos and tarsiers. Results highlight a wide array of diets among this community: fruit-eaters (*Carpolestes*, *Ignacius*, *Chiromyoides*), insects (*Dryomomys*, *Arctodontomys*), leaf-eaters (*Plesiadapis*), gum-eaters (*Phenacolemur*) and mixed feeders (*Phenacolemur*, *Plesiadapis*, *Tinimomys*). Diet seems to have been a strong factor in limiting competition between taxa. For example, the micromomyids *Dryomomys* and *Tinimomys* most probably incorporated different

amounts of fruit in their diet, thereby limiting ecological overlap. However, although there is a remarkable dietary diversity among this community, some taxa may still have competed for similar resources. Both *Arctodontomys* species (*A. simplicidens* and *A.* n.sp) seem to have been predominantly insectivorous. These taxa have very different sizes (430g and 60g respectively). In this case, it would seem that size might have been the most important factor in niche separation. Other factors limiting ecological overlap might include different locomotor habits, or even different exploited sector of the forest (e.g., emergent, main canopy, understory).

Symposium 3 (Friday, November 1, 2013, 8:15 AM)

U-PB DATING OF CARBONATES FROM TERRESTRIAL VERTEBRATE FAUNA-BEARING UNITS

RASBURY, Troy, Stony Brook University, Stony Brook, NY, United States, 11794; COLE, Jennifer, Western Kentucky University, Bowling Green, KY, United States; PARRISH, Randall, U. Leicester, UK and NIGL, British Geol Survey, Keyworth, United Kingdom; BOWRING, Samuel, MIT, Cambridge, MA, United States; LANZIROTTI, Antonio, University of Chicago, Chicago, IL, United States

Terrestrial deposits are important archives of evolution of vertebrate fauna but they are often poorly dated because volcanic ash deposits are not recognized everywhere. In order to test models of vertebrate biostratigraphy absolute ages from the units that contain these fossils are required. We have examined the U-Pb systematics of a variety of carbonate types, including lacustrine limestones, shoreline tufa deposits, and calcretes. Based on published and unpublished results, it is clear that only about five percent of samples that are analyzed have high enough U/Pb and well behaved enough U-Pb systematics to give precise ages with current techniques involving dissolution of several milligram-size samples, column chemistry and thermal ionization mass spectrometry (TIMS). The ones that do have high enough U/Pb can give ages with uncertainties smaller than one percent. Synchrotron XRF techniques can be used to understand the distribution of these elements and to determine U oxidation state. Surprisingly U oxidation states vary in carbonate systems, and differ from redox predictions. We will review the types of carbonates that yield ages that are consistent with other evidence for the age of the deposits, in particular volcanic ashes, and discuss the carbonates in the context of the behavior of U in the various fluids from which they formed. The results span from the Pennsylvanian (about 300 Ma) to the Miocene (about 14 Ma) and combined will offer insights for sampling for paleontologists who have important vertebrate fossils finds in deposits with carbonates. We will particularly focus on the great potential for laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) for quick analyses, which has improved our ability to select carbonates for dating to about thirty percent of the samples tested. The laser ICPMS results will help to refine micro-sampling of the carbonate, and combined with improved blank levels, this should lead to better success with TIMS.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ONTOGENETIC TRENDS IN THE CRANIOMANDIBULAR SKELETON OF *MAJUNGASAURUS CRENATISSIMUS* AND DERIVATION OF THE ABELISAURID SKULL MORPHOTYPE

RATSIMBAHOLISON, Nirina, Université d'Antananarivo, Antananarivo, Madagascar; O'CONNOR, Patrick, Ohio University, Athens, OH, United States; FELICE, Ryan, Ohio University, Athens, OH, United States

Abelisaurid theropods represent a clade of medium- to large size, predatory dinosaurs characterized by high, short, and broad skulls and a robust cervical skeleton that contrast markedly with the condition in most other nonavian theropods. The robust cervicocerphalic architecture has been interpreted to provide increased resistance to torsional loads during feeding behavior (e.g., during prolonged interaction with prey items). As most abelisaurids are based on single specimens, our understanding of the ontogenetic development of this distinctive morphology remains incomplete. Recent discoveries of several new partial- to complete and size-diverse skulls of *Majungasaurus crenatissimus* allow for a detailed examination of ontogenetic trends within this exemplar abelisaurid. We used two- and three-dimensional geometric morphometrics to assess ontogenetic trends in selected cranial elements representing the major regions of the skull in each of six specimens.

Landmarks and semi-landmarks were used to quantify shape variation in the maxilla, jugal, postorbital, and quadrate in a growth series of *Majungasaurus* consisting of one small, two medium, and three large specimens. Point landmarks and curves were assigned using either the software package tpsDig (2D) or Landmark (3D), with the coordinate data analyzed in RStudio. Ontogenic patterns were visualized by plotting common allometric components of shape against the logarithm of centroid size.

Preliminary results indicate that for certain elements, within-bone allometric growth dynamics play a significant role forming the distinctive abelisaurid morphotype. For example, the anterior portion of the maxilla exhibits disproportionate growth along the dorsoventral axis relative to other parts of this element, contributing in part to the high skull shape of *Majungasaurus*. Similarly disproportionate dorsoventral expansion characterizes the jugal, postorbital, and quadrate, accounting for the increase in skull height relative to length. These findings indicate that significant changes in skull shape occur in *Majungasaurus* throughout ontogeny, suggesting that craniomandibular biomechanics and function (e.g., feeding behavior) likely also varied over the life span of an individual. Hence, the more generalized nonavian theropod morphology (e.g., relatively elongate skulls) of smaller size-class members would have necessitated behavioral and/or dietary accommodations by smaller (i.e., younger) members of the species during typical feeding behaviors.

Technical Session XVIII (Saturday, November 2, 2013, 3:15 PM)

A FUNCTIONAL INSIGHT INTO THE EVOLUTION OF THE DEFINITIVE MAMMALIAN MIDDLE EAR

RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom; GILL, Pamela, University of Bristol, Bristol, United Kingdom

Of central importance to mammalian evolution is the transformation of bones forming the ancestral quadrate-articular jaw hinge into the two apomorphic mammalian middle ear ossicles, the malleus and incus, and the supporting ectotympanic ring. A key question concerns how the jaw hinge was able to remain viable and load-bearing during transformation into the vibratory ossicles of the ear, alongside the evolution of the apomorphic dentary-squamosal joint. Here we test the load-bearing capacity of the mandibular component of the jaw hinge in two Jurassic mammaliaform taxa, *Morganucodon watsoni* and *Kuehneotherium praecursoris*. Ordinarily *K. praecursoris* is considered more derived than *M. watsoni* (which also possesses a larger, more robust articular condyle), yet both taxa co-exist in the early Jurassic fissure-fill deposits of South Wales, United Kingdom. Component parts of the mandibles of each taxon were scanned using synchrotron radiation X-ray microtomography and micro-CT scanning. Jaw parts were digitally reassembled to produce a 3D composite mandible for each taxon. These models were used to generate 3D finite element reconstructions. Muscle insertion sites were identified, and muscle lines of action predicted. Analyses were performed to calculate the load experienced at the articular condyle during biting at different gapes and for varying muscle-force magnitudes. Both models are equivalent in surface area, and results show that for the same muscle force input, *K. praecursoris* generates a bite force that is only 57-65% that of *M. watsoni*. However it experiences a load at the condyle that is 15-31% greater than *M. watsoni*. When muscle forces are scaled to generate the same bite force (2N) in each model, *K. praecursoris* experiences nearly twice as much load at the articular condyle. Dissimilarity in performance between the two taxa is partly due to morphological differences at the condyle and in the jaw as a whole, but is also attributable to variation in muscle architecture. The fully understand the evolution of the mammalian jaw and middle ear, a detailed understanding of the functional and ecological performance of the skull is warranted.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

BONE HISTOLOGY OF THE STEGOSAUR *KENTROSAURUS AETHIOPICUS* (ORNITHISCHIA: THYREOPHORA) FROM THE UPPER JURASSIC OF TANZANIA

REDELSTORFF, Ragna, University of Cape Town, Cape Town, South Africa; HUEBNER, Tom, Niedersaechsisches Landesmuseum Hannover, Hannover, Germany; CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa; SANDER, Martin, Universitaet Bonn, Bonn, Germany

Stegosaurs (Ornithischia: Thyreophora) appear to be unusual among most dinosaurs in having relatively slow growth rates, as revealed by analysis of the bone histology of the highly derived *Stegosaurus*. The bone histology of the basal thyreophoran *Scutellosaurus* shows even slower growth rates. The stegosaur *Kentrosaurus* from the Tendaguru beds of Tanzania is phylogenetically intermediate between *Scutellosaurus* and *Stegosaurus* and is examined in this study to assess whether slow growth rates are plesiomorphic for the Thyreophora. An ontogenetic series (subadult to adult) of six femora, as well as one scapula, was sampled and processed into thin sections for bone histological analyses. Thin sections of the bones revealed growth marks (lines of arrested growth and annuli) as well as distinctive shifts in the pattern of vascularization. The varying occurrence of these types of growth marks is interpreted as variable responses to annual climatic fluctuations. The primary bone is mainly highly vascularized fibro-lamellar bone with some reticular organization of the vascular canals, indicating an overall higher growth rate in *Kentrosaurus* than in *Scutellosaurus* and *Stegosaurus*. This suggests that slow growth rates previously reported in *Scutellosaurus* and *Stegosaurus* are not a phylogenetic characteristic of the Thyreophora and do not reflect a plesiomorphic condition. Instead, the slow growth rates in *Stegosaurus* may have been secondarily derived or alternatively it may be that *Kentrosaurus* is the exception in having increased growth rates. The different growth rates between the medium-sized *Kentrosaurus* and the large-sized *Stegosaurus* are also contrary to an earlier suggestion that small-bodied dinosaurs have slower growth rates than larger ones.

Technical Session XV (Saturday, November 2, 2013, 8:15 AM)

DID INTERFERENCE COMPETITION BETWEEN GRIZZLY BEARS AND COYOTES PREVENT HOLOCENE COASTAL COYOTES FROM CONSUMING MARINE FOODS?

REID, Rachel, University of California Santa Cruz, Santa Cruz, CA, United States, 95064; KOCH, Paul, University of California Santa Cruz, Santa Cruz, CA, United States

As generalist carnivores, coyotes (*Canis latrans*) have been shown to benefit from marine resources in some modern environments, such as Baja California. The impact marine subsidies to coyotes may have in a community will depend on their magnitude and continuity in space and time. We sought to determine the magnitude of marine subsidies to coyotes in coastal California over the past several thousand years. To do so, we measured carbon and nitrogen isotope values in modern coyote feces and Holocene coyote bones from archaeological middens.

Stable isotope and content analyses on scats collected at Año Nuevo State Park and Reserve, located ~20 miles north of Monterey Bay, suggest that marine resources are important to some modern coastal coyotes. Seventeen genetically verified coyote scats collected along a coast-to-inland gradient in May and September of 2011 have nitrogen isotope values ranging from ~4.7° to 17.1° and carbon isotope values ranging from -28.4° to -19.6°. Not all individuals use marine resources, but five of the seventeen coyote scats have relatively high carbon and nitrogen isotope values and contain evidence of marine

foods (i.e., seal or sea lion hair). In contrast, Holocene coyote bone collagen from Elkhorn Slough (n = 3) and Moss Landing (n = 12), both located along central Monterey Bay and occupied ~2000 BP, have a slightly lower range in nitrogen isotope values (~4.0° to 12.2°) in comparison to modern coyote scats. Two individuals have higher isotope values, but most samples cluster around mean nitrogen and carbon isotope values of 6.9 (±2.0)° and -19.5 (±0.7)°, respectively, which are outside of the range expected for coyotes with partially marine diets. These data suggest that marine resources were not a major proportion of coastal coyote diets in the Holocene and thus that the use of marine foods has become more prominent in the modern. One possible explanation for this diet shift may lie in the restructuring of the central California coastal ecosystem and food web following the extinction of the California grizzly bear (*Ursus arctos californicus*) in the 1920s. Removing grizzly bears from the ecosystem may have allowed coyotes to change their diets and move into the grizzlies' former niche. Data from the one grizzly bear bone analyzed to date, also from the Elkhorn Slough site, supports this hypothesis, as it has nitrogen and carbon isotope values suggestive of a purely marine diet (-12.8° and 18.0°, respectively).

Symposium 1 (Wednesday, October 30, 2013, 10:30 AM)

EMBRYONIC DEVELOPMENT OF A SAUROPODOMORPH DINOSAUR FROM THE EARLY JURASSIC OF CHINA, PATTERNS OF OSSIFICATION AND GROWTH

REISZ, Robert, University of Toronto Mississauga, Mississauga, ON, Canada, L5L1C6; LEBLANC, Aaron, University of Toronto Mississauga, Mississauga, ON, Canada; SULLIVAN, Corwin, Key Laboratory of Evolutionary Systematics of Vertebrates, Beijing, China; HUANG, Timothy, National CHung Hsing University, Taichung, Taiwan

Fossil dinosaur embryos are surprisingly rare, and are almost entirely restricted to the Cretaceous Period. Notable exceptions are the oldest known embryos from the Early Jurassic South African sauropodomorph *Massospondylus*, and Late Jurassic embryos of a theropod from Portugal. The fact that dinosaur embryos are rare and typically enclosed in eggshells limits their availability for tissue and cellular level investigations of development and growth. Consequently, little is known about growth patterns in dinosaur embryos, even though post-hatching ontogeny has been studied in several taxa. Recent discovery of an embryonic dinosaur bonebed from the Lower Jurassic of China, the oldest such occurrence in the fossil record, has allowed us to do extensive histological examination of the longbones, in particular the femur. The embryos are similar in geological age to those of *Massospondylus* and are assignable to a sauropodomorph dinosaur, most likely *Lufengosaurus*. The preservation of numerous disarticulated skeletal elements at different stages of incubation and therefore derived from different nests, provides opportunities for examining embryological development and growth within a single taxon. For example, comparisons among embryonic femora of different sizes and different developmental stages reveal a consistently rapid rate of growth throughout development, possibly faster than other dinosaurian taxa where histological information is available. Our ability to section individual femora at both the mid-shaft and at the level of the 4th trochanter, led us to the discovery of asymmetric radial growth of the femoral shaft and rapid expansion of the fourth trochanter during embryonic ontogeny. This suggests that embryonic muscle activation played an important role in the pre-hatching ontogeny of these dinosaurs. Embryonic dentition has also been found in the bonebed, confirming the identity of this material as the remains of basal sauropodomorphs, and indicating that tooth development had already started in the preserved individual, but the teeth had not yet erupted beyond the ventral edge of the maxilla.

Symposium 3 (Friday, November 1, 2013, 11:15 AM)

^{40}AR/^{39}AR GEOCHRONOLOGY OF THE LANCIAN-TORREJONIAN INTERVAL, HELL CREEK REGION, MONTANA

RENNE, Paul, Berkeley Geochronology Center, Berkeley, CA, United States, 94709; SPRAIN, Courtney, University of California, Berkeley, CA, United States; WILSON, Gregory, University of Washington, Seattle, WA, United States; CLEMENS, William, Univ of California Berkeley, Berkeley, CA, United States

Latest Cretaceous through early Paleocene terrestrial strata from the western Williston Basin provide a trove of fauna and flora that elucidate our view of terrestrial paleoenvironmental and biotic change across the end-Cretaceous boundary (KPB). An abundance of volcanic ashes in the northwestern portion of the basin, where they are typically preserved in lignite beds, enables ^{40}Ar/^{39}Ar chronostratigraphy with unprecedentedly high age resolution. Recent calibration of the ^{40}Ar/^{39}Ar system enables seamless comparison with U/Pb and other geochronometers. We report here new high-precision ages for some previously dated ashes as well as many that have never previously been dated. Our new data confirm that the lithostratigraphic boundary between the Hell Creek (below) and Tullock (above) formations, often taken as a proxy for the KPB, is diachronous, ranging from 66.04 Ma in Garfield County to 66.02 Ma in McCone County. It is also now clear from two sections that the depauperate Puercan1 fauna in the basal ~5m of the Tullock Fm. spans less than 50 ka, favoring the hypothesis that this fauna is dominated by immigrants rather than evolutionary first appearances. Torrejonian faunas in the Farrand Channel and Horsethief Canyon localities, separated by 42 km, can now be confidently correlated temporally and may be the oldest yet known Torrejonian at 65.2 Ma. A further goal of our ongoing study is to improve calibration of the geomagnetic polarity time scale, which will enable much improved temporal correlation between terrestrial and marine records. Preliminary results will be presented. In particular, precise and accurate ages for boundaries of polarity Chrons 29 and 28 will anchor orbitally-tuned marine chronologies, which are otherwise floating, based on the easily resolved 405 ka eccentricity cycle. Such improved calibration, particularly of the Chron 29R/28N boundary, will also provide key datums for terrestrial sequences lacking datable ashes as is the case in much of the eastern Williston Basin.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE EL CASCO SUBSTATION FAUNA AND FLORA: NEW RECORDS FROM THE PLIOCENE–PLEISTOCENE AGE SAN TIMOTEO FORMATION, RIVERSIDE COUNTY, CALIFORNIA

REYNOLDS, Robert, n/a, Redlands, CA, United States, 92373; SAMPLE, Lloyd, LSA Associates, Irvine, CA, United States; CONKLING, Steven, LSA Associates, Irvine, CA, United States

The El Casco Substation fauna and flora were recovered during Southern California Edison Co. excavation in the San Timoteo Formation, Riverside County, California. This terrestrial formation provides critical data about the climatic, botanic, and zoologic transitions through three North American Land Mammal Ages (NALMA)—Hemphillian, Blancan, and early Irvingtonian. The five million year span of deposition encompasses a period that includes mammalian radiations to North American from South America and Asia. El Casco Substation yielded 77 taxa (65 animals and 12 plants). Twenty-six of the mammalian taxa represent geographical and temporal range extensions. This exceptional assemblage from a single silty sandstone interval has only 13 taxa in common with taxa reported from all five members of the entire San Timoteo Formation. The taxa and magnetostratigraphy suggest a 1.7 Ma age. The El Casco Substation Fauna contains eight genera of riparian and aquatic mollusks, stickleback fish, three salamanders, a frog, giant tortoise, pond turtle, two water birds, lizards, and snakes. Small mammals include a shrew and mole, temporal extensions for heteromyids and cricetids, and the earliest record of the microtine *Allophaiomys* sp. in the southwestern United States. Large mammals include deer, camels, horse, two species of ground sloth, and partial skeletons of two saber cats, *Homotherium crenatidens* and *Smilodon gracilis*. The associated El Casco Substation flora is distinct from similar southern California floras because it contains plants from aquatic and foothill communities in addition to riparian and upland slope communities. The El Casco Substation faunal assemblage is important for understanding the transition from the Blancan to Irvingtonian NALMA west of the Rocky Mountains. Specimens are curated by the Western Science Center at Hemet, California.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

EVOLUTION OF DENTITION IN *MEROËHYRAX* FROM THE LATE OLIGOCENE OF KENYA: PALEONTOLOGICAL ANALYSIS AND ^{40}AR/^{39}AR DATING

REYNOSO, Dawn, University of Nevada Las Vegas, Las Vegas, NV, United States, 89131; SPELL, Terry, University of Nevada Las Vegas, Las Vegas, NV, United States

Nakwai is an area in the Turkana Basin of Kenya that is rich in late Oligocene fossils. Of all of the mammals that are native to Africa members of the order Hyracoidea are of particular interest. The genus *Meroëhyrax* is the focus of this study because some *Meroëhyrax* species exhibit hypsodont features in their cheek teeth. Dental features such as hypsodonty are long thought to have evolved in response to an increase in silica-rich C_4 grasses. However, in Africa these grasses did not arrive until the late Miocene. Documenting the occurrence and potential evolution of hypsodonty and selenodonty is important in illustrating the early occurrence of these features and will be instrumental in developing an alternate hypothesis for the evolution of hypsodonty in hyracoids. Dental measurements were made of *Meroëhyrax* from the Nakwai fossil locality and have been compared to another species of *Meroëhyrax* from the early Miocene as well as a mid-Miocene species *Parapliohyrax*. The measurements include mesiodistal length, mesial, and distal widths along with measurements from the base to the top of the crown in three separate locations. The preliminary comparisons of the dental measurements show that there is a distinct increase in tooth size through time. Comparisons of crown height were also made and although the data is less distinctive there is a trend among the lower molars to have an increase in crown height through time. In addition to more detailed comparisons of the dental measurements, timing the evolution of these dental features will be an important step in the documentation process. Samples of basalt that cap the section that were taken along with samples of intercalated amphibole rich mudstone and air fall tuff from measured sections within the Nakwai field area will be used to constrain the age of the fossils using the ^{40}Ar/^{39}Ar dating method.

Preparators' Session (Thursday, October 31, 2013, 12:00 PM)

IMPARTING OUR KNOWLEDGE: EDUCATING THE NEXT GENERATION OF FOSSIL PREPARATORS AND COLLECTIONS PERSONNEL

RHUE, Vanessa, Natural History Museum of Los Angeles County, Los Angeles, CA, United States, 90007

As working professionals in supportive roles to curators, researchers, and educators, we maintain an underlying commitment to the advancement of science. While our immediate responsibilities are often constrained to the laboratory and collection areas, our contributions to the scientific community have widespread and lasting effects. Cultivating a pedagogy of learning, that is, a philosophy of education, among preparators and collections personnel will not only better equip ourselves for the tasks at hand, but also make an impact on the future development of our profession. Unlike our academic colleagues, there are limited avenues of education available to those interested in learning how to prepare fossils and care for fossil collections. How might we as a community of working professionals better equip the next generation of staff, students, and volunteers? In order to better equip others, we must first be intentional about broadening our current understanding of fossil preparation and curation. A holistic approach to professional development involves understanding what we do and for what end or purpose. Imparting our knowledge to the next generation involves laying a foundation of thought regarding the "best practices" of our day. Increasingly larger numbers of professionals are urging us to standardize our terms, build our knowledge base, and disseminate this knowledge to

others. Advances in technology are allowing us the opportunity to gather together our ideas, pause, reflect, and think critically about the future development of our profession.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THEROPOD EGG SITES FROM THE LOURINHA FORMATION, PORTUGAL

RIBEIRO, Vasco, Faculdade de Ciencias e Tecnologia da Universidade Nova de Lisboa & Museu da Lourinha, Caparica, Portugal; HOLWERDA, Femke, Bayerische Staatssammlung fur Palaontologie und Geology & Ludwig-Maximilians Universitat, Munich, Germany; MATEUS, Octavio, Faculdade de Ciencias e Tecnologia da Universidade Nova de Lisboa & Museu da Lourinha, Caparica, Portugal

Dinosaur eggs and eggshells of Jurassic age or older are relatively rare worldwide when compared with Cretaceous ones. However, the Lourinha region in central-west Portugal is rich in Kimmeridgian-Tithonian dinosaur egg- and eggshell localities, two with associated theropod embryo material of *Lourinhanosaurus* and another large theropod.

Here, we describe specimens from two sites from the Late Kimmeridgian-Early Tithonian Sobral Member of the Lourinha Formation: i) eggshells from Casal da Rola (Museu da Lourinhã [ML]1194) and ii) a new isolated egg from Porto das Barcas (ML1842). These are compared with previous findings with similar morphology: *Lourinhanosaurus* nest from Paimogo (ML565) and clutches from Peralta (ML156), and the theropod clutch ML1403, also from Porto das Barcas but in a different horizon and locality than ML1842.

Two main ootaxa were identified: ML1194 as *Preprismatoolithus* and ML1842 as an undescribed *Dendroolithus*-like phaceloolithid. The first is clearly identified by the dinosauroid eggshell morphotype angustiprismatic/obliquiprismatic, with an obliquicaniculate or angusticaniculate pore system, smooth outer surface, and an eggshell thickness range of 0.8-1.0 mm. *Dendroolithus* is identified by: eggs are medium sized (10-20 cm) and spherical in shape; eggshell morphotype dendrospherulitic, with shell units irregularly shaped and displaying a fanning pattern; pores display a prolatocanaliculate network throughout the eggshell; outer surface ornamentation is irregular with crests and the pores irregularly dispersed between the crests; and average eggshell thickness is approximately 1.1 mm.

The eggshells from Casal da Rola are identical to *Preprismatoolithus* eggs from Paimogo and Peralta. The eggs from Paimogo have been assigned to *Lourinhanosaurus* by the presence of embryos, so we ascribe Casal da Rola also to *Lourinhanosaurus*.

The phaceloolithid egg ML1842 is morphologically identical to the clutch ML1403 found in the same area and assigned to a large theropod. Apart from Porto das Barcas, Phaceloolithidae is only known from the Late Cretaceous of China and Mongolia.

Preparators' Session (Thursday, October 31, 2013, 9:45 AM)

NEW TECHNIQUE TO REMOVE ASPHALT FROM MICROFOSSIL-RICH MATRIX FROM RANCHO LA BREA

RICE, Karin, George C. Page Museum, Los Angeles, CA, United States, 90036; LAI, Katherine, California Institute of Technology, Pasadena, CA, United States; SESSIONS, Alex, California Institute of Technology, Pasadena, CA, United States; TAKEUCHI, Gary, Natural History Museum of LA County, Los Angeles, CA, United States

Rancho La Brea is one of the richest terrestrial late Pleistocene fossil localities. Typical Rancho La Brea fossils are composed of unaltered organic material—bone, plant remains, shells, insect exoskeletons. Extraordinary preservation of Rancho La Brea fossils is due principally to asphalt impregnation which helps protect the material from diagenetic changes. Vertebrate fossils from Rancho La Brea rarely display permineralization.

Asphalt-preserved fossils present specific cleaning and preparation challenges not encountered with permineralized fossils. Historically, heated kerosene was used to remove the asphalt but is flammable and occasionally caught fire. Solvents used since include 1, 1, 1-trichloroethane and perchloroethylene but these come with a variety of drawbacks including environmental hazards, regulatory restrictions, adverse health effects, and expense. Biodiesel is a safe, economical, and efficient alternative.

Pure biodiesel, or B100, is a diesel fuel consisting of methyl esters of fatty acids produced by refining vegetable oil triglycerides. While biodiesel is not an effective asphalt solvent at room temperature, it becomes very effective when heated to temperatures between 60°C and 80°C. Biodiesel can subsequently be removed from the treated fossil materials by soaking them in an n Propyl Bromide. Our current excavation, Project 23, has yielded large quantities of microfossil-rich asphaltic sand. We have found heated biodiesel to be an effective and efficient solvent for processing these asphaltic samples.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

TWO UPPER TRIBOSPHENIC MOLARS FROM THE MESOZOIC OF AUSTRALIA AND TWO HYPOTHESES

RICH, Thomas, Museum Victoria, Melbourne, Australia; TRUSLER, Peter, Monash University, Melbourne, Australia; EVANS, Alistair, Monash University, Melbourne, Australia; VICKERS-RICH, Patricia, Monash University, Melbourne, Australia; SIU, Karen, Australian Synchrotron, Clayton, Australia

Since 1997, twenty-eight mandibles of tribosphenic mammals have been collected from polar Early Cretaceous deposits in southeastern Australia. Assigned to an endemic family erected to accommodate them, Ausktribosphenidae, two suggestions have been made regarding their affinities. Originally, they were tentatively allocated to the Placentalia. Soon afterwards, they were placed in a newly established Southern Hemisphere group of primarily tribosphenic mammals, the Australosphenida. Placentals and marsupials were by contrast placed in simultaneously established group, the Boreosphenida to emphasize their presumed Northern Hemisphere origin. Little progress has been made since the beginning of the current Millennium in resolving this difference of interpretation, a reflection of the fact that other elements of tribosphenic mammals from the Mesozoic of Australia have previously not been found. There is now a single specimen of two unfortunately both heavily worn and damaged upper tribosphenic molars from the Early Cretaceous of Australia. What is preserved of this specimen suggests possible affinities with metatherians. Illustrations of this specimen and the placental-like or placental ausktribosphenids have been made from synchrotron scans. Based on these images, with significant restoration in the case of the upper molars, feasibility of an occlusal fit between upper and lower molars was assessed. The ausktribosphenid *Bishops whitmorei* does not have a lower dentition likely to have occluded with these two upper molars. However, at this writing, the situation in this regard to the other ausktribosphenid, *Ausktribosphenos nyktos*, is not as clear. If a plausible occlusal fit is found, this would suggest the existence of a mammal with eutherian-like lower molars occluding with metatherian-like upper molars. If such an incongruous association can be established in a single species or even closely related genus, it would suggest it/they were neither metatherians nor eutherians and thus favor the Australosphenida hypothesis. At this stage, two hypotheses present themselves. First, in Australia there are Australosphenida dentally convergent on both eutherians and metatherians. Alternatively, that eutherians and metatherians were in Australia in the Early Cretaceous. This is considerably earlier than Eocene, the age of the next oldest record of either group on that continent.

Technical Session V (Wednesday, October 30, 2013, 3:15 PM)

THE FIRST MESOZOIC LIZARD FROM NORTHERN GERMANY (PARAMACELLODIDAE, LATE JURASSIC, LANGENBERG QUARRY) AND ITS TAPHONOMY

RICHTER, Annette, Niedersächsisches Landesmuseum Hannover, Hannover, Germany; KNÖTSCHKE, Nils, Dinopark Münchehagen Germany, Rehburg-Loccum, Germany; KOSMA, Ralf, Staatliches Naturhistorisches Museum Braunschweig, Braunschweig, Germany; SOBRAL, Gabriela, Museum für Naturkunde Berlin, Berlin, Germany; WINGS, Oliver, Niedersächsisches Landesmuseum Hannover, Hannover, Germany

Remains of a fossil lizard were discovered during the 2012 field season of the *Europasaurus*-Project in the Langenberg Quarry in Oker, Lower Saxony. The bone fragments are between 1.5 and 4 mm in size and derive from a middle Kimmeridgian (154 my) micritic, marly limestone layer deposited under shallow marine conditions. Besides a femur, the majority of the identifiable bones belongs to the skull. Parts of both dentaries, a frontal, a jugal, a supposed squamosal and a part of a premaxillary bone are well-preserved. Another tooth-bearing fragment is situated below the main bone conglomeration; osteoderms are not preserved. The characteristic teeth with their chisel-like morphology and marked, oblique cutting edges and the unpaired frontal with its rugose surface define this specimen as belonging to Paramacellodidae. Thus, it represents the first Mesozoic lizard from northern Germany.

The tiny bones of the Langenberg lizard are disarticulated, although right and left dentary fragments are preserved side by side, the right one on top. Taphonomic interpretation follows known disarticulation stages of complete lizards (Messel Pit, Eocene, Germany) and lizard skulls (Uña, Barremian, Spain). The best comparison can be made with lizard bone aggregates from the Kimmeridgian of Guimarota, Portugal. Its predominantly terrestrial coal sedimentation has preserved a rich paramacellodid lizard fauna with several genera and species. We describe their taphonomy for the first time and compare it to the preservation of the Langenberg lizard. Two bone aggregates of Portuguese paramacellodids are especially suitable for comparison. One coal slab contains both dentaries and postdentary bones plus one maxillary, still adducted, but all other skull elements are slightly disarticulated. The other specimen shows less skull bones, but both dentaries lie aside. With only a small distance between the mandible tips, the two bones still keep their original orientation. Disarticulation of the Langenberg paramacellodid must range between these two stages. The skull and especially the snout tip remained rather complete during the beginning decay and it is very likely that all bones belong to the same individual. The find shows that the marine sediments in the Langenberg Quarry have not only potential for large terrestrial vertebrates such as the dwarfed sauropod *Europasaurus*, but also for fragile and minute remains.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW FOSSIL FISHES FROM THE PERMIAN PEDRA DE FOGO FORMATION, PARNAIBA BASIN, NORTHEASTERN BRAZIL

RICHTER, Martha, Natural History Museum, London, United Kingdom; CISNEROS, Juan Carlos, Universidade Federal do Piaui, Ininga, Teresina, Brazil; KAMMERER, Christian, Museum für Naturkunde, Berlin, Germany; FRÖBISCH, Jörg, Museum für Naturkunde, Berlin, Germany; SMITH, Roger, South African Museum, Cape Town, South Africa

Three multidisciplinary expeditions to Permian localities in the States of Maranhao and Piaui since 2011 have yielded abundant fossil fishes, tetrapods, invertebrates and plants. Most fossils were surface collected at approximately 100 GPS marked sites. The Pedra de Fogo Formation (PFF) accumulated in a large shallow epeiric sea that became shallower towards the top of the sequence where alluvial plain deposits become interdigitated with extensive aeolian dune fields. There are no radiometric data available so far to precisely date the 240 meter-thick PFF, whose Permian age is principally based on palynology and the tree-fern *Psaronius* sp. Teeth and fin spines of ctenacanths, xenacanths, and other chondrichthyans, including new taxa, represent the shark fauna recovered from wavy-bedded sandstones and siltstones that accumulated within the basin depocenter. The petalodont holocephalan *Itapyrodus puctatus* is indistinguishable from a species found in the Early Permian Irati Formation and the Late Permian Corumbatai Formation of the Parana basin further south in Brazil. This suggests that these two basins may have been linked during the Permian, and that *Itapyrodus* represents a geologically

long-lasting taxon. The concurrence of petalodont teeth, mostly found in marine rocks elsewhere in the world, with dipnoan tooth plates in both basins is intriguing, but both bear durophagous dentitions. This, together with evidence provided by coquina levels suggests an abundance of shelled invertebrates as a fish food source. Dental remains of the endemic eugeneodontid chondrichthyan *Anisopleurodontis pricei* are common in the near shore and evaporitic shoreline facies. A collection of teeth from the same individual was found, which shed some light on their anatomical arrangement. We also collected teeth and fin spines of ctenacanth sharks including *Glikmanius*, which occurs in the Lower Permian of the USA and the Carboniferous of Russia and Europe. We recognize at least four distinct dipnoan tooth plate morphologies. Fragmentary remains of palaeoniscoid-grade actinopterygians are common in the lower PFF. Well-preserved bony fishes occur in more continental deposits in the upper PFF, where we collected lower actinopterygians with close affinities to Mesozoic taxa and coelacanthiforms. The apparent absence of strictly marine fossils, together with the upward transition to continental facies within the PFF support the view that the PFF fish fauna evolved more or less in geographic isolation through long periods of time leading to endemicity of many taxa.

Symposium 3 (Friday, November 1, 2013, 11:45 AM)

MAGNETOSTRATIGRAPHY ACROSS THE WASATCHIAN/BRIDGERIAN NORTH AMERICAN LAND MAMMAL AGE BOUNDARY IN THE WIND RIVER BASIN, WYOMING

RIEDEL, Jeremy, University of New Hampshire, Durham, NH, United States, 03824; CLYDE, William, University of New Hampshire, Durham, NH, United States; STUCKY, Richard, Denver Museum Of Nature & Science, Denver, CO, United States; RAYNOLDS, Bob, Denver Museum Of Nature & Science, Denver, CO, United States

The Wasatchian/Bridgerian (Wa/Br) North American Land Mammal Age (NALMA) boundary represents a significant early Eocene faunal turnover that may be linked to global climate change during the Early Eocene Climatic Optimum (EECO). The EECO (~52–50 Ma) was the largest warming trend of the Cenozoic. North American western interior mean annual temperature (MAT) rose to nearly 23°C while global deep ocean water mean temperature warmed to about 15°C (at least 14.5°C and 12°C greater than the 20th century mean estimates, respectively). The elevated MAT, along with relatively high western interior mean annual precipitation of up to 140 cm/y, contributed to escalated floral diversity and habitat complexity. Paratropical conditions made possible the expansion of tropical foraminifera, broad-leaved evergreens, crocodiles, and arboreal mammals into high latitudes. Diversification intensified within the Artiodactyla, Perissodactyla, Rodentia, and Primates, despite absence of major immigration events, while all members of the previously successful order, Pantodonta, abruptly went extinct.

Timing of the Wa/Br boundary relative to the EECO is still uncertain. Until this faunal boundary is more accurately dated, precise correlation with climate proxy records is not possible, and consequently, related hypotheses about the role of extreme climate change in mammalian evolution are difficult to test. In order to better constrain the age of the Wa/Br boundary, we developed a magnetostratigraphic framework for the Wind River Formation in northeastern Wind River Basin, Wyoming. The Wind River Formation, predominantly terrestrial mudstone and siltstone floodplain deposits with interbedded channel sandstones, contains the stratotype section for the Wa/Br boundary. We collected 220 oriented in situ hand samples from 50 sites across the boundary covering 424 m of overlapping stratigraphic sections. Samples were subjected to either AF or thermal stepwise demagnetization and measured with a 2G superconducting rock magnetometer equipped with DC SQUID sensors. Previous magnetostratigraphic work in the adjacent Green River Basin placed the Wa/Br boundary in either Chron C22r or C23r of the Geomagnetic Polarity Timescale (GPTS), leaving a temporal range in uncertainty of nearly 2 Myr. Our new magnetostratigraphic framework in the Wind River Basin reduces that uncertainty and provides a more precise correlation for the Wa/Br boundary to the GPTS.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW INFORMATION ON TITANOSAURIDAE REMAINS (DINOSAURIA, SAUROPODA) FROM THE MARILIA FORMATION (MAASTRICHTIAN, BAURU BASIN) OF CAMPINA VERDE, MINAS GERAIS STATE, BRAZIL

RIFF, Douglas, Universidade Federal de Uberlandia, Uberlandia, Brazil; COSTA, Ana Clara Santos, Universidade Federal de Uberlandia, Uberlandia, Brazil; MACHADO, Elaine, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

A new outcrop of the Echaporã Member of the Marilia Formation located at municipality of Campina Verde provided remains of titanosaurid dinosaurs. Three opisthocoelic cervical vertebrae were found and are housed in the Zoological Collection of the Universidade Federal de Uberlândia (INBIO/UFU) under numbers MBC 032-PV, MBC 034-PV and MBC 035-PV. The smallest one is MBC 032-PV (325 mm long and 209 mm tall); MBC 034-PV is somewhat medium sized element (305 mm long and 240 mm tall – measurements based only in preserved portions). The third specimen, MBC 035-PV is a robust element, which certainly occupies a more posterior position in the neck (560 mm and 400 mm tall). All elements are incompletely preserved, and the overall description is based on mutually complementary portions preserved in the specimens, which are assumed to represent the same individual due to close association and only slight variability. The vertebrae lack pleurocoels, as do other titanosaurids from the Bauru Basin, e.g., *T. pricei*, *M. topai* and "Series A", but differ from *U. ribeiroi*, where pleurocoels are present in the posterior vertebrae. The prezygapophysis (PRZ) are short, barely surpassing the condyle, differing from *U. ribeiroi*. The spinoprezygapophyseal laminae (SPRL) are well delimited, similar to the pillar-like structure described for *U. ribeiroi*. This lamina extends until the PRZ, differing from the condition seen in "Series A". This specimen possesses a relative tall neural spine which is not laterally expanded, similar to *U. ribeiroi*, *M. topai*, and *T. pricei*, but different from "Series A". The posterior centrodiapophyseal lamina (PCDL) is at least 50% thicker than the postzygodiapophyseal lamina (PODL), a feature only previously reported in *A. maximus*. The postzygapophysis (POZ) is short, hardly reaching the cotyle. Along the three cervical vertebrae, it can be observed that in more posterior elements two specific aspects undergo noticeable transformations. The first one concerns the extension of the PODL lamina which is relatively short, but elongates posteriorly, reaching the base of the POZ as seen in MBC 035-PV. The second aspect is the shape and size of the cotyle, which starts small and rounded as seen in MBC 032-PV, rapidly enlarges and becomes less round in shape in MBC 034-PV, and is ovoid in MBC 035-PV. Although preliminary, bones are still being recovered from the outcrop. This finding represents the first fossil from the Echaporã Member of the Marília Formation in Minas Gerais State, and its unique combination of features suggests it represents a new taxon.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW EARLY MIOCENE BASAL PROCYONIDS FROM PANAMA: THE OLDEST NORTH AMERICAN PROCYONID AND ORIGIN OF THE TRIBE POTOSINI (CARNIVORA, PROCYONIDAE).

RINCON, Aldo F., University of Florida, Gainesville, FL, United States, 32611; MORGAN, Gary, New Mexico Museum of Natural History, Albuquerque, NM, United States; HULBERT JR., Richard, University of Florida, Gainesville, FL, United States; BLOCH, Jonathan I., University of Florida, Gainesville, FL, United States; WOOD, Aaron, University of Florida, Gainesville, FL, United States

The extant and fossil geographic distribution of New World procyonids indicates that a significant part of their evolution occurred in subtropical and tropical forested habitats of southern North America. Isolated fossils of the apparent stem-procyonine (cf. *Amphictis* sp.) recovered from the Anderson Ranch Formation (~19.2 Ma) in Nebraska place the arrival of the group in North America by at least the latest Arikareean North American Land Mammal Age (NALMA). By the Hemingfordian NALMA, diversity of hypocarnivoran forms increased significantly in southern North America and fossil procyonids became more abundant in subtropical fossil assemblages of the Gulf Coast and Nevada with no tropical occurrences. Procyonids managed to colonize South America during the late Miocene via island hopping before the final closure of the Panama Isthmus during the Pliocene. Here, we report isolated procyonid teeth from early Miocene terrestrial volcaniclastic sequences in the Panama Canal basin. A new procyonid represented by an isolated P4/ from the early Miocene Las Cascadas Formation (~21 Ma) represents the oldest procyonid in North America and oldest potosini procyonid in the New World Tropics (NWT). The new taxon is placed in the Tribe Potosini based on a P4/ with an enlarged internal protocone widely separated from the paracone. It differs from late Hemingfordian *Bassaricyonoides stewartae* from the Massacre Lake I Local Fauna (L. F.) from Nevada in having a P4/ with a reduced parastyle, slightly reduced metacone blade, and a more anterior protocone with a partially developed internal shelf. Additional isolated teeth, including a P4/, partial M1/, and /m2, from the younger (~19 Ma) late Arikareean Centenario Fauna, are identified as *Bassaricyonoides* sp. based on shared morphologies with *Bassaricyonoides* from the Massacre Lake I L. F. and the early Hemingfordian Miller L. F. in Florida. The partial P4/ from the Centenario Fauna has an inflated protocone and shorter metacone blade than those in the late Hemingfordian *B. stewartaei*, while the /m2 is most similar to that of early Hemingfordian *B. phyllismillerae* from the Miller L. F. Presence of Potosini in the New World tropics is confirmed from at least the late Arikareean NALMA through the Neogene. Our interpretation is consistent with molecular data suggesting an early Neogene divergence of the kinkajou (*Potos flavus*) from other living procyonids. More complete fossils will be critical to further understand the early evolution of this ancestral lineage in the NWT and its relationships within Procyonidae.

Symposium 2 (Thursday, October 31, 2013, 2:00 PM)

PALEONTOLOGY OF VENEZUELAN TAR PITS AND THE GREAT AMERICAN BIOTIC INTERCHANGE

RINCÓN, Ascanio D., Instituto Venezolano de Investigaciones Cientificas, Caracas, Venezuela; SOLÓRZANO, Andrés, Instituto Venezolano de Investigaciones Cientificas (IVIC), Caracas, Venezuela; MCDONALD, H. Gregory, National Park Service Museum, Fort Collins, CO, United States

The Great American Biotic Interchange (GABI) is well documented by fossil sites in North America and southern South America, but in northern South America there are few known faunas that provide data for the phases of this event and the timing of the first appearance of North American taxa in South America. While Venezuela is a major oil producing country, it is only in the last two decades that two amazing deposits resulting from surface seeps of oil have been studied. These tar pit fossil assemblages represent two distinct episodes of the GABI. One site, Mene de Inciarte, dated by 14C between 25 to 27 thousand years old is located in northwestern Venezuela. In this locality 37 mammalian taxa, of which 32 are terrestrial mammals, have been recovered, 53% of which are North American immigrants, and 47% South American natives. These percentages are similar to the modern mammal assemblage for Venezuela (54% of North American immigrant, 46% of South American natives). The fauna from Mene de Inciarte in northern South America represents the last pulse of GABI. Another locality is El Breal de Orocual in eastern Venezuela. It has been dated biochronologically as Plio-Pleistocene based on the presence of *Smilodon gracilis* and *Pachyarmatherium leiseyi*. The percentages of the fauna of North and South American origin in the mammalian assemblage at Orocual is reversed from that of Mene de Inciarte or the modern assemblage (42% North American immigrants and 58% South American natives), indicating that the fauna from Orocual preserves a fauna from the second pulse of the GABI. The habitat at both localities at the time of the accumulation of the faunas has been interpreted as savanna with patches of dispersed trees, which is in agreement with previous interpretations that GABI episodes occurred during dry and cold environments dominated by savannas. Localities in northern South America such as Urumaco, Codore,

and La Venta consist of 100% South American natives, and represent faunas that existed prior to the GABI. In Venezuela there are 50 localities that represent the post-contact episode of the GABI. Presently we don't know the absolute age for most of these faunas, except at Taima-Taima, Falcón state (14 Ka), and Mene de Inciarte, Zulia state, which is one of the most diverse mammalian assemblages in the northern South America at 25 to 27 Ka. More work is needed to establish a better chronology documenting the first appearance of North American taxa in northern South America and the timing and routes of their subsequent dispersal across the continent.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DENTAL MICROWEAR ANALYSIS OF THE LATE CRETACEOUS (LATE CAMPANIAN) HADROSAURS FROM THE CERRO DEL PUEBLO FORMATION, NORTHERN MEXICO

RIVERA-SYLVA, Hector, Museo del Desierto, Saltillo, Mexico; BARRÓN, Christian, University of Calgary, Calgary, AB, Canada

Dental microwear has proven to be a valuable source of information for inferring diet and jaw mechanics in several vertebrate taxa. However, studies of dental microwear in dinosaurs have been limited compared to other vertebrate groups, most notably mammals. One of the reasons for the paucity of microwear studies in dinosaurs is the lack of comprehensive comparative datasets. Compiling of such datasets for different dinosaur taxa and at various geographic and temporal scales will contribute to a better understanding of dinosaur feeding ecology. Here, we report the results of a microwear study for the hadrosaurs from the Cerro del Pueblo Formation (late Campanian), Coahuila, Mexico. These results are part of an ongoing project with the objective of establishing a microwear dataset and investigating the dinosaur paleoecology of the late Cretaceous of northern Mexico. The Cerro del Pueblo Formation represents a paralic ecosystem deposited in a low gradient coastal plain. The cyclic sequences are interpreted as deltaic lagoons and bays. Several hadrosaurs have been found, both Hadrosaurinae and Lambeosaurinae, including numerous isolated teeth. In the present study, a total of 40 teeth were moulded to produce high-resolution clear epoxy casts, which were examined under a light stereomicroscope at various magnifications. Eight specimens showed fairly well-preserved microwear features and these were photographed using high dynamic range imaging for microwear analysis. For each photographed specimen, the orientation and number of scratches as well as the number of pits were counted in two areas of the occlusal surface of the tooth, each measuring 400 x 400 µm. The results show that the specimens posses a large number of straight and subparallel scratches (33.5 ± 4.1; mean ± standard deviation) arranged in distinct orientations, with the most common scratches inclined 76º (standardized to a right maxillary tooth) from the mesiodistal axis. Scratch orientation for the hadrosaurs from Coahuila is generally comparable to that reported for *Edmontosaurus*, and suggests similar jaw mechanics in both taxa. The mean percent incidence of pits, the number of pits divided by the number of features multiplied by one-hundred, is 22. This value is higher than the incidence reported in the literature for late Campanian hadrosaurs from Texas, Wyoming, and Alberta; although in all cases sample size is small and, for the moment, statistical testing is precluded. Nevertheless, taken at face value, this result suggests the Coahuila hadrosaurs may have fed on harder food items.

Symposium 3 (Friday, November 1, 2013, 11:00 AM)

A SYSTEMATIC APPROACH TO DATING MESOZOIC-PALEOGENE CONTINENTAL VERTEBRATE ASSEMBLAGES IN AFRICA

ROBERTS, Eric, James Cook University, Townsville, Australia; O'CONNOR, Patrick, Ohio University, Athens, OH, United States; STEVENS, Nancy, Ohio Univ, Athens, OH, United States

In 2002, our team began exploring for fossil vertebrates in the Rukwa Rift Basin, Tanzania. This initial survey revealed Paleozoic through Pleistocene strata containing a mixture of vertebrate, invertebrate and plant fossils of largely unknown ages, many from units that were not previously dated or even mapped. Continued work over the last decade in the basin has demonstrated the existence of important Cretaceous-Paleogene faunas. In an attempt to date these fossils and the entire stratigraphy of the Rukwa Rift, we have employed a systematic approach and in the process learned a great deal about dating fossils in frontier settings of Africa. Because arc or rift-related volcanic activity is largely unknown for the interior of sub-equatorial Africa during this time, we initially applied heavy mineral analysis and detrital zircon geochronology to search for potential kimberlite-derived volcanics to help constrain the maximum depositional age of these units. This approach has proven to be invaluable and led to a more diversified approach that also involves seeking out carbonatite and other alkaline volcanic indicator minerals. These studies have revealed the presence of previously unknown magmatic episodes in western Tanzania and led to significant refinements in the chronostratigraphy of vertebrate bearing units. In the Cretaceous Galula Fm, Late Jurassic kimberite zircons were dated and provide a broad maximum depositional age. In the Paleogene Nsungwe Fm, dating of detrital zircon samples revealed an Oligocene maximum depositional age. Further identification of a unique heavy mineral assemblage in Nsungwe Formation fluvial sandstones, which includes pyrochlore, titanite, andradite, and phlogopite, ultimately led to the discovery of unusual devitrified carbonatite ash beds that were initially misidentified as paleosols. We utilized a combination of dating approaches, including Ar-Ar on phlogopite, U-Pb laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) on titanite, U-Pb sensitive high-resolution ion microprobe (SHRIMP) and chemical abrasion thermal ionization mass spectrometry (CA-TIMS) on zircon, and pilot magnetostratigraphy to precisely and accurately date the formation and develop this sequence into one of the best dated continental Paleogene sedimentary successions in Afro-Arabia. We have applied similar techniques to recent explorations of other terrestrial Jurassic-Paleogene successions in Zimbabwe, South Africa and DRC with varying levels of success. In each case, we have identified young kimberlites/alkaline volcanic grains, and in one case, we identified Late Cretaceous kimberlite zircons in rocks previously dated as Late Jurassic.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE SCIMITAR-TOOTHED CAT *MACHAIRODUS APHANISTUS* (CARNIVORA, FELIDAE) IN THE VALLÈS-PENEDÈS BASIN (NE IBERIAN PENINSULA): NEW REMAINS AND TAXONOMIC REVISION

ROBLES, Josep M., Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; MADURELL-MALAPEIRA, Joan, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; CASANOVAS-VILAR, Isaac, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; ABELLA, Juan, Museo Nacional de Ciencias Naturales-Consejo superior de Investigaciones Científicas (MNCN-CSIC), Madrid, Spain; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain

The genus *Machairodus* includes extinct lion-sized, scimitar-toothed cats from the late Miocene, classified in the tribe Homotheriini (Carnivora: Felidae: Machairodontinae). The type species of the genus, *Machairodus aphanistus*, has been mostly recorded from the Vallesian (MN9-MN10) of Eurasia, whereas Turolian (MN11-MN13) specimens from this continent are generally allocated to another genus species, *Amphimachairodus giganteus*. Here we revise all the published and unpublished scimitar-toothed cat remains from the Vallès-Penedès basin (NE Iberian Peninsula), in order to confirm their taxonomic attribution to *M. aphanistus* as well as to further precise its chronological distribution in this basin. The studied material (including dentognathic as well as postcranial remains) comes from the following localities: Can Mata indeterminate (MN8 or MN9), Creu Conill 22 (MN9), Can Poncic 1 (MN9), Can Llobateres 1 (MN9), Santiga (MN9), La Tarumba 1 (MN10), Ronda Oest Sabadell ROS-D6 (MN10), and Torrent de Febulines (MN10).

Most of the studied material fits well with the morphologic and metrical features characteristic of the Vallesian species *M. aphanistus*, with the exception of the remains from Creu Conill 22 (an undescribed partial P4 formerly attributed to this taxon), which belongs in fact to a medium-sized hyaenid. Taking into account the scarce fossil record of *M. aphanistus* in Eurasia, several of the newly reported postcranial specimens (mainly autopodial remains such as metapodials, carpals and tarsals) provide significant data for further undestanding the locomotor adaptations and predatory behavior of this taxon. From a biostratigraphic viewpoint, the removal of the Creu Conill material from the hypodygm of *M. aphanistus* has important implications. This locality, dated at ca. 11.1 Ma, represents the oldest MN9 locality of the basin as indicated by the presence of the equid *Hippotherium*. Therefore, our results indicate that the first appearance datum of *Machairodus* in the Vallès-Penedès Basin might be later than previously assumed—although dating uncertainties for the Can Mata remains preclude a more precise assessment. In contrast, the new mandibular remains from ROS-D6 (9.7-9.4 Ma) are roughly coeval with those from La Tarumba 1, with the last appearance datum of *M. aphanistus* in the Vallès-Penedès Basin corresponding to Torrent de Febulines (ca. 9.0 Ma).

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

LITTLE MORPHOLOGICAL VARIATION IN THE PTEROSAUR *ORNITHOCHEIRUS SIMUS*

RODRIGUES, Taissa, Universidade Federal do Espírito Santo, Alegre, Brazil; KELLNER, Alexander, Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Ornithocheirus simus is a species of historical importance, being one of the first pterosaurs described based on an anterior fragment of a rostrum from the Cambridge Greensand of England (a deposit whose fossils are probably Albian). It is also an important taxon for pterodactyloid taxonomy as the type species of *Ornithocheirus*. The family Ornithocheiridae is pointed out by several researchers as an important faunal component during the 'middle' Cretaceous, being present on almost all continents. However, the basic structure of *O. simus* is controversial. Several authors consider it a long-snouted animal with a robust premaxillary crest, based on the alleged similarities between *O. simus* and the more complete holotype of *Tropeognathus mesembrinus* from the Aptian–Albian Romualdo Formation of Brazil (sometimes referred as *O. mesembrinus*). There are plenty of comparisons between pterosaurs from the Cambridge Greensand and from the Romualdo Formation in the literature, mostly motivated by the fact that the species are morphologically similar and that it is unlikely that new and/or more complete material will be discovered from the English deposit. However, despite being known from several complete skulls, the range of individual, ontogenetic and sexual variation in the Brazilian pterosaurs is still poorly understood. This is especially true because most of these skulls are isolated, and associated postcranial material that would enable the identification, for instance, of the osteological maturity of the individuals based on size-independent criteria, is very rare. Thus, this material contributes little to the knowledge of morphological variation in the group. In the case of *O. simus*, however, at least five other fragmentary specimens from the Cambridge Greensand are referable to this species and shed light on the matter: despite showing distinct sizes (possibly representing different ontogenetic stages), they show very little morphological variation. These specimens enable the diagnosis of *O. simus* as a pterosaur with a tall rostrum, which is not expanded anteriorly, and with the first pair of premaxillary teeth directed ventrally and slightly displaced posteriorly from the anterior margin of the premaxilla. All specimens referable to *O. simus* lack a dorsally reflected palate, which is a derived feature present in different degrees in several other toothed pteranodontoids, including *Tropeognathus mesembrinus*. Thus, *Ornithocheirus* and Ornithocheiridae are taxonomically and geographically more restricted than previously thought.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW EARLY EOCENE PANTOLESTID SKELETON FROM FOSSIL BUTTE MEMBER, WYOMING, AND SKELETAL ONTOGENY IN PANTOLESTIDAE (MAMMALIA, PANTOLESTA)

ROSE, Kenneth, Johns Hopkins University School of Medicine, Baltimore, MD, United States, 21205; DUNN, Rachel, Univ of Missouri - Columbia, Columbia, MO, United States; GRANDE, Lance, Field Museum of Natural History, Chicago, IL, United States

Pantolestids were archaic Paleogene eutherian mammals most recently included in an ordinal-level category Pantolesta within the larger taxon Cimolesta. They were Holarctic in distribution and are best known from articulated skeletons from the early Eocene of Wyoming (Fossil Butte) and the middle Eocene of Messel, Germany. The moderately robust skull and skeleton show a suite of anatomical features widely associated with semi-fossorial and/or semi-aquatic habits in extant mammals, and skeletons from both Messel and Fossil Butte contain fish remains in the gut region.

Here we report a new subadult partial skeleton of a pantolestid from the late Wasatchian Fossil Butte Member of the Green River Formation. Molar size and morphology, including a well-developed paraconid, indicate that the skeleton represents *Palaeosinopa didelphoides*. The specimen is significant in having a full permanent dentition with incompletely erupted third molars and no diastemata, together with a relatively short skull, shallow dentaries, and unfused elbow epiphyses (typically the first epiphyses to close)—indications that it was a young juvenile. It adds to evidence that pantolestids had relatively early eruption of permanent premolars and late epiphyseal closure. Two other pantolestid skeletons were previously reported from the Fossil Butte Member, and were tentatively referred to *Palaeosinopa*. Despite differences in skeletal size and robustness among the three known Fossil Butte pantolestid skeletons, all of which are skeletally immature, similarity in molar size and morphology suggests that the three skeletons represent three growth stages of *P. didelphoides*. If this is correct, it has implications for recognition of fossil species based on such traits as jaw depth, presence/absence of diastemata, and relative robustness of skeletal features.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW INSIGHT IN THE EARLY EVOLUTION OF PECORA: CRANIAL ANATOMY OF *AMPHIMOSCHUS* (MAMMALIA, ARTIODACTYLA, RUMINANTIA)

RÖSSNER, Gertrud, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; RUF, Irina, Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn, Germany; MAIER, Wolfgang, Univ of Tuebingen, Tuebingen, Germany

The early differentiation of crown Pecora, predominantly cranial appendage bearing artiodactyls, is characterized by a number of hornless members. From the late Oligocene to the middle Miocene they have populated the Old World and North America and gave rise to all the well-known families of the modern world (Bovidae, Moschidae, Cervidae, Giraffidae, Antilocapridae) and extinct groups. However, the phylogenetic origin of extinct hornless pecorans is difficult to assess, as their record is mainly restricted to plesiomorphic dentition.

This contribution is a first time presentation on details of the external and internal cranial anatomy of the appendage-less Eurasian pecoran *Amphimoschus* Bourgeois, 1873. It is based on a recently unearthed, extraordinarily well-preserved cranium of a subadult individual from the Middle Miocene of Taiwan. Previously, *Amphimoschus* was basically known from dentition and has undergone a taxonomic odyssey from moschid to cervid to bovid to a hoplitomerycid relative. Most recently, it was assigned as a bovoid because of its comparably large tooth crown height. With our study, we aim at a substantial augmentation of knowledge on *Amphimoschus*, its more conclusive systematic assessment, and a more comprehensive idea on plesiomorphic features of basal crown Pecora.

Our comparisons with extant and extinct Ruminantia revealed, among other features, an external overall morphology with an outstandingly long and slender snout as well as caudally elongated occipitals. There is just one lacrimal foramen rostral of the orbital rim. Micro-CT scans display the complete non-erupted pecoran dentition including a male enlarged saber-shaped upper canine. The virtual endocast of the inner ear bony labyrinth comprises an oval lateral semicircul with a sharp bend between the anterior leg of the canal and the lateral ampulla, most similar among living Pecora to giraffids. Moreover, *Amphimoschus* shows a secondary common crus of the semicircular ducts, which is a plesiomorphic mammalian feature, but absent in extant derived bovids, antilocaprids, and tragulids.

In summary, besides the predominantly plesiomorphic appearance, there is evidence for an early derived/specialized condition most similar to giraffids and we conclude a possible giraffid affinity of *Amphimoschus*. A dorsocaudally horizontal profile of the occipitals is found to be a plesiomorphic ruminant feature, conserved in Giraffoidea. Initial tooth crown height increase as an autapomorphy of early Bovoidea in Ruminantia has to be taken with caution.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW SPECIMENS OF THE LATE CRETACEOUS MAMMAL *COLONIATHERIUM CILINSKII* (MAMMALIA, MERIDOLESTIDA): DENTAL ANATOMY, RECONSTRUCTION OF THE DENTAL SERIES, AND RELATIONSHIPS OF SOUTH AMERICAN MERIDOLESTIDS

ROUGIER, Guillermo, University of Louisville, Louisville, KY, United States, 40202; MARTINELLI, Agustin, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; SCHÖNING, Meike, Universität Hamburg, Hamburg, Germany

Coloniatherium cilinskii, from the Late Cretaceous La Colonia Formation, Chubut province, Patagonia, Argentina is known by a collection of more than a hundred specimens. Most of the fossils come from the "El Uruguayo" quarry, but a few other specimens are known from other localities of the same unit. The bulk of the specimens are isolated teeth, but a few jaws, petrosals, and postcranial elements can be referred to this taxon. By comparing the jaws in the collection and isolated dental elements of *Coloniatherium* with the closely related meridiolestids *Mesungulatum* and *Peligrotherium*, we have reconstructed the whole postcanine dental series. The dental formula is interpreted as: I?/?C1/1P3/3M3/3, but there is no evidence of dental replacement in the collection and alternative interpretations are possible. The largest tooth of the series is the multi-rooted, fully molarized last premolar (P/p3). The molar series diminishes in size from the M/m1to the M/m3, with a much reduced M3. The upper dentition is dominated by a central stylocone and a prominent lingual paracone; while in the lowers the protoconid, paraconid and metaconid are the dominant cusps. The M2 and M3 reduce the metastylar portion of the crown suggesting a strongly curved maxilla, also suggested by the strongly asymmetrical P2. In the lower dentition only the m3 reduces its distal cingulum. *Coloniathierium* teeth are comparatively large and show a pronounced bunodont dentition that is further complemented by large and elaborated cingula, building on a more primitive morphology like that present in the Late Cretaceous *Mesungulatum*. *Peligrotherium* from the Paleocene of Patagonia is even larger and further develops these traits with robust blunt cusps and cingula incorporated into the occlusal surface. *Coloniatherium*, *Mesungulatum*, *Peligrotherium*, and the more enigmatic *Reigitherium* form a monophyletic group of highly-derived bunodont/herbivorous meridiolestids: Mesungulatoidea. The ungulate-like mesungulatoids are the most common Late Cretaceous mammals in South America, being first recorded in the Coniacian, prospering during the Late Cretaceous, and surviving the K/T extinction event.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ENDEMISM AND DISPERSAL IN EAST AFRICAN BOVIDAE FROM THE LATE MIOCENE THROUGH THE RECENT

ROWAN, John, Institute of Human Origins, Arizona State University, Tempe, AZ, United States, 85281; REED, Kaye, Institute of Human Origins, Arizona State University, Tempe, AZ, United States

Bovids are frequently used as environmental indicators and in habitat reconstructions of the East African Plio-Pleistocene due to their ubiquity in fossil deposits and their tribal preferences for particular habitats. However, their commonness also lends itself to testing biogeographical hypotheses regarding endemism and dispersal in mammalian assemblages during this time period. We examined 131 extant and fossil bovid species from 80 modern and fossil localities spanning the late Miocene through the present using the Dice similarity index and cluster analyses to test the hypothesis that due to increased oscillations in climate that stressed the habitats of terrestrial communities beginning ~2.8 Ma, bovid taxa after that time are more widely dispersed. We expected bovid assemblages prior to 2.8 Ma to show higher levels of isolation relative to younger communities, because habitats were likely more stable. The results demonstrate that, with few exceptions, the strongest taxonomic similarity is between geologic members of the same site rather than with contemporaneous sites before 2.5 Ma. Sites younger than 2.5 Ma cluster together irrespective of geography. These results suggest that bovid communities in East Africa are characterized by high degrees of isolation and possible endemism since the late Miocene and that large geographic ranges are a unique characteristic of extant species that have evolved relatively recently. The climatic changes beginning at 2.8 Ma likely began to influence bovid distribution and range expansion which culminated in the pattern observed today.

Symposium 3 (Friday, November 1, 2013, 9:00 AM)

U/PB RADIOMETRIC DATES FROM THE KAROO SUPERGROUP (SOUTH AFRICA) ENABLE CORRELATION OF PERMIAN CONTINENTAL SEDIMENTARY SUCCESSIONS AND CONSTRAIN MID-LATE PERMIAN TETRAPOD BIODIVERSITY CHANGES

RUBIDGE, Bruce, University of the Witwatersrand, Johannesburg, South Africa; ERWIN, Douglas, H., National Museum of Natural History, Washington, D.C., VA, United States; RAMEZANI, Jahandar, Massachusetts Institute of Technology, Cambridge, MA, United States; BOWRING, Samuel A, Massachusetts Institute of Technology, Cambridge, MA, United States; DAY, Mike, BPI Palaeontology Wits SA, Johannesburg, South Africa

The Karoo Supergroup of South Africa preserves the best record of continental Permian to Jurassic tetrapod faunal biodiversity. An abundance of fossils has enabled studies of biodiversity change over this extended time period, particularly in documenting the evolutionary dynamics of therapsids, faunal responses to the Permian icehouse to greenhouse transition, and the Permo-Triassic mass extinction event. This rich record of fossil tetrapods has allowed biostratigraphic subdivision of the Beaufort Group into seven Permian and two Triassic biozones, which have served as the basis for global correlation of Permian–Triassic continental sedimentary deposits and played a role in basin development models for the Karoo and allowed paleoenvironmental reconstruction.

A major hindrance for studies of the vertebrate record has been the lack of reliable radiometric dates for Permian assemblages and, until now, age determination for the Beaufort Group biozones has been dependent on faunal correlation with other Pangaean tetrapod successions, where paleomagnetism and marine biostratigraphy have provided some time constraints. However, the correlation of Permian tetrapod faunas to the marine standard has been controversial. Of particular interest has been whether any of the identified declines in vertebrate diversity within the Permian correlate to the end-Guadalupian marine mass extinction.

U-Pb zircon isotope dilution-thermal ionization mass spectrometry (ID-TIMS) dates for volcanic ashes from different stratigraphic horizons of the Permian Beaufort Group establishes age constraints for the different vertebrate biozones within the lower Beaufort. Integration of these dates with vertebrate biozones will for the first time provide ages for global correlation of Middle-Late Permian continental successions, constrain patterns of

vertebrate biodiversity change and evolution, and revolutionize basin development models of the Karoo Supergroup. Determination of reliable radiometric ages for Karoo biozones establishes the Beaufort Group as the reference succession for the terrestrial Mid-Late Permian.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A SILESAURID (ARCHOSAURIA: DINOSAURIFORMES) FROM THE TRIASSIC OF THE ATACAMA DESERT, CHILE

RUBILAR-ROGERS, David, Museo Nacional de Historia Natural, Santiago, Chile; EZCURRA, Martín, Ludwig-Maximilians-Universität München, Munich, Germany; IRMIS, Randall, University of Utah, Salt Lake City, UT, United States; DESOJO, Julia, Comisión Nacional de Investigación Científica y Técnica, Sección Paleontología Vertebrados, Museo Ar, Buenos Aires, Argentina; SOTO-ACUÑA, Sergio, Red Paleontológica Universidad de Chile, Santiago, Chile

Silesaurids are dinosauriform archosaurs hypothesized to be the sister-taxon of Dinosauria. The clade includes species from the Middle and Late Triassic of North and South America, Europe, and Africa, and consists of herbivorous/omnivorous quadrupedal forms with beaked lower jaws. In South America, silesaurids are currently restricted to one taxon from the early Norian of Brazil and preliminary reports from the late Carnian of Argentina. Here, we substantially expand the South American silesaurid record with the description of a partial postcranial skeleton from the Triassic strata of the Atacama Desert in northern Chile. The Museo Nacional de Historia Natural specimen SGO.PV.22250 comes from the "Estratos El Bordo", a sedimentary unit that can currently only be constrained to the Triassic; it has also yielded the pseudosuchian *Chilenosuchus forttae*. The specimen is mainly preserved as natural moulds in a silicified limestone block. The slab includes a sequence of ten articulated presacral vertebrae, partial ilia and hind limbs, and several ribs. The ilium has a preacetabular process that does not extend beyond the anterior margin of the pubic peduncle and the acetabulum is partially closed, with a gently concave ventral margin. The femur is sigmoidal in posterior view and possesses a prominent fourth trochanter. The fibular shaft is only slightly transversely thinner than that of the tibia. The femoral head is trapezoidal in posterior view and separated from the shaft by a distinct notch. A deep popliteal fossa extends along at least one-quarter of the length of the bone. The latter three femoral characters are apomorphies of Silesauridae, but the fragmentary nature of the specimen prevents us from determining its phylogenetic relationships within Silesauridae. However, the presence of a partially closed acetabulum distinguishes the Chilean form from other silesaurids with preserved ilia (e.g. *Silesaurus*, *Sacisaurus*, *Asilisaurus*). This specimen increases the diversity and biogeographic range of Silesauridae, and represents only the second tetrapod lineage known from the Triassic of Chile.

Technical Session VIII (Thursday, October 31, 2013, 3:45 PM)

NASAL ANATOMY OF THE ADVANCED CYNODONT *BRASILITHERIUM RIOGRANDENSIS* REVEALS NEW ASPECTS OF MAMMALIAN EVOLUTION

RUF, Irina, Universität Bonn, Bonn, Germany; MAIER, Wolfgang, Universität Tübingen, Tübingen, Germany; RODRIGUES, Pablo G., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; SCHULTZ, Cesar L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

A highly complicated nasal cavity that houses a specific system of turbinates is a unique characteristic of mammals. These turbinates are not only involved in olfaction but also in warming and moistening of air. The two-fold function of the turbinates is an essential feature correlated with the macrosmatic and endothermic adaptations of therapsids and early mammals. However, fossil evidence for the origin of the highly derived mammalian nasal cavity is lacking, because their skeletal support most probably still consisted of cartilage. Ossification of the endocranial nasal capsule and its turbinates seems to have occurred very late in synapsid evolution. The few published reconstructions of the turbinate system in advanced therapsids and early mammals do not agree well with the morphological concepts derived from craniogenetic studies of extant mammals.

In order to elucidate the early evolution of the mammalian nasal cavity, we studied a very well preserved skull of the advanced cynodont *Brasilitherium riograndensis* from the Late Triassic of Southern Brazil. High resolution computed tomography and virtual 3D reconstructions of internal structures of the nasal cavity provide the first evidence for delicate ethmoidal bones in this sister-group of mammals. The maxilloturbinal is T-shaped and thus resembles the homologous structure observed in young fetuses of extant mammals. The nasoturbinal is also partly ossified and attached to a distinct ridge of the nasal bone. The partly ossified nasal septum contributes to the mesethmoid; it shows impressions of the olfactory nerves. The posteriorly expanded nasal cavity (ethmoturbinal recesses) houses a small bony lamella that we interpret as the anteriormost ethmoturbinal of extant mammals. The ethmoturbinal recesses are ventrally separated from the nasopharyngeal duct by an ossified posterior transversal lamina, which also incorporates lateral processes of the vomer. A virtual reconstruction of the anterior nasal floor reveals that the vomeronasal organ and its cartilages were mainly housed within grooves of the medial palatine processes of the premaxillary bones. Our observations clearly demonstrate that principal features of the mammalian nasal bauplan were already present in the forerunners of mammals.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW RELICT BASAL CERATOPSID FROM THE OLDMAN FORMATION (CAMPANIAN) OF ALBERTA WITH IMPLICATIONS FOR CENTROSAURINE EVOLUTION

RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, United States, 44106; HOLMES, Robert, University of Alberta, Edmonton, AB, Canada; MALLON, Jordan, Canadian Museum of Nature, Ottawa, ON, Canada

*In 1937, C. M. Sternberg collected a disarticulated, partial skull of a ceratopsid from the upper unit of the Campanian Oldman Formation (OF) of what is now the Milk River Natural Area in southeastern Alberta (AB). He referred the specimen to '*Brachyceratops*' based, in part, on the distinctive squamosal and the thin parietal lacking epiossifications. Reexamination of the material identifies it as a subadult-sized centrosaur (basal skull length ≈1m) with long postorbital horncores and a deep face. Long-grained bone texture is present on all of the flattened surfaces, supporting a subadult age designation. Both robust postorbital horncores are present and the complete right element (~200 mm in length) has a round base; both have a shallow sinus at the base of the shaft, and a modest medial inflection. As reconstructed, the base of each horn is oriented anterolaterally so that their apices would have arced towards the midline. Although neither nasal was recovered, the posterodorsal margin of the right premaxilla has an expanded dorsal surface indicative of contact with at least a modest nasal ornamentation. The large, flat parietal fragment is from the posterior right half of the frill and preserves a portion of a straight posterior margin with 4 well-developed scallops. Parietal fenestrae, if present, would have been small and confined to the anterior margin of the frill. A phylogenetic analysis places the specimen as a basal long brow-horned centrosaur closely related to *Albertaceratops*, *Diabloceratops*, and *Xenoceratops*, but its exact taxonomic designation cannot be determined due to its immature status. However, the parietal morphology suggests that it differs from these taxa in having loci for epiparietals distributed evenly across a straight posterior margin. In southern Alberta, the upper unit of the OF is time equivalent to the lower Dinosaur Park Formation (DPF) in the region of Dinosaur Provincial Park (DPP) ~200 km to the north, making the specimen ~1 Ma younger than *Albertaceratops* and contemporaneous with *Centrosaurus* that is known from both the upper OF of southern AB and the DPF of DPP. This indicates that basal centrosaurs persisted in Laramidia much longer (~79 to 76 Ma) than previously thought and overlapped temporally with the short brow-horned centrosaurs. Their rarity in well-sampled sediments suggests that they may have had different ecological preferences than the latter group, and may not have formed large aggregations prone to mass death events.

Symposium 4 (Saturday, November 2, 2013, 11:45 AM)

FIRST EVIDENCE FOR A HIGH ARCTIC CAMEL SUGGESTS HIGH LATITUDE ORIGINS FOR *CAMELUS* ANCESTOR

RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada, K1P 6P4; FRASER, Danielle, Carleton University, Ottawa, ON, Canada; BUCKLEY, Mike, University of Manchester, Manchester, United Kingdom; GOSSE, John, Dalhousie University, Halifax, NS, Canada

A partial tibia of a camel fossil, collected from ~78 degrees North, in the Strathcona area of Ellesmere Island (Nunavut, Canada), represents the first evidence that camels lived in the High Arctic. The taxonomic identity was verified using collagen fingerprinting, which involved comparison with collagen of 37 modern mammals. In particular the "collagen fingerprint" of the High Arctic camel matched that of the modern dromedary (*Camelus dromedarius*) and the Pleistocene Yukon giant camel (cf. *Paracamelus*), but was distinguishable from the Bactrian camel, *C. bactrianus* (one peak difference). Although Camelidae (Camelini+Lamini) originated and diversified in North America, as documented by a rich mid latitude fossil record, near relatives of the modern camel (i.e., the "*Paracamelus*" lineage) are unknown from the mid-latitude fossil record of North America. Based on the new evidence, we suggest that "*Paracamelus*" originated in the high latitudes of North America, dispersing to Eurasia via the Bering Isthmus by 6-7 Ma. This Eurasian dispersal is represented by latest Miocene fossil remains of *Paracamelus* in both Spain and China. The High Arctic camel lived during the mid-Pliocene warm period (MPWP). The >3.5 Ma age of the fossil was determined using terrestrial cosmogenic nuclide burial dating of the sands associated with the fossil camel remains. During the MPWP, global temperatures were 2 to 3 degrees warmer than today, while the area where the camel lived was 14 to 22 degrees warmer than today, yielding a regional palaeoclimate mean annual temperature of near freezing. Modern Camelini (*C. dromedarius* and *C. bactrianus*) are associated with open, arid habitats, yet the High Arctic camel was associated with a polar boreal-type forest. Our hypothesis that a forest habitat (specifically a boreal-type high latitude forest) was the original adaptive regime of the *Paracamelus*+*Camelus* lineage is supported by dental evidence (e.g., hyposdonty and dental wear), which suggests that the early high latitude camels were closed-habitat specialists. Taken together, the results suggest modern camels can trace their heritage back to a recent ancestor specialized for living in northern boreal-type forests.

Technical Session II (Wednesday, October 30, 2013, 8:30 AM)

NEW APPROACH TO MAMMALIAN PALEOECOLOGY - OCCLUSAL WEAR ANGLES OF MOLAR TEETH AS A MEASURE OF DIET ABRASIVENESS IN ELEPHANTS AND THEIR FOSSIL RELATIVES (MAMMALIA, PROBOSCIDEA)

SAARINEN, Juha, University of Helsinki, Helsinki, Finland; KARME, Aleksis, University of Helsinki, Helsinki, Finland; UNO, Kevin, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, United States; SAILA, Laura, University of Helsinki, Helsinki, Finland

The analysis of the secondary, wear induced shape of the occlusal surface of herbivorous mammal teeth, known as mesowear analysis, has proven out to be a rapid

and robust method for assessing the proportion of abrasive plant material (mainly grass) in the diet of herbivorous mammals. This method has important applications for paleoecological reconstruction, because it reflects the actual diet in populations of herbivorous mammals and it gives valuable information about feeding ecology in fossil mammal communities, and ultimately it reflects environmental conditions.

The traditional mesowear method can only be applied for herbivorous mammals with selenodont, ectolophodont or plagiolophodont molar morphology, because a buccal enamel crest is needed to show facets from which relief and shape of the buccal cusps can be readily observed. However, the principle can be extended to other kinds of tooth morphology. Elephants have specialised lamellar tooth morphology, and their propalineal chewing causes a wear pattern that cannot be analysed with the traditional mesowear method, because the enamel ridges of the lamellae are rubbed against each other in oblique direction and facets do not develop. However, the relief of the occlusal surface of elephant molars should follow similar principles as those of other herbivorous mammals so that increasingly abrasive food causes a lower relief. Here we introduce a new approach similar in principle to the mesowear method based on angle measurements taken from dentine valleys between the enamel lamellae on the occlusal surface of an elephant molar. We show that these tooth wear angles correlate significantly with stable carbon isotope values measured from tooth enamel of fossil and recent populations of elephants in tropical Eastern Africa and Asia. Because the carbon isotope values reflect the proportion of C4-photosynthetising grasses in the diet of tropical elephant populations, we conclude that the wear angle measurements reflect the proportion of abrasive material, mainly C4 grass, in elephant diet. We applied the wear angle method for assessing the diet of the Late Pleistocene Columbian mammoth (*Mammuthus columbi*) population from Rancho la Brea, California, and found it to be highly abrasion dominated, as expected.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

COMPARATIVE MASS ESTIMATE METHODS OF 3D DIGITAL MODELS OF ORNITHISCHIAN SKELETONS AND GASTROLITHS

SADLEIR, Rudyard, Saint Xavier University & Field Museum, Chicago, IL, United States, 60655; MAKOVICKY, Peter, Field Museum, Chicago, IL, United States; HUTCHINSON, John, Royal Veterinary College, Hatfield, United Kingdom

Accumulations of gastroliths for the trituration of ingested food are known from an increasing range of archosaurian taxa. Recent gastrolith research has made great progress using extant herbivorous birds for comparative insight on saurischian dinosaur gastrolith function and physiology. Despite this growing understanding of gastroliths, some ornithischian dinosaurs show the apparent redundancy of possessing a sophisticated masticatory apparatus and a gastrolith mass. These features suggest a more dynamic pattern of gastrolith function and physiological regimes than what is currently understood. The basal ornithopod, *Haya griva*, is one of only three known ornithischian genera with a well-defined gastrolith mass associated with articulated skeletal material. The combination of computer modeling approaches and scanning technologies facilitate estimation of gastrolith and body volumes and their masses for insight into the anatomy and physiology of the digestive system of extinct archosaurs. Computed tomography (CT) scans from a General Electric VCT 64 instrument were segmented to reconstruct a three-dimensional (3D) surface model of a *Haya* skeleton for mass estimation. We present a methodological approach for large jacket scanning, CT computation to improve image resolution, and methods for digital skeletal mounting. Compared with gastrolith mass estimates from incompletely prepared specimens, we compute a highly accurate gastrolith mass estimate of the *Haya* gastrolith mass of 250 g using the 3D digital volumes. Using a linear metric estimate of *Haya*'s body mass (7 kg) we observe a gastrolith-to-body mass ratio range of 2.6% and 3.6%. This value is significantly above the observed avian gastrolith mass mean of 1.05% of body mass, and suggests that observed avian values may be constrained by the shortening of the trunk region that occurred with the origin of flight. Whether non-avian dinosaurs were free of such constraint and therefore ingested a proportionately larger gastrolith mass can be further tested through examination of other taxa known to retain gastroliths. Since gastrolith masses represent a minimum stomach volume, they can be used as a proxy for this organ in addressing questions about dinosaur digestion and physiology. This study represents the first attempt at mass estimation using digital 3D methods for basal neornithischians, permitting comparisons with previously developed linear metric mass estimates and an understanding of mass distribution from body segment masses in this group of dinosaurs.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CROC'S TWO REALMS: NEW CENOZOIC DISCOVERIES FROM THE AMAZONIAN BASIN AND THE PACIFIC COAST OF PERU

SALAS-GISMONDI, Rodolfo, Université Montpellier 2, Montpellier, France; ANTOINE, Pierre-Olivier, Université Montpellier 2, Montpellier, France; CLARKE, Julia A., University of Texas at Austin, Austin, TX, United States; BABY, Patrice, Université de Toulouse, Toulouse, France; URBINA, Mario, Museo de Historia Natural, UNMSM, Lima, Peru

During the last decade, a number of vertebrate-bearing localities from Western Amazonia and the coastal desert of Peru have yielded remarkable new material of Cenozoic fossil crocodyliforms. Each region provides different and complementary data on the evolutionary history of the clade within South America. Whereas the Amazonian material (Eocene to Miocene) offers evidence of high taxonomic diversity and highly divergent snout morphotypes, particularly during the Miocene, coastal remains document only longirostrine crocodyles from the late Eocene up to the Pliocene. Isolated crocodyliform teeth from Paleogene localities of Peruvian Amazonia strongly suggest that sebecids, caimanines, and putative gavialoids have occupied this realm at least since the middle Eocene. The same general assemblage is revealed in several foreland bonebeds belonging to the middle Miocene Pebas mega-lake complex that occupied most Western.Amazonia. A single gavialoid species along with a diversified array of caimans (giant to small) inhabited this network of aquatic environments. Prior to the fluvial-dominated Acre System, the Pebas System marks the last record of *Eocaiman*-like forms and the first appearance of a taxon allied to *Paleosuchus*, possibly a breaking point for basal and relatively advanced caimanines. In the coastal realm, the oldest conclusive gavialoid from South America is recorded in late Eocene strata of the Pisco Basin. Its affinity to Paleogene African gavialoids suggests a Paleocene-early Eocene transatlantic dispersion followed by other episodes of this kind, unless parallel acquisition of derived characters in later South American and African-Indian gavialoids might be considered an option. By Neogene times, longirostrine crocodyles that occupied coastal marine environments reflect neither long term endemism, or even close phylogenetic relationships. A new late Miocene gavialoid found in association with the coastal *Piscogavialis* is strongly reminiscent of early "thoracosaurs" from the Cretaceous-Paleogene of North America and Europe. This data emphasizes the prominent role of transoceanic dispersals and effective salt tolerance in gavialoids history. On the other hand, caimanine fossil record implies a diminished competence to cross salt water barriers, although dispersal events to Central America in the Miocene might occurred. Suggestive evidence indicates that caimanines evolved in the pan-Amazonian wetlands under any sort of occasional marine influence during the Cenozoic.

Technical Session XIII (Friday, November 1, 2013, 3:45 PM)

THE ONTOGENY OF ROMER'S GAP FISHES (TOURNAISIAN, CARBONIFEROUS) AND THE ESTABLISHMENT OF POST-HANGENBERG RAY-FINNED FISH (ACTINOPTERYGII) DIVERSITY

SALLAN, Lauren, University of Michigan, Ann Arbor, MI, United States, 48109

In the aftermath of the end-Devonian Hangenberg extinction (359 million years ago, My), ray-finned fishes (Actinopterygii) diversified into a variety of novel forms, cementing their subsequent dominance of aquatic ecosystems. However, the breadth and source of this new diversity has been obscured by long-term taxonomic neglect relative to co-occurring lobe-finned fishes and tetrapods. The actinopterygians of the Tournaisian Mississippian of Foulden, Scotland (~348 My) have not been given more than a few paragraphs of published description since their discovery over a century ago, despite their presence in the "Romer's Gap" recovery interval. Re-examination of specimens of two key taxa, *Fouldenia* and *Aetheretmon*, has revealed new data on early ray-finned fish diversity and the oldest known actinopterygian ontogenetic series. *Fouldenia* is shown to be the earliest known shell-crushing actinopterygian, its traits marking it as the oldest member of a newly erected yet widespread and long-surviving plesion of durophagous fishes, the Eurynotiformes. As this group contains multiple deep-bodied taxa as well as more fusiform fish, such as *Fouldenia*, its recognition overturns previous hypotheses uniting all deep-bodied Paleozoic actinopterygians in a single monophyletic clade ("Platysomoids"). *Fouldenia* itself increased in relative body depth as it grew, giving insight into how deep-bodied forms might have evolved multiple times in the initial actinopterygian radiation. *Aetheretmon* juveniles show that the axial lobe of the tail grew on a trajectory independent from the body, increasing in relative length, width and prominence with age. This undermines the validity of character states widely used to define major living clades (e.g., crown Neopterygii) and hypotheses of recapitulation in teleosts, while revealing a potential source of observed diversity in Paleozoic actinopterygian tails. These taxa illustrate how detailed re-examination of the actinopterygian fishes of Foulden and other Romer's Gap localities is essential to understanding subsequent ray-finned fish diversity.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE CHRONOLOGY OF LEMUR EXTINCTION IN NEAR AND DEEP TIME

SAMONDS, Karen, Northern Illinois University, DeKalb, IL, United States, 60115; GODFREY, Laurie, University of Massachusetts, Amherst, MA, United States; CROWLEY, Brooke, University of Cincinnati, Cincinnati, OH, United States; SUTHERLAND, Michael, University of Massachusetts, Amherst, MA, United States

Recent phylogenetic analyses of molecular as well as morphological data have greatly elucidated the pattern and timing of diversification of now-extinct and extant Malagasy lemurs. Not merely do we know the likely extant sister taxa for each clade of extinct lemurs, but we know their likely divergence dates. We can now use this knowledge, together with tools for modeling speciation and extinction rates, to identify episodes of unusually high extinction, when species loss greatly exceeded expected background extinction rates. One such episode likely occurred at around the time of the Grand Coupure (the Eocene/Oligocene boundary, 34 Ma), when global temperatures dropped precipitously and an ice cap began forming on Antarctica. This period was followed by rapid diversification of lemur families. Seven of the eight known lemur families (including extinct ones) arose around this time or not long thereafter. A second such episode is ongoing; it began not more than 2000 years ago. This decline can be documented in great detail, as a number of the subfossil sites from which extinct lemurs are known have yielded excellent radiocarbon records. Now-extinct lemurs had their populations decimated by around 1000 years ago, although at least five species survived past ~500 years BP. During the course of the past two millennia, a total of three lemur families disappeared completely, and two others lost members. This lemur extinction episode also coincided with the extinctions of other endemic vertebrate clades on the island of Madagascar. Lemur extinctions during the past 2000 years have been described as "slow" or "prolonged," but in geological terms they have been extremely rapid. Their pace is unsustainable. While climate change has been invoked to explain these extinctions, the timing and tempo of this event supports the view that they were triggered by humans.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE FIRST RECORDS OF LEPTOCHOERIDS (ARTIODACTYLA) FROM THE JOHN DAY FORMATION OF OREGON

SAMUELS, Joshua, John Day Fossil Beds National Monument, Kimberly, OR, United States, 97848; MACKENZIE, Kristen, University of Oregon, Eugene, OR, United States; FREMD, Ted, University of Oregon, Eugene, OR, United States

Leptochoerids are a family of small, primitive bunodont artiodactyls known from rare finds dating to the Eocene and Oligocene of North America. Recent fieldwork at John Day Fossil Beds National Monument has yielded specimens of two leptochoerids, *Leptochoerus* and *Stibarus*. *Leptochoerus* is represented by two specimens: one with fragments of a skull and a partial skeleton and the other with two fragments of a dentary. A particularly small species of *Stibarus* is represented by a single upper molar. Both species were discovered in the Turtle Cove Member of the John Day Formation; *Leptochoerus* from the Whitneyan age unit A, and *Stibarus* from the early Arikareean age unit D. Due to the well-studied stratigraphy and traceable ash layers of Turtle Cove, these specimens can be dated to between 30.6 and 29.75 Ma for *Leptochoerus* and between 29.75 and 28.8 Ma for *Stibarus*.

Leptocherids have only been reported previously from the Great Plains, making these new discoveries from Oregon the first records of the family west of the Rockies. The locality where these specimens were found is among the best studied and most productive in the John Day Basin, having yielded tens of thousands of specimens to date. Larger bunodont artiodactyls, entelodonts and tayassuids, are uncommon but well-known from this and other sites from the John Day Formation. The presence of leptochoerids in the John Day fauna indicates a greater diversity in omnivorous artiodactyls in the Oligocene of Oregon. The eventual extinction of this group in the region may be linked to the diversification of small hypocarnivorous borophagine canids in the early Arikareean, which are particularly abundant in Turtle Cove and may have been potential competitors of leptochoerids.

Symposium 1 (Wednesday, October 30, 2013, 10:45 AM)

AGING, MATURATION AND GROWTH OF SAUROPODOMORPH DINOSAURS: EVIDENCE FROM THE HISTOLOGICAL GROWTH MARK RECORD IN LONG BONES

SANDER, P. Martin, University of Bonn, Bonn, Germany; GRIEBELER, Eva Maria, University of Mainz, Mainz, Germany; KLEIN, Nicole, University of Bonn, Bonn, Germany

Information on aging, maturation, and growth is important for understanding life histories of organisms. In extinct dinosaurs, such information can be derived from the histological record of growth in the mid-shaft cortex of long bones. Here, we construct growth curves to estimate ages at death, ages at sexual maturity, ages at which individuals were fully grown, and maximum growth rates from long bones of six sauropod dinosaur individuals (one indeterminate mamenchisaurid, two *Apatosaurus* sp., two indeterminate diplodocids, and one *Camarasaurus* sp.) and one basal sauropodomorph dinosaur individual (*Plateosaurus engelhardti*). Using these estimates, we establish allometries between body mass and each of these traits and compare these to extant taxa.

Growth models considered for each dinosaur individual were the von Bertalanffy model, the Gompertz model, the logistic model (LGM), all of which have inherently fixed inflection points, and the Chapman-Richards model in which the point is not fixed. We use the arithmetic mean of the age at the inflection point and of the age at which 90% of asymptotic mass is reached as an estimate of age at sexual maturity because unambiguous indicators of maturity in Sauropodomorpha are lacking.

According to a model selection process based on the corrected Akaike's information criterion, the LGM was the best model for our sample. Allometries established are consistent with literature data on other Sauropodomorpha. All Sauropodomorpha reached full size within a time span similar to scaled-up modern mammalian megaherbivores and had similar maximum growth rates to scaled-up modern megaherbivores and ratites, but growth rates of Sauropodomorpha were lower than of an average mammal. Sauropodomorph ages at death probably were lower than that of average scaled-up ratites and megaherbivores. Sauropodomorpha were older at maturation than scaled-up ratites and average mammals, but younger than scaled-up megaherbivores. We conclude that similar environmental factors shaped the life history of Sauropodomorpha and of extant mammalian megaherbivores and ratites.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

CLASSIFICATION AND BIOCHRONOLOGY OF AFRICAN MIOCENE PROBOSCIDEANS

SANDERS, William, Univ of Michigan, Ann Arbor, MI, United States, 48109-1079

Proboscidea arose in the early Paleogene of Africa, and most of its important evolutionary events occurred on the continent. Survived now only by elephants, African proboscideans were far more diverse taxonomically in the Miocene. Chronostratigraphic improvements and advances in systematic studies provide the means to delimit the temporal ranges of African proboscidean taxa with more precision and to recognize significant evolutionary episodes. In this study, Miocene African proboscideans were classified by comparative morphometric analysis of features such as loph(id) formula, patterns of half-loph(id) offset, distribution of accessory conules or crescentoids, molar crown proportions, relative size of median conelets, number of conelets per loph(id), relative crown height, development of cementum, tusk shape, occurrence of lower tusks, expression of tusk enamel, tusk curvature, and size and angulation of mandibular symphyses. For example, *Protanancus* is distinguished from other amebelodontine gomphotheres by pseudo-anancoidy of half-loph(id)s, lower tusk shape, molar proportions, and m3 lophid formula. Taxa identified consist of deinotherioids, a host of elephantoids including mammutids and highly diverse gomphotheriids, stegodontids, and elephantids. Temporal calibration of these taxa circumscribes successive proboscidean events: early Miocene ≥19 Ma, presence of *Eozygodon*, *Progomphotherium*, and first appearance of *Prodeinotherium hobleyi*; latest early Miocene, presence of *Archaeobelodon*, first appearance of *Afrochoerodon*, *Zygolophodon*, and *Gomphotherium angustidens libycum*; middle Miocene, presence of *Afromastodon*, *Protanancus*, first appearance of *Choerolophodon*; late Miocene, first appearance of *Deinotherium*, *Anancus*, *Tetralophodon*, *Stegodon*, and true elephants. Morphological stages and FAD/LADs of these taxa permit finer resolution of dating within these intervals. The results are valuable for more accurate dating of sites such as hominoid-bearing Moroto, Uganda, alternatively dated to >20 Ma, late early Miocene, or early middle Miocene, and for examining the timing of evolutionary events among different lineages in Miocene African faunal succession.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

UNVEILING THE DIGGING ADAPTATIONS IN PROSCALOPIDAE HUMERUS BY MEANS OF COMPARATIVE 3D FINITE ELEMENT ANALYSIS

SANSALONE, Gabriele, Roma Tre University, Rome, Italy; TERESI, Luciano, Roma Tre University, Rome, Italy; COX, Timothy, University of Washington & Center for Developmental Biology, Seattle, WA, United States; MOSCATO, Marco, Studio dentistico Moscato, Rome, Italy; KOTSAKIS, Tassos, Roma Tre University, Rome, Italy

The extinct North American family Proscalopidae (Oligocene–Miocene) possess one of the most highly modified humeri among mammals. It has been hypothesized in the past that their functional adaptation has no extant homolog. The closest functional morphology appears to be that observable in Chrysochloridae and Talpidae, two extant families of fossorial mammals. In fact proscalopids present an extremely expanded lateral epicondyle and a distally placed teres tubercle. It has been proposed in the past that proscalopid locomotion involved both head lifting and humeral digging as happens in chrysochlorids. These two clades also share similar anatomy of the cervical vertebrae and skull suggesting functional analogies in the head lifting during digging.

We tested here the mechanical performance of the humerus of the exquisitely preserved *Mesoscalops montanensis* (early Miocene of Wyoming) as compared to those of the extant highly specialized digger talpid *Talpa romana*, to the less specialized talpid *Urotrichus talpoides*, and to the chrysochlorid *Chrysochloris stuhlmanni*. We achieved this by performing 3D Finite Element Analysis starting from CT scans of humeri. Geometries were imported in Comsol Multiphysics and a 3d elasticity problem was solved. In particular, for *Talpa romana* and *Urotrichus* we placed anatomical constraints in correspondence of the humeral head and clavicular articular facet. As for *Mesoscalops* and *Chrysochloris*, instead, we used just the humeral head, as the clavicle articulates only with the scapula and not with the humerus. In all the four genera, the loads were placed in correspondence of insertions of main muscles involved in digging. For *Mesoscalops* these muscles are the M. teres major and M. infraspinatus, while for *Talpa* and *Urotrichus* we choose the M. teres major and M. pectoralis pars sternalis and for *Chrysochloris* the M latissimus dorsi and the M. triceps. We found that the stress experienced by *Mesoscalops* is similar to that of *Chrysochloris* in terms of total elastic energy. The distribution of stresses is similar in the two taxa while *Talpa* experiences the lowest stress and *Urotrichus* the highest. These results suggest that the mode of digging in *Mesoscalops* was more similar to that observed in extant Chrysochloridae than in Talpidae as previously suggested on the basis of qualitative considerations.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

HABITAT DIVERSIFICATION IN EARLY VERTEBRATES – A CRITICAL TEST OF MARINE MACROEVOLUTIONARY PATTERNS

SANSOM, Ivan, University of Birmingham, Birmingham, United Kingdom; SALLAN, Lauren, University of Michigan, Ann Arbor, MI, United States; FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom; SANSOM, Robert, University of Manchester, Manchester, United Kingdom

The fossil record of Paleozoic vertebrates provides a potential test of over-arching models for marine biodiversity patterns that have been developed largely on the basis of marine benthic invertebrates. Although underlying mechanisms are not yet fully understood, many invertebrate lineages make a first appearance in shallow water, nearshore environments, before undergoing a range expansion into deep-water ecosystems. Another major biogeographic conclusion informed by fossil invertebrates is that the tropics represent a cradle of evolutionary innovation, with strong latitudinal diversity gradients being a prominent feature of life on Earth over the past 500 million years.

During their early evolutionary history, fishes underwent a series of evolutionary radiations and showed a major ecological revolution within their adult behavior. The earliest fish appear to have been minor predators or suspension feeders, but these were subsequently joined by a suite of large free-swimming apex predators. We have documented ecological shifts using new compilations of early vertebrate occurrences and phylogenetic comparative methods, allowing the impact of the diverse body plans of early fishes on ecological habit to be disentangled. All major clades of early fish have their origin in shallow water environments (Benthic Assemblage zones 1-3) so “onshore” is the primary signal of any lineage; this is in accord with the pattern deduced from invertebrates. However, more detailed, taxon specific, analyses demonstrate that the heavily armored osteostracans remain within BA 1-3 (and migrating into freshwater) throughout their stratigraphic and phylogenetic range, while the microsquamous thelodonts quickly disperse into a wider range of range of environments after the Ordovician. Thus early vertebrate dispersal is heavily influenced by body plan.

Technical Session XVII (Saturday, November 2, 2013, 2:45 PM)

FOSSILIZATION FILTERS RESULT IN SIGNIFICANT LOSS OF PHYLOGENETIC SIGNAL AND CAUSE ORGANISMS TO APPEAR ERRONEOUSLY PRIMITIVE

SANSOM, Robert, University of Manchester, Manchester, United Kingdom; WILLS, Matthew, University of Bath, Bath, United Kingdom

The fossil record is key to understanding the rates and sequences of evolutionary events occurring in deep time. Its utility in this context is entirely contingent on our ability to accurately reconstruct phylogenetic relationships of extinct organisms. Here, we demonstrate that the inherent taphonomic bias of the fossil record to preserve just hard, skeletal tissues systemically misleads parsimony analyses of phylogeny. Removal of soft-part characters from 59 neontological vertebrate datasets reduced resolution and accuracy of trees significantly more than random character ablation. Furthermore, removing soft characters from individual extant terminals (pseudoextinction) caused placement of taxa (62%) significantly lower in their respective trees, closer to the root. As such, data filters intrinsic to fossilization not only reduce tree accuracy, but positively mislead parsimony analyses. Stem-ward slippage, whereby taphonomic biases cause extinct taxa to be reconstructed as more primitive than they should, is found to be a ubiquitous and worrying phenomenon.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW RECORDS OF TERRESTRIAL VERTEBRATES FROM AN EOCENE BONEBED IN ORANGE COUNTY, CALIFORNIA

SANTOS, Gabriel, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States, 92834; CORTEZ, Crystal, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States; GARIBAY, Adrian, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States; MAGALLANES, Isaac, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States; PARHAM, James, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States

Study of the terrestrial Eocene of Southern California is mostly based on localities from Ventura and San Diego Counties. Orange County localities were not reported until 2003, with the first described records of late Uintan vertebrate assemblages from the Santa Ana mountains. In 1998, mitigation of the Talega Housing Development in San Clemente uncovered a large terrestrial middle Eocene bonebed that was subsequently collected in 48 large jackets (approximately one cubic meter each). The bonebed is approximately 10 cm thick, and is composed of a densely packed layer of fossils and sandstone with some reworked material found in the overlaying sediment. The majority of the fossils are fragmented or poorly preserved, and lack obvious associations. Better-preserved specimens, such as isolated teeth and vertebrae, are found throughout the bonebed. Matrix removed from the jackets was screen washed and sorted for microfossils. Preliminary identification of fossils indicates the presence of brontotheres, amynodonts, artiodactyls, rodents, crocodilians, turtles, snakes, and birds. This site, dubbed the 'Talega Rhino Quarry', is the first bonebed in Southern California reported to yield terrestrial middle Eocene fossils and has proven to be a significant site in the study of the Eocene of Orange County.

Technical Sesssion XII (Friday, November 1, 2013, 4:00 PM)

EXPLORATION OF AIRFLOW PATTERNS IN THE LUNG OF *ALLIGATOR MISSISSIPPIENSIS* (ARCHOSAURIA: CROCODYLIA) USING CFD MODELING, AND IMPLICATIONS FOR THE EVOLUTION OF UNIDIRECTIONAL AIRFLOW IN ARCHOSAURIA

SARRAZIN, John, University of Utah, Salt Lake City, UT, United States, 84112; SCHACHNER, Emma, University of Utah, Salt Lake City, UT, United States; FARMER, Colleen, University of Utah, Salt Lake City, UT, United States

Unidirectional airflow patterns have been observed in the lungs of both birds and crocodilians, indicating that this trait is likely plesiomorphic for Archosauria. These airflow patterns are proposed to be maintained by a series of aerodynamic valves resulting from the topography and branching angles of the primary and secondary pulmonary bronchi (not mechanical flaps or sphincters). Computational fluid dynamic (CFD) models of the bronchial tree of an extant crocodylian (*Alligator mississippiensis*) were generated from the CT data, to explore the key structural features that maintain these airflow patterns. Simplified anatomical models of the bronchial tree were created to test the aerodynamic valving phenomena and support the experimental *in vivo* and *ex vivo* flow measurements gleaned from *A. mississippiensis*. The validated models were then expanded upon systematically to explore geometrical and operational effects (such as bronchus branching angle and airflow pressure) on the flow patterns within specific regions of the lung. Preliminary data suggest that the aerodynamic valves result from a balance of geometric characters (i.e., ostium size, branching angle and bronchus position), as well as operational airflow parameters controlled by the organism during the respiratory cycle (including flow rates and intrapulmonary pressures). Understanding the functional properties of the alligator bronchial tree integral to sustaining unidirectional airflow lends insight into aspects of the respiratory system present in the common ancestor of crocodylians and birds (basal archosaurs) as well as certain topographical structures in the lung that were retained as the two groups diverged into their respective extant lineages.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

ASYMMETRY AND VESTIGIAL STRUCTURES IN EXTANT BIRDS

SARTIN, Catherine, Johns Hopkins School of Medicine, Baltimore, MD, United States, 21201

It is commonly asserted that vestigial structures have a greater degree of fluctuating asymmetry than functional structures. The reason given for this link between vestigial structures and fluctuating asymmetry is relaxed selection pressure, as well as fitness benefits associated with redirection of energy and other resources to functional structures. Perhaps surprisingly, few studies have examined and quantified the amount of fluctuating asymmetry in paired vestigial structures, especially limbs.

The present study is an attempt to fill this void and to test the following hypotheses: (1) Skeletal elements of limbs not used for locomotion will be more asymmetric than the skeletal elements of limbs used for locomotion (both within specimens and between groups), and (2) limb asymmetry will increase with time since the limb became vestigial. Four locomotor categories were examined: Tropicbirds (regularly use forelimb, but not hind limb for locomotion), Flighted rails (regularly use both fore- and hind limb for locomotion), Grounded Rails (only use hind limb for locomotion; lost flight recently), ratites (only use hind limb for locomotion; did not lose flight recently). Within each category, attempts were made to obtain a statistically-significant sample ($n \geq 30$) while still controlling for phylogeny and body size.

Eight bilateral measures were taken, including maximum lengths and condylar breadths. Dimensions were converted into percentage directional (%DA) and absolute (%AA) asymmetries. Results reveal significant fluctuating asymmetry in the forelimb elements of flightless taxa; however, tropicbirds do not show significant asymmetry in their hind limb elements. Despite a small sample size of ratites, results also suggest a greater degree of fluctuating asymmetry in the forelimbs with time since the limb became vestigial.

Technical Session V (Wednesday, October 30, 2013, 3:45 PM)

A NEW NOTHOSAUROID (REPTILIA, SAUROTPERYGIA) FROM THE MIDDLE TRIASSIC OF CHINA

SATO, Tamaki, Tokyo Gakugei University, Koganei City, Tokyo, Japan; CHENG, Yen-nien, National Museum of Natural Science, Taichung, Taiwan, China; WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada; SHAN, Hsi-yin, National Museum of Natural Science, Taichung, Taiwan, China

The Sauropterygia (Reptilia, Diapsida) include various Triassic forms and the Plesiosauria, and the latter is the only clade which survived the end-Triassic extinction and flourished later in the Mesozoic. An intriguing aspect of plesiosaurian diversity is the variability of the neck length which roughly corresponds with the number of cervical vertebrae which ranges from 13 to over 70 in the most derived forms of the Late Cretaceous. A relatively long neck consisting of more than 30 vertebrae characterizes long-necked plesiosaurs of the Jurassic and a few Triassic pistosauroid genera, but such a long neck had been unknown among non-pistosauroid sauropterygians of the Triassic. Here we report on a new species of the Nothosauroidea from China which indicates independent and multiple occurrences of neck elongation among the Triassic sauropterygians.

The new nothosauroid came from the Middle Triassic (Ladinian) Xingyi fauna of southern China, which has revealed a surprising diversity of marine reptiles in the Eastern end of the Tethys. The new taxon is represented by a single articulated skeleton lacking most of the skull and extremities of the tail and limbs. Our phylogenetic analysis recovered this taxon as the sister taxon of *Lariosaurus* within the Nothosauroidea (supported by two unambiguous synapomorphies), but it differs from known species of this genus in several postcranial features, including a long neck which consists of 35 cervical vertebrae including a partially articulated atlas and axis; only 18 to 23 cervicals are known among the previously known nothosauroid taxa in which reliable cervical counts are available for comparison. The anterior cervical centra of the new taxon are much longer than wide or high, but the centra become relatively and absolutely shorter towards the middle portion of the neck, then they lengthen in more posterior portion of the cervical series. Despite the unusual length of the neck, other features of the postcranial skeleton of the new taxon are mostly typical of the Nothosauroidea.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

IS THE FAMILY AETIOCETIDAE MONOPHYLETIC?

SAWAMURA, Hiroshi, Ashoro Museum of Paleontology, Ashoro, Japan; ANDO, Tatsuro, Ashoro Museum of Paleontology, Ashoro, Japan; SHINMURA, Tatsuya, Ashoro Museum of Paleontology, Ashoro, Japan

Aetiocetidae is a mysticete family known from the North Pacific rim. Aetiocetids are archaic toothed mysticetes, sharing derived cranial characters with the crown Mysticeti but retaining functional teeth. Some aetiocetids show ventral foramina and sulci on the maxilla, and thus are considered to have possessed functional teeth and baleens at the same time. The group Aetiocetidae was originally diagnosed by 13 cranial and dental characteristics and its monophyly was tested in previous studies based on the cranial and dental characters. However, disparity of the cervical vertebrae among aetiocetids raises questions about the monophyly of these archaic whales.

Aetiocetidae includes four genera and seven species, mostly described from the skull and teeth. The postcranial skeleton is only known in *Aetiocetus cotylalveus*, showing primitive conditions similar to that in Archaeoceti. Undescribed postcranial skeletons are preserved in the two aetiocetid holotypes, *A. polydentatus* and *Morawanocetus yabukii*, from the late Oligocene Morawan formation, Ashoro, Japan, although the postcrania were only briefly mentioned in the original descriptions. Those two aetiocetids show contrasting morphology in cervical vertebrae. In *A. polydentatus*, the cervical vertebrae are basically identical to those in *A. cotylalveus*: relatively long

(anteroposteriorly thick) vertebrae, well-developed neural spine of the axis, large transverse process of atlas, and median ridge on the dorsal dens. On the contrary, cervical vertebrae in *M. yabukii* (very short vertebrae, small transverse process of atlas, lack of hyapophyses on the ventral surface, no median ridge on the dorsal dens) appear more derived than the cervical vertebrae in the geologically older edentulous mysticete *Eomysticetus* (e.g., thick vertebrae, median ridge on the dorsal dens). The disparity in the cervical vertebrae could suggest that *Morawanocetus* is placed phylogenetically more crown-ward than *Eomysticetus* and therefore the family Aetiocetidae is not monophyletic. We tested the phylogenetic position of *Morawanocetus* using the published analysis with addition of postcranial characters. The preliminary result indicated that the family Aetiocetidae is monophyletic, but the robustness of the aetiocetids clade expressed by GC value of standard bootstrap resampling (1000 replicates) was much lowered from the original result. Interestingly, the exclusion of *Eomysticetus* from the analysis placed *Morawanocetus* as a sister taxon of the crown mysticetes.

Symposium 1 (Wednesday, October 30, 2013, 9:15 AM)

THE CLANDESTINE ROLE OF HETEROCHRONY IN CERATOPSIAN EVOLUTION AS REVEALED BY JUVENILE *TRICERATOPS*

SCANNELLA, John, Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States, 59717; FOWLER, Denver, Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; GOODWIN, Mark, University of California Museum of Paleontology, Berkeley, CA, United States; HORNER, John, Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States

The upper Cretaceous Hell Creek Formation (HCF) of Montana has produced a large sample (n>100) of the chasmosaurine ceratopsid *Triceratops*, including representatives of previously rare or unknown early growth stages. Comparative osteology and stratigraphic data confirm that major features of the skull underwent transformation throughout the HCF. Juvenile specimens collected from the upper third of the HCF possess characters (including morphology of the premaxilla and nasal) typically observed in more mature individuals collected from lower in the formation. These character states are absent in more mature *Triceratops* from the upper third of the HCF. Many of the cranial features which are restricted to early ontogeny in *Triceratops* (including recurved postorbital horn cores, morphology of the supracranial sinus, and contribution of the supraoccipital to the foramen magnum) have been suggested to be phylogenetically informative in more basal ceratopsian taxa. New details of the cranial anatomy of juvenile *Triceratops* indicate the persistence of additional characters used to diagnose taxa that predate the latest Maastrichtian. For example, the chasmosaurine *Anchiceratops* and several centrosaurine taxa exhibit a pronounced ridge on the lateral surface of the dentary. A homologous feature has not been previously reported in *Triceratops*, however at least one juvenile specimen (Museum of the Rockies [MOR] 1199) clearly preserves this character. Similarly, a bony flange on the posterior surface of the narial strut of the premaxilla has been described in several chasmosaurine taxa (including *Chasmosaurus* and *Pentaceratops*) and used to distinguish these clades from *Triceratops* and its close relatives. Several specimens of immature *Triceratops* are found to exhibit this flange, though it is absent in more mature specimens. The transitory nature of these characters in *Triceratops* illustrates the potential problems of including immature specimens in phylogenetic analyses and designating juveniles as holotypes. The fact that primitive characters, though previously undetected, are present in early *Triceratops* ontogeny reveals that they were still subject to selection and suggests the potential for 'Lazarus characters' in the dinosaur fossil record. This is consistent with the hypothesis of clandestine evolution and indicates that heterochrony played a critical role in ceratopsian evolution.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ANCIENT DNA AND THE ROLE OF ISLAND FRAGMENTATION IN DIVERGENCE OF LIZARDS OF THE GENUS *AMEIVA*

SCARPETTA, Simon, Stanford University, Palo Alto, CA, United States, 94304; KEMP, Melissa, Stanford University, Stanford, CA, United States; HADLY, Elizabeth, Stanford Univ, Stanford, CA, United States

The episodic fragmentation of islands during the Pleistocene and into the Holocene from rising sea levels serves as a unique system to study how changes in habitat connectivity and island size facilitate or inhibit genetic divergence and, ultimately, speciation and extinction. Furthermore, the use of ancient DNA allows us to accurately assess genetic diversity through time and the spatiotemporal distribution of species. In warm, humid regions, such studies are limited by the poor preservation of fossils and ultimately, aDNA. Here, we report the first mitochondrial aDNA sequences from fossils of the lizard *Ameiva* collected from Anguilla, a Caribbean island in the northern Lesser Antilles. The teiid genus *Ameiva* is found throughout Central and South America but its primary distribution occurs in the West Indies. There are two species endemic to the Anguillan bank (*A. plei* and *A. corax*), while a separate species (*A. corvina*) is endemic to the small, nearby island bank of Sombrero. We integrate the ancient genetic data with modern genetic data, island bathymetry, and sea level curves to determine which species are present on Anguilla since the Pleistocene, to characterize genetic diversity through time in these Anguillan bank species, and to understand their phylogenetic relationships. Our study provides a framework through which molecular divergence in other insular taxa can be assessed, and documents the waxing and waning of diversity in this group of lizards in response to changing island area and connectivity.

Technical Session V (Wednesday, October 30, 2013, 4:00 PM)

BONE HISTOLOGY OF PLACODONT MARINE REPTILES (SAUROPTERYGIA) FROM EUROPE

SCHEYER, Torsten, University of Zurich, Zurich, Switzerland; NEENAN, James, University of Zurich, Zurich, Switzerland

Placodonts are the sister group to all remaining eosauropterygians within Sauropterygia, one of the most successful and long-lived radiation of Mesozoic marine reptiles. The placodont skull is characterized by a highly specialized crushing dentition. Basal forms are unarmored (*Paraplacodus*, *Placodus*), whereas more highly nested forms (e.g. *Cyamodus*, *Psephoderma*) show extensive body armor. Based on their body shape, conserved limb morphology and sedimentary data, both armored and unarmored forms are characterized as slow swimmers or bottom walkers inhabiting near-coastal environments along the northern margins of the Triassic Tethys ocean.

Long bone microstructure is known to be influenced by heritage, as well as structural and functional aspects, and by comparison with extant animals phylogenetic and ecological signals can thus often be inferred in fossils. In contrast to other marine reptile groups (e.g., eosauropterygians and ichthyosaurs), however, little is known about the bone microstructure of placodonts. Preliminary accounts noted derived histological features in long bones such as fibro-lamellar bone tissue with high degrees of plexiform or irregular vascularization. Here we survey the bone microstructure of selected unarmored and armored placodonts, including the basal-most taxon *Paraplacodus broilii* (Besano Formation, Anisian-Ladinian boundary, Monte San Giorgio, southern Switzerland), to better understand the evolution of limb bone microstructures in Sauropterygia as a whole, the potential conservation of such among placodonts, and whether unarmored and armored taxa exhibit diverging ecological signals.

Results show that bone histology is variable among placodonts and that there is no clear signal between armored and unarmored forms. *P. broilii* limb bones indicate that the previously described histology represents a derived condition, which has developed from a dense lamellar-zonal tissue characterized by low vascularization. *Placodus* and *Cyamodus* share similar limb bone histologies with highly vascularized fibro-lamellar bone tissue, whereas the last representative of placodonts, the armored *Psephoderma* (Upper Triassic, Alps) shows a reversal to lamellar-zonal bone tissue in dense cortices but increased amounts of secondary remodeling of the internal-most primary compact layers. This study indicates an unexpected degree of divergence in bone microstructure in a highly specialized clade, and shows that fibro-lamellar bone has independently evolved at least twice in Sauropterygia.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PALEONEUROANATOMY AND BRAINCASE MORPHOLOGY INDICATES THE PRESENCE OF AT LEAST TWO DIPLODOCINE TAXA (DINOSAURIA: SAUROPODA) AT HOWE RANCH (WYOMING, USA)

SCHMITT, Armin, Universität Bonn, Bonn, Germany; TSCHOPP, Emanuel, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal; KNOLL, Fabien, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain; SANDER, Martin, Universität Bonn, Bonn, Germany

The Howe Ranch, north of Shell (Wyoming, USA), has been known for its abundant and excellently preserved dinosaur finds since the 1930s. The five sites on the Howe Ranch produced numerous diplodocid, camarasaurid, allosaurid, stegosaurian, and ornithopod dinosaurs from the Morrison Formation (Kimmeridgian, Late Jurassic). Surprisingly, almost all of these taxa are also represented by either partial or complete skulls, which are generally rarely found in the Morrison Formation.

For the current study, three braincases (Sauriermuseum Aathal [SMA] 0004, SMA D16/3, and SMA O25/8) from the Howe Ranch were CT scanned, and 3D renderings of their cranial endocasts and osseous labyrinths were generated.

The braincase morphology indicates the presence of a second diplodocine taxon different from *Kaatedocus* (as represented by the holotype SMA 0004, consisting not only of a braincase but rostral elements and partially articulated neck elements, too, and a second braincase SMA D16/3). The reduced participation of the basioccipital in the dorsal surface of the occipital neck, the slightly concave caudal surface of the basal tubera, and their concave rostral margin distinguish SMA O25/8 from that of *Kaatedocus*. Based on as yet undescribed postcranial material with very elongate mid-cervical vertebrae (compared to *Kaatedocus*), the previously proposed presence of *Barosaurus* is probable. The braincase may belong to this taxon. If confirmed, it would be the first reported cranial remains of *Barosaurus*.

Observations of preliminary endocast reconstructions of the braincases of these specimens suggest similarities with other diplodocids. The endocranial cavity of this possible *Barosaurus* braincase has a relatively shorter hypophyseal fossa than that of *Kaatedocus*, despite being larger overall. Furthermore our investigation suggests that a reduction of brain and inner ear sizes relative to body mass took place during diplodocid evolutionary history, which was possibly related to the space restrictions in the small skull and predominantly horizontal neck movements in diplodocids.

Technical Session XVI (Saturday, November 2, 2013, 2:30 PM)

EVOLUTIONARY DRIVERS OF GIANT EYES IN LARGE OCEAN PREDATORS

SCHMITZ, Lars, Claremont Colleges, Claremont, CA, United States, 91711; MOTANI, Ryosuke, Univ of California - Davis, Davis, CA, United States; WAINWRIGHT, Peter C., Univ of California - Davis, Davis, CA, United States

The eyes of giant and colossal squids are the largest of all living organisms, with adult individuals reaching 27 cm in eye diameter. Eyes of similar size are only found in ichthyosaurs, a group of Mesozoic marine reptiles. Direct observations of the biology of giant and colossal squids are extremely rare and are impossible for fossils, thus the function of large eyes is not well understood. Hence, theoretical models offer a

particularly important perspective on their visual performance, on which basis one can develop hypotheses about eye size evolution. It has been suggested that the evolution of extreme eye size in ichthyosaurs and squids was driven by predators, based on an optical model that indicated high performance of large eyes in detecting approaching predators in the presence of photoluminescent plankton. We chose an integrative approach to test this hypothesis. We first revised the constants used in the model and show that large eyes perform equally well for different visual tasks, providing several optical advantages in the reduced light of the deep mesopelagic zone. Hence, predator-driven evolution of large eyes is optically not well-supported. Next, we examined whether allometry may inform hypotheses about extreme eye size evolution. We accounted for body size while asking whether giant and colossal squid have unusually large eyes among squid (88 species), and whether squid eyes are larger than those of acanthomorph fishes (237 species). While squid have larger eyes than most acanthomorphs, a comparison of relative eye size among squid suggests that giant and colossal squids do not have unusually large eyes. Our finding indicates that the giant eyes of giant squid result from a phylogenetically conserved developmental pattern manifested in very large animals rather than predator-driven evolution. Finally, we examined the temporal sequence of eye-size and predator evolution that was proposed along with the aforementioned optical model. The Lower Jurassic ichthyosaur *Temnodontosaurus* features eyes exceeding 25 cm in diameter, yet when it first appeared in the Hettangian, it was by far the largest of the coeval marine reptiles. Very large *Rhomaleosaurus*, identified as the potential driver of eye size evolution in this genus, is known from the Toarcian, some ten million years after *Temnodontosaurus* first appeared. To conclude, predator-driven eye size evolution is poorly supported. Large eyes likely evolved in response to the combination of multiple optical benefits in low light environments combined with phylogenetic constraints.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

REDESCRIPTION OF *ASPIDORHYNCHUS ORNATISSIMUS* AGASSIZ, 1834 FROM GERMANY

SCHRÖDER, Kerstin, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; LÓPEZ-ARBARELLO, Adriana, BSPG, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung fur Palaontologie und Geologie, Munich, Germany

Aspidorhynchus ornatissimus is an aspidorhynchid fish from the Jurassic limestones of Southern Germany, which was previously considered as a junior synonym of the type species of the genus *Aspidorhynchus, A. acutirostris. Aspidorhynchus ornatissimus* was revalidated in a recent taxonomic revision of the German species of *Aspidorhynchus*, according to which three species were considered valid. In this recent work, a diagnosis for *A. ornatissimus* was proposed, but no further anatomical description of the species was presented. The only description of this species dates from 1834 and is based only on a partial postcranium. The species *A. ornatissimus* is rarely represented in museums, and the few specimens in public collections are generally incompletely preserved. Thanks to the cooperation of a few German private collectors, access to excellent material was possible for this study and the species *A. ornatissimus* could be completely described for the first time. *Aspidorhynchus ornatissimus* differs from other species of this genus in several features, including two possible autapomorphies: only five to six rows of ventral scales are present, and the first pectoral fin ray is reduced at the base and attached to the base of the second fin ray. As in the case of other species of *Aspidorhynchus, A. ornatissimus* presents high intraspecific variation in the ornamentation of the scales, the dentition of the predentary and the number of principal caudal fin rays. The species *A. ornatissimus* is only present in the eastern part of the so-called 'Solnhofen Archipelago' between the localities Kapfelberg and Eichstätt, and has a chronostratigraphic range from the Upper Kimmeridgian to the Lower Tithonian. Therefore, the distribution of *A. ornatissimus* differs paleobiogeographically and stratigraphically from the other two species represented in this paleoarchipelago.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

INNER EAR MORPHOMETRY OF *MYOTRAGUS BALEARICUS* (BOVIDAE, CETARTIODACTYLA) SUPPORTS DECREASE IN LOCOMOTOR AGILITY

SCHUBERT, Anne, Universität Bonn, Bonn, Germany; RUF, Irina, Universität Bonn, Bonn, Germany

The inner ear bony labyrinth houses the hearing and the sense of balance. The three semicircular canals of the inner ear are involved in detecting angular acceleration of the head and their morphometry gives information on the agility of an animal. Faster species possess a greater semicircular canal radius of curvature (SCR) in comparison to body mass (BM) than slower ones. This correlation can be used to gain information about the agility of fossil species.

For the first time the inner ear of two individuals of the peculiar bovid *Myotragus balearicus*, a dwarfed fossil species from the Quaternary of Mallorca, was analyzed. During the isolation of Mallorca since the Messinian, *Myotragus* developed several adaptations to the insular environment e.g., low-gear locomotion as revealed by several postcranial and physiological features. These locomotor adaptations should also be reflected by the semicircular canals. For investigation of the inner ear of *Myotragus* the petrosals were scanned by high-resolution x-ray computed tomography and virtual three dimensional models of the inner ear bony labyrinth were created. SCR was calculated from the height and width of the canals. Log_{10} of the averaged SCR was plotted against log_{10} BM and compared to data taken from the literature. Additionally the locomotor agility score of *Myotragus* was calculated based on published equations.

Our analysis shows that *Myotragus* has a smaller SCR in comparison to taxa with similar BM e.g., *Hemitragus jemlahicus*, *Capra hircus*, *Gazella bennettii* or the closer related *Ovis aries*. In our data set *Myotragus* plots among species with slow to medium-slow agility. The calculated agility scores of *Myotragus* lie between 2.6 to 2.8 (according to the range of the mean BM taken from literature), indicating a slow to medium-slow agility. Based on field observations the agility score of *Ovis aries* is 4, that indicates a medium type of locomotion. These observations suggest a decrease in agility of *Myotragus* and support previous assumptions based on the postcranial skeleton. *Myotragus* moved slower or to a lesser degree of agility than closely related species with similar BM living on the main land. This is interpreted as an adaptation to the isolation of the island with resource limitations and the absence of predators.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE SIGNIFICANCE OF RANCHO LA BREA FOR INTERPRETING THE PALEOBIOLOGY OF GIANT SHORT-FACED BEARS

SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, United States, 37614; COX, Shelley, George C Page Museum, Los Angeles, CA, United States; COLTRAIN, Joan, University of Utah, Salt Lake City, UT, United States

North American giant short-faced bears (*Arctodus simus*) are known from across the continent, and range in age from Irvingtonian to late Rancholabrean. Although over 100 localities are known for the species, most fossil occurrences are represented by isolated individuals. In contrast, the material from Rancho La Brea (RLB) represents the largest sample from a single locality and provides a unique opportunity to address paleobiological questions associated with this taxon. We report undescribed *A. simus* material from RLB, raising the total to over 700 elements and at least 30 individuals. This new material is critical for interpreting size variation documented for this bear. In fact, one of the primary questions among researchers has been whether or not "*A. simus*" represents a single species, two species, or temporal and/or geographic subspecies. The debate stems from the fact that these bears fall into two distinct size ranges, one of which is exceedingly large. Rancho La Brea is the only locality that contains adults of both size classes. Further, re-examination of the RLB collection, including the newly discovered material, has substantially increased the upper size range of short-faced bears from the site, and new radiocarbon dates indicate equivalent ages for both sizes. We suggest this variation indicates extreme sexual dimorphism in the species, with males being considerably larger than females; a trend that is also notable in large extant ursids. Thus, the concept of invoking subspecies or species status to these *A. simus* size variants is unwarranted. In addition to addressing size variation, this relatively large collection is key for interpreting other paleobiological questions, such as diet. Dietary interpretations of *A. simus* have ranged from pursuit predator to herbivore, and omnivore to specialized scavenger. Reported stable isotope ($\delta^{13}C$, $\delta^{15}N$) analyses for *A. simus* are restricted to northwestern North America, and suggest a diet high in animal protein. The high quantity and diversity of taxa at RLB provide an opportunity to examine the species diet from another part of its range using stable isotope biogeochemistry. Previous research that analyzed these isotopes on ten other taxa from RLB, ranging from carnivores to herbivores, provides a baseline of comparison for placing *A. simus* into a trophic context. Our results indicate that $\delta^{15}N$ values varied for these bears, with some individuals in the same trophic category as sabertooth cats (*Smilodon fatalis*).

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW MOSASAUR FROM THE TYPE MAASTRICHTIAN

SCHULP, Anne, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands; JAGT, John, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands

We report the discovery of a disarticulated mosasaur skeleton from the Maastrichtian (Late Cretaceous) type section, near Maastricht, The Netherlands. The Maastrichtian type area is renowned for its pristine, three-dimensionally preserved marine vertebrate fossils. So far, discoveries of fossil tetrapods were limited to the upper half of the c. 80 meters of limestones exposed in local quarries. The lower reaches of the section, deposited in a deeper-water setting under more temperate/boreal conditions, were held to be virtually barren of tetrapod remains, except for a few tooth crowns.

In September 2012, however, quarry operator Carlo Brauer uncovered the remains of a mosasaur in the lower reaches (the flint-rich Lixhe 3 Member, Gulpen Formation) at the quarry.

To date, preparation work has exposed cranial material, including partial jaw sections, and various elements of the axial skeleton. Tooth morphology suggests affinities with *Prognathodon sectorius* (previously known as *Liodon sectorius*, but recently reassigned to *Prognathodon*), by virtue of the swollen base in the tooth outline, the labiolingually flattened crown and the sharp carinae.

The absence of mosasaur fossils in the lower reaches of the Type Maastrichtian has previously been suggested to reflect an immigration event soon after the deposition of the Lixhe Member, when the shallower waters and presumed increased availability of food provided more favorable living conditions. The new fossil, however, extends the range of *P. sectorius* further downward; the markedly different taphonomy of the specimen suggests that the apparent 'immigration' of mosasaurs following deposition of the Lixhe Member to represent -at least in part- a taphonomic bias instead.

A preliminary analysis of the $\delta^{13}C$ stable isotope signal in the tooth enamel has yielded a lesser negative value compared to all other mosasaurs studied so far in the Type Maastrichtian. An initial screening of dental microwear shows this individual to have experienced little wear compared to other mosasaurs from the same area.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FIRST DOCODONT PETROSALS FROM THE MIDDLE JURASSIC OF WESTERN SIBERIA (RUSSIA)

SCHULTZ, Julia, Universität Bonn, Bonn, Germany; RUF, Irina, Universität Bonn, Bonn, Germany; AVERIANOV, Alexander, Zoological Institute of the Russian Academy of Sciences, St Petersburg, Russia; LOPATIN, Alexey, Borissiak Paleontological Institute of the Russian Academy of Sciences, Moscow, Russia; MARTIN, Thomas, Universität Bonn, Bonn, Germany

Two petrosals from the Berezovsk Quarry in southern Krasnoyarsk Territory in Siberia (Russia) can be attributed to docodonts. The specimens were collected from a fluvial flood plain bonebed in the upper part of the Bathonian Itat Formation. Mammaliaforms and mammals so far recorded from the Berezovsk coal mine comprise the eleutherodontid haramiyid *Sineleutherus issedonicus*, the docodonts *Itatodon tatarinovi*, *Simpsonodon sibiricus*, and *Hutegotherium yaomingi*, an amphilestid-grade eutriconodontan, as well as the cladotherian amphitheriid *Amphibetulimus krasnolutskii* and an undescribed dryolestid. µCT technology and virtual reconstruction of the inner ear bony labyrinth reveal a pattern of petrosal characters that assign the two Berezovsk specimens to being basal mammaliaforms. The two petrosals show a lateral flange foramen which is a derived feature among mammaliaforms as it is not present in *Morganucodon* or *Sinoconodon*. Both show a distinct promontorium with a unique bony ridge, not known from any other Mesozoic mammal, a large pneumatic mastoid recess and a significantly widened stapedial muscle fossa also found in the docodont *Haldanodon exspectatus*, and a perilymphatic foramen, which is a plesiomorphic feature of mammaliaforms. The virtual inner ear endocasts reveal a secondary common crus, a general feature of basal therians as well as of Mesozoic mammals and non-mammalian cynodonts and therefore plesiomorphic in the mammaliaform groundplan. The most striking features of the bony labyrinths are a distinctly curved cochlear canal (about 180°) with an apical inflation. No internal cochlear structures like the primary or secondary bony laminae are present. This pattern is also observed in *Haldanodon*, though evidence for a lagenar nerve is missing in both petrosals. The cochlear canal is more curved than in the basal mammaliaforms *Sinoconodon* and *Morganucodon*, but less than in dryolestoids. The multituberculate petrosal and inner ear morphology is significantly different with a thin cochlear canal and different proportions of pars vestibularis and pars cochlearis of the petrosal bone. However, the overall morphology of both petrosals shows striking similarities to the petrosal and inner ear features of the docodont *Haldanodon*, though the Berezovsk specimens are about 20 Ma older than the Kimmeridgian *Haldanodon*. The Siberian specimens are not only the oldest known docodont petrosals so far but also the second record of docodont ear regions and provide important information on the diversity of the inner ear morphology of this group.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

HOW TO CHOOSE AND USE 3D SURFACE TEXTURE PARAMETER TO RECONSTRUCT FEEDING ECOLOGY AND CHEWING MECHANICS: PARAMETER RUSH AND BASIC PRINCIPLES OF 3D TRIBOLOGY

SCHULZ, Ellen, University of Hamburg, Hamburg, Germany; KAISER, Thomas, University of Hamburg, Hamburg, Germany

Quantitative three dimensional techniques to evaluate dental wear have become established methods for reconstructing dietary adaptation as well as chewing biomechanics. Dietary reconstruction in mammals has long been the focus of cheek tooth microtexture analyses. Technical surface applications have been developed from the need to analyse machined surfaces, using wavelength filtering to analyse the geometric information separately. Three classes of geometric information have been established: form, waviness and roughness. While form describes broad-scale geometry, waviness includes shorter (more closely spaced) wavelength surface alterations from a nominal shape as reference. Roughness includes the shortest wavelength alterations. The form and waviness descriptions of the surface have not yet been exploited in dietary reconstructions as independent lines of evidence, nor have their functional implications been explored. Therefore we use scale-sensitive fractal analysis as well as 46 industrial 3D surface texture parameters and test their capability to robustly indicate specific dietary adaptation as well as biomechanics. The focus is set on the surface patterns at the micro-textural scale representing a snapshot of the dietary habits of an individual. In addition to discriminating between dietary preferences, surface texture parameters reflect the dynamic processes in the occlusal space that can hardly be observed in situ. We found that during mastication, the occlusal gap is larger when the food consumed consists of more grasses and is smaller when browse is comminuted. With the narrowing of the occlusal gap, high peaks of surface texture are more likely to be ground down, either by attrition (tooth-tooth contact) or by fast fluid movements in the centre of the gap. A larger food bolus, in turn, is more likely to prevent peaks from being flattened. Thus, we found new evidence from basic principles of 3D tribology and describe a tool set how to choose 3D surface texture parameters appropriate to the hypothesis to be tested.

Technical Session XIII (Friday, November 1, 2013, 4:00 PM)

WHEN PLANKTON RULED THE COMANCHE NATIONAL GRASSLAND: DISCOVERY OF A THIRD NORTH AMERICAN CRETACEOUS FILTER-FEEDING VERTEBRATE

SCHUMACHER, Bruce, USDA Forest Service, La Junta, CO, United States, 81050; MALTESE, Anthony, Rocky Mountain Dinosaur Resource Center, Woodland Park, CO, United States

Until recently, the only Mesozoic record of vertebrate filter-feeding was European occurrences of the bony fish *Leedsichthys* from the Middle and Late Jurassic. The earliest reported occurrence of a vertebrate filter feeder in the North American Mesozoic is isolated teeth attributable to *Megachasma comanchensis* (megamouth shark) from the Cretacaceous Greenhorn Limestone (Cenomanian) on the Comanche National Grassland (CNG) in southeastern Colorado. More recently the existence of two lineages of Cretaceous filter-feeding bony fish was brought to light with the descriptions of *Bonnerichthys* (North America) and *Rhinconichthys* (Europe and Japan). Now the CNG has produced further foundational information about the evolution of vertebrate filter-feeding. A complete skull, pectoral girdle and proximal pectoral fins of a bony fish (Denver Museum specimen DMNH 63794) from the lowermost Carlile Shale (Middle Turonian, zone of *Collignoniceras woollgari*) confirm the existence of a second lineage of filter-feeding Pachycormidae in North America. The maxillae and dentaries are elongate and edentulous as in other suspension feeding fish, and complete fusion of cranial elements reveals only a distant relationship with *Bonnerichthys*. The tip of the dentaries to the center of the articulated pectoral girdle measures 38 cm. Comparison with complete skeletons of Jurassic planktivorous pachycormids *Martillichthys* and *Asthenocormus* suggest a standard total length of 1.6 m. Well ossified and sutured cranial elements suggest adult size of the CNG specimen was rather modest for a group known to produce exceptionally large animals. The skull shows broad similarities to *Rhinconichthys* including a narrow profile drawn to a rather pointed anterior extremity and elongate posterior projections of the dermopterotics. The specimen possesses ventrolateral processes of the rostrodermethmoid, a character formerly used to distinguish *Bonnerichthys*. The lower jaws protrude anteriorly beyond the rostrodermethmoid, giving the appearance of a pronounced ‘under-bite’, a character shared by *Martillichthys*. Certain of these characters are perhaps also present in *Rhinconichthys* but are not preserved in known specimens. Not enough of the pectoral fins are preserved to determine whether the anterior edge is composed of bifurcating fin rays as in other pachycormids. Formal taxonomic treatment of this specimen is forthcoming. This discovery and others like it are rapidly changing our perception of planktivory and its evolution in the Earth’s oceans.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

MORPHOLOGY AND FUNCTION OF THE EXTANT *DIDELPHIS* MOLAR DENTITION IN COMPARISON TO MESOZOIC DIDELPHIMORPHA

SCHWERMANN, Achim, Universität Bonn, Bonn, Germany; KULLMER, Ottmar, Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt am Main, Germany; MARTIN, Thomas, Universität Bonn, Bonn, Germany

The plesiomorphic tribosphenic molars of *Didelphis* frequently served as a comparative model for Mesozoic therians in the past. *Didelphis* is a relative large didelphid weighting up to 5.5 kg, whereas Mesozoic Didelphimorpha were much smaller with a weight up to a few hundred grams.

The ontogenetic development of tooth macrowear has been analyzed based on more than 80 *Didelphis* molar rows. We observed a high variation in several aspects of dental wear: a wear gradient exists between the first and last molar, and various types of abrasion, formation of facets, and preferred chewing sides were detected. Furthermore, wear of *Didelphis* differs in the ratio of trigonid- and talonid wear from the studied fossil specimens. In *Didelphis*, the wear in the trigonid is considerably more advanced than in the talonid, whereas the rates of wear are more similar in both tooth sectors in the fossil taxa.

A detailed analysis of the functional morphology of the teeth revealed further significant differences between the extant *Didelphis* and Mesozoic Didelphimorpha such as *Alphadon*, *Pediomys*, and *Peradectes*. The orientation of wear facets can be treated as an indicator for the functional mode of dental use in the mastication cycle. The direction of all facets (strike) is very similar in all of these taxa, whereas the inclination (dip angle) is lower in *Didelphis* than in the fossil taxa.

The value of *Didelphis* molars as a comparative model for Mesozoic Didelphimorpha is limited to its basal tribosphenic morphology. Functional aspects distinctively differ from the smaller taxa, indicating a less constrained occlusion in *Didelphis*. More similar to the fossil taxa is the extant *Monodelphis* with a much more kinematically constrained occlusion than *Didelphis*. This could be related to size, because *Monodelphis* is much smaller than *Didelphis* with a weight up to 150 g in the size range of the Cretaceous taxa. With a more similar wear pattern and facet arrangement, the dentition of *Monodelphis* is functionally much closer to the investigated fossil specimens than *Didelphis*, and a more suitable comparative model respectively.

Technical Session VI (Thursday, October 31, 2013, 11:15 AM)

DIFFERENTIATION AND SIMPLIFICATION IN DENTAL MORPHOLOGY AND FUNCTION DURING ARTIODACTYL EVOLUTION

SCHWERMANN, Leonie, Universität Bonn, Bonn, Germany; VON KOENIGSWALD, Wighart, Universität Bonn, Bonn, Germany

During the evolution of artiodactyls the development of an increasingly complex occlusal surface contrasts with the simplification of the masticatory movement. *Diacodexis*, the oldest and most primitive artiodactyl, had a relatively less derived tribosphenic bunodont dentition. From there, a variety of different tooth morphologies (bunodont, bunoselenodont, selenodont, lophodont) evolved within the Artiodactyla, due to the conquest of different habitats and access to a broad food spectrum. In order to understand the changes of tooth morphology and function that occur during artiodactyl evolution, the masticatory process of *Diacodexis* and other primitive artiodactyls and basal members of extant groups (Suina, Tylopoda, Ruminantia) were investigated. The main focus of this study lies on the transition to the selenodont dentition, which occured several times convergently in different groups and can be found in the majority of extant artiodactyls. The reconstruction of masticatory movement is based on the analysis of wear facets on the occlusal surface. The Occlusal Fingerprint Analyser (OFA) provides a new approach for the digital manipulation of 3D models of teeth in order to reconstruct the masticatory cycle. Furthermore, the OFA offers a detailed analysis of contacting areas on antagonistic teeth during the power stroke. *Diacodexis* had tritubercular upper molars and, in contrast to all advanced artiodactyls, no hypocone. The power stroke consisted of two phases with a change of direction and inclination of the lower jaw from phase I to phase II. Primitive bunoselenodont taxa (e.g. Anthracotheriidae) that have a hypocone show a less differentiated masticatory movement. While the power stroke still consists of two phases, the second phase just differs in inclination. The development of a hypocone and the concomitant mesial shift of the protocone caused a uniform directionsl movement in both phases. In modern ruminants (e.g. bovids) with selenodont molars and four symmetrically arranged cusps and a small height gradient between buccal and lingual cusps, the power stroke is a uniform movement that is not divisible in two phases. The selenodont cusp morphology is the most important development in artiodactyl evolution and it allows a simplification of the mastication. The transition to a one-phased power

stroke also goes together with a symmetrical arrangement of cusps and a reduction of relief. Early selenodont taxa (e.g. Cainotheriidae) achieved the same combination, but with a fifth cusp, could not reach the same masticatory mode.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A LATE CRETACEOUS SHARK COPROLITE WITH BABY TURTLE VERTEBRAE

SCHWIMMER, David, Columbus State University, Columbus, GA, United States, 31907-5645; WEEMS, Robert, Paleo Quest, Gainesville, VA, United States; SANDERS, Albert, The Charleston Museum, Charleston, SC, United States

A small (3.0 cm) coprolite from Late Cretaceous sediments that are age-equivalent to the Coachman Formation (mid-Campanian, South Carolina), contains six complete, well-preserved vertebrae from a very small trionychid turtle. The coprolite shows some spiral morphology and is likely from one of several common selachian taxa in the associated fauna, most likely *Squalicorax kaupi*. The vertebrae are located toward the tapered end of the coprolite and are miniscule, with the largest 3.7 mm long. However, they are remarkably well-preserved, with two parallel pairs in apparent articulation on one side, and the two larger on the opposite side. Overall, the turtle vertebrae comprise the bulk of the mass at the tapered end of the coprolite.

The vertebrae inclusions are identified as cervicals from a newly-hatched trionychid turtle. This occurrence implies that the shark, presumably marine, ate a hatchling freshwater turtle. This specimen's co-occurrences therefore also imply that the fossil site represents either a near shore marine environment with fluvial or other freshwater input, or that the shark was feeding in a fluvial environment, as is observed in modern species of *Carcharhinus*. Either scenario is plausible.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

EVOLUTIONARY PATTERNS IN BONE THICKNESS AND COMPACTNESS IN DIVING BIRDS

SCLAFANI, Michelle, North Carolina State University, Raleigh, NC, United States, 27606; KSEPKA, Daniel, National Evolutionary Synthesis Center, Durham, NC, United States; SMITH, Adam, National Evolutionary Synthesis Center, Durham, NC, United States

Wing-propelled and foot-propelled pursuit diving strategies have evolved multiple times in marine birds. It is well known that penguins have dense osteosclerotic bone structure, which is hypothesized to reduce buoyancy. However, it remains unresolved whether these changes are associated primarily with the acquisition of wing-propelled diving capabilities, with the loss of aerial flight, or with both.

In order to determine the relationship between of bone density changes and diving strategy, histological sections were collected from the humerus and femur of modern and fossil specimens with a variety of diving modes and flight capabilities. Sampled species include the wing-propelled diving Sphenicidae (including stem and crown fossil species) and Pan-Alcidae (including volant and flightless species), foot-propelled diving Gaviiformes and Podicipediformes, and non-diving outgroup taxa from the Procellariiformes and Charadriiformes. For each species, long bones were sectioned, mounted onto slides, and photographed to create digital composite images of cross-sections from the midshaft. Cortico-diapophyseal (CDI) index and bone compactness values were calculated for each section using BoneProfiler.

Our results support a simple pattern of increase in the compactness and CDI in the hind limb of wing-propelled diving birds: diving taxa have higher values than non-diving taxa, and flightless diving taxa have higher values than volant diving taxa. This supports the inference that volant diving birds benefit from a reduction in buoyancy, yet are constrained to a lower density threshold by the demands of flight. However, a more complex pattern is noted in the humerus. Pan-alcids show higher compactness but lower CDI values than penguins. Additionally, basal stem penguins show substantially lower values than extant penguins, indicating that reorganization of wing bone internal structure continued for a long phylogenetic and temporal interval after the initial loss of flight.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

***EQUUS SCOTTI* FROM THE TULE SPRINGS LOCAL FAUNA, SOUTHERN NEVADA: IMPLICATIONS FOR THE DIVERSITY AND BIOGEOGRAPHY OF LATE PLEISTOCENE EQUIDS IN WESTERN NORTH AMERICA**

SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States, 92374; SPRINGER, Kathleen, San Bernardino County Museum, Redlands, CA, United States; MANKER, Craig, San Bernardino County Museum, Redlands, CA, United States

The specific diversity and biogeographic extent of horses (genus *Equus*) in Pleistocene North America remain unresolved, due largely to confusing taxonomy and poorly diagnostic remains. Two species of large horses are here recognized. *Equus scotti*, characterized in part by large size, stout metapodials, and infundibula in the lower incisors, is present in multiple early and middle Pleistocene faunas throughout western North America. In the later Pleistocene a second species replaces *E. scotti* as the common large horse in southern California and possibly New Mexico. This form, often assigned to the species *Equus occidentalis*, is as large as or larger than *E. scotti* but lacks infundibula in the lower incisors. *E. scotti* remains the sole large horse species north and east of this range, but detailed biogeographic distributions for these taxa are unsolved.

New discoveries from southern Nevada enable a more precise definition of the geographic boundary between these species. Exposures of the Las Vegas Formation (LVF), a remarkably continuous paleowetland sequence in the upper Las Vegas Wash, have yielded the Tule Springs local fauna (TSLF), the largest late Pleistocene assemblage from the Mojave Desert and southern Great Basin region. Horses are a major component of the TSLF, but diagnostic remains have been lacking despite decades of study. Recent work by the San Bernardino County Museum and volunteers under permit from the Nevada Bureau of Land Management has yielded a partial skull, mandible, and metatarsal of *Equus scotti* - the first horse fossils from the LVF to be reliably referable to species. The newly-recovered remains represent a large equid with stout metatarsals and lower incisor infundibula.

Pleistocene localities in northern Nevada have previously yielded fossils of *Equus scotti* (as *E. pacificus*) dating to ~25.5 ka. The fossils from the TSLF, from high in the section of the LVF, are directly associated with a ^{14}C date of ~11.88 ka. These remains are therefore the youngest and most southerly record of this species in Nevada and among the youngest recorded anywhere in North America.

The presence of *Equus scotti* in the TSLF demonstrates close geographic and temporal proximity to other late Pleistocene Mojave Desert localities reportedly containing the *E. "occidentalis"* morph. The range extension documented here forces reevaluation of these prior records. Coupled with the presence of small horses in the TSLF, the new fossils demonstrate that multiple large and small horse species coexisted in western North America in the latest Pleistocene.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE RELIABILITY OF MAXILLARY AND MANDIBULAR FIRST AND SECOND MOLARS FOR IDENTIFYING DIETARY CATEGORY IN EXTANT BOVIDS VIA DENTAL MICROWEAR TEXTURE ANALYSIS

SCOTT, Jessica, University Of Arkansas at Little Rock, Little Rock, AR, United States, 72204; O'HARA, Mackie, University of Arkansas at Little Rock, Little Rock, AR, United States

Dental microwear has been successfully used to infer dietary category in fossil vertebrates for more than four decades, with studies having been conducted on taxa including carnivores, primates, bovids, suids, and dinosaurs. Due to the need for unobscured antemortem microwear surfaces, sample sizes have often been small. This problem was first addressed in the 1980's, with comparisons of the wear signatures from four molar types (upper first, upper second, lower first, and lower second). The research, conducted with a scanning electron microscope, indicated that these four teeth evince comparable microwear signatures. A new technique for analyzing microwear, known as dental microwear texture analysis, analyzes data at a higher resolution and therefore, the reliability of these four teeth as equal indicators of diet must be retested. In this study, we compare upper and lower M1s and M2s of extant African Bovidae with diets ranging from obligate grazer to browser to dedicated frugivore. Bovids include *Aepyceros*, *Antidorcas*, *Cephalophus*, *Damiliscus*, *Gazella*, *Hippotragus*, *Kobus*, *Litocranius*, *Neotragus*, *Oreotragus*, *Philantomba*, *Raphicerus*, *Redunca*, *Sylvicapra*, *Syncerus*, *Taurotragus*, and *Tragelaphus*. Representatives of the four molar types were scanned with a white-light confocal profiler and analyzed using scale-sensitive fractal analysis. We predicted that due to the cooperative processing of food by the molar complex, the four molar types would consistently yield equivalent microwear signatures. The multiple tooth types were compared both within the individual, as well as for the species as a whole. The interaction between the location (upper vs. lower) and position (first vs. second) of the molars failed to explain the variability in any of the DMTA variables: complexity *Afsc* ($p>0.276$), anisotropy *epLsar* ($p>0.177$), scale of maximum complexity *Smc* ($p>0.495$), textural fill volume *Tfv* ($p>0.597$), or heterogeneity *HAfsc9* ($p>0.163$) and *HAfsc81* ($p>0.509$). This suggests that molar type does not affect microwear signature and that all four molars are equally reliable for identifying dietary signals. These results confirm previous results of SEM analysis and suggest that future molar microwear studies may use these four tooth types interchangeably and with confidence. While it is still ideal to restrict a study to a single tooth type, the ability to combine molars for larger samples sizes is invaluable, particularly when analyzing rare fossil material.

Technical Session I (Wednesday, October 30, 2013, 8:30 AM)

EVOLUTION OF APPENDAGE MODULARITY DURING THE FIN TO LIMB TRANSITION

SEARS, Karen, University of Illinois, Urbana, IL, United States, 61801; MABEE, Paula, University of South Dakota, Vermillion, SD, United States; DECECCHI, Alexander, University of South Dakota, Vermillion, SD, United States

Morphometric and developmental studies suggest that the segments of the tetrapod limb (i.e., girdle, stylopod, zeugopod, and autopod) form distinct modules. This modular design is believed to allow the limb segments to evolve relatively independently, facilitating the adaptive evolution of the limb. Researchers have hypothesized that this modular pattern evolved during the fin to limb transition in response to the effect of changing functional pressures on the genetic architecture of the developing limb. However, this hypothesis has not been rigorously tested, and developmental data suggest that at least some of the genetic modules that regulate limb development in tetrapods were present in their finned ancestors. This raises the possibility that the modularity that characterizes the limbs of modern tetrapods may also have been present in more basal sarcopterygians. To test among these hypotheses, a dataset of discrete limb characters was downloaded from Phenoscape. Phenoscape is a collaborative database designed to integrate developmental phenotypes with the fossil record. The downloaded database consisted of 39 published matrices from the tetrapodomorph literature spanning the fin to limb transition. This dataset was then partitioned into four subsets, some of which overlap: all taxa, all tetrapods, all non-tetrapods, and non-tetrapods that form the closest outgroups to tetrapods. In this study "tetrapod" refers to only those taxa with digits. For each dataset, the correlation of evolutionary changes between each pair of characters was calculated using the pairwise comparison method, Pagel's Test and Maddison's Test (implemented within a phylogenetic context in Mesquite and R), and the level of correlation within and among limb segments compared. Results indicate that character correlations are significantly higher within- than among- segments within all taxa and all tetrapods. In contrast, within- and among- segment correlations are similar in non-

tetrapods. These results are consistent with an increase in the modularity of appendage segments around the time of the origin of the tetrapod limb, possibly in response to the limb's new functional role in terrestrial locomotion.

Technical Session X (Friday, November 1, 2013, 8:45 AM)

SHIFTING ENVIRONMENTS AND CONTROLS ON BODY SIZE IN PLEISTOCENE HORSES FROM THE GREAT PLAINS

SECORD, Ross, University of Nebraska, Lincoln, NE, United States, 68521; LILIENTHAL, Nathan, University of Nebraska, Lincoln, NE, United States

In the modern world there is a strong, positive correlation between mammalian body size in a species, or in closely related species, and geographic latitude. This relationship is known as Bergmann's Rule and is usually attributed to latitudinal temperature variation and the optimization of mammalian body size. Alternatively, it has been attributed to the availability of food resources related to primary productivity. Bergmann's Rule predicts that average mammalian body size should decrease with warming climate and increase with cooling climate though time. This pattern is seen in early Eocene equids and other mammals during the Paleocene-Eocene Thermal Maximum but is not well documented in other parts of the geologic record. Here we use oxygen and carbon stable isotopes from *Equus* teeth (M3/s) as proxies for relative temperature and diet, respectively, and metacarpal length as a proxy for *Equus* body mass. Samples are from six late Irvingtonian and two late Rancholabrean localities in Nebraska, USA. Results yielded a strong, positive correlation between mean $\delta^{13}C$ and $\delta^{18}O$ values when averaged by locality, and strong positive correlations between metacarpal length and both $\delta^{13}C$ and $\delta^{18}O$ values among the Irvingtonian localities. The range of $\delta^{13}C$ values shows that horses were consuming primarily C_3 plants at some localities, but mixed C_3/C_4 vegetation at others. Oxygen isotopes in meteoric water are positively correlated with mean annual temperature at mid-latitudes today. Thus, the carbon and oxygen isotope correlation suggests that C_4 grasses shifted northward during warmer intervals. Alternatively, C_4 plants may have had higher $\delta^{18}O$ values than C_3 plants. However, this explanation does not account for the greater body size in horses consuming C_4 vegetation, implied by the positive correlation between metacarpal length and $\delta^{13}C$ values. The nutritional content of C_4 plants is lower or equal to that of C_3 plants, so consumption of a higher percentage of C_4 plants should not result in greater body size. We suggest that *Equus* body size was controlled by greater primary productivity in warmer intervals, which had both longer growing seasons and longer growing days. Increased body size with warming is the opposite of the expectation from Bergmann's Rule, but is most consistent with our results, and suggests that primary productivity can be a stronger controlling factor on body size than mean annual temperature.

Technical Session VII (Thursday, October 31, 2013, 3:15 PM)

ESTIMATING MUSCLE PARAMETERS FOR STUDIES OF SAUROPOD LOCOMOTION

SELLERS, William, University of Manchester, Manchester, United Kingdom; MARGETTS, Lee, University of Manchester, Manchester, United Kingdom; CORIA, Rodolfo, Museo Municipal Carmen Funes, Plaza Huincul, ; MANNING, Phillip L., University of Manchester, Manchester, United Kingdom

It has been shown repeatedly that uncertainty in the sizes of muscles is one of the biggest challenges in reconstructing the locomotor capabilities of extinct vertebrates. The range of variation in modern animals is large both between and within species, and when sensitivity analyses are performed, this variation causes a similarly large variation in predicted locomotor performance. However there are certain biomechanical limitations that allow us to bracket the muscle mass of an animal. The animal must have sufficient muscle to perform a minimal set of locomotor functions, and similarly the animal cannot have so much muscle that its skeleton is unable to accommodate the generated loads. Here we explore the lower of these limits using a reconstruction of one of the very largest sauropod dinosaurs, *Argentinosaurus huinculensis* (40 metres long, weighing 83 tonnes), as an exemplar. Using comparative data we show how most muscles in terrestrial vertebrates operate over a contractile range that is approximately half of their resting length. From this observation we show how a minimum muscle mass equation can be derived entirely from the load moment arm in the skeleton and the joint range of motion. We test this approach using forward dynamic modelling to generate a slow walking gait and demonstrate that only simulations where the muscle mass is greater or equal to the amount predicted are successful. Limited comparative data suggest that there is little if any size dependency on joint range of motion patterns. However, if we use elephant derived joint ranges of motion, our *Argentinosaurus* simulation is unable to generate gait and that considerably reduced ranges of motion are necessary for this animal unless we propose improbably high levels of muscle mass. These results allow us to functionally bracket the likely joint range of motion and muscle mass combination and this approach should therefore allow more accurate gait and posture reconstructions in all fossil vertebrates.

Technical Session I (Wednesday, October 30, 2013, 11:00 AM)

SHOULDER GIRDLE ARCHITECTURE: A MAJOR CONSTRAINT IN THE EVOLUTION OF AMNIOTE LOCOMOTION

SERENO, Paul, Univ of Chicago, Chicago, IL, United States, 60637; ISCH, April, University of Chicago, Chicago, IL, United States; CONROY, Lauren, University of Chicago, Chicago, IL, United States

We use computed-tomographic scans of two superbly preserved Cretaceous amniotes—the multituberculate *Kryptobaatar* and the crocodylomorph *Araripesuchus*—to determine the neutral standing posture and step cycle by way of bone segmentation, rearticulation, and animation. We then compare the animated step cycle of the rearticulated forelimb and shoulder girdle to that observed by computed-tomographic scans and high-speed film of living descendants. We demonstrate conclusively that the neutral pose of the forelimb of *Kryptobaatar* was near-parasagittal and maps well onto the step cycle of small living therians. We demonstrate similarly that the neutral pose of the forelimb of *Araripesuchus* was also near-parasagittal and maps well onto the near-parasagittal bounding gait of the living crocodylian *Crocodylus johnstoni*. The marked contrast in the architecture of the shoulder girdle in these two representative Cretaceous quadrupedal amniotes, *Kryptobaatar* and *Araripesuchus*, posed major constraints with regard to speed and agility on land in quadrupedal mammals and archosaurs, respectively. The first, with its mobile architecture, gave rise to a diversity of distinctive gaits and agile cursorial herbivores and carnivores among therian mammals. The second, with its relatively rigid structure, proved to be a disadvantage for speed and agility on land, although an advantage in the achievement of forelimb powered flight. The absence of true quadrupedal cursors among Mesozoic archosaurs and the paucity of gaits among extant survivors attests to the structural primacy of shoulder girdle architecture in parasagittal terrestrial locomotion.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ISOLATED THEROPOD TEETH FROM THE "ARGILES DE L'IRHAZER" (MIDDLE JURASSIC) OF NIGER

SERRANO-MARTÍNEZ, Alejandro, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; ORTEGA, Francisco, Universidad Nacional de Educación a Distancia, Madrid, Spain; KNOLL, Fabien, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

*Isolated theropod teeth are common fossils in continental Mesozoic deposits. Three well-preserved crowns were found associated with the holotype skeleton of *Spinophorosaurus nigerensis* from the "Argiles de l'Irhazer" (Middle Jurassic: ?Bathonian) of Niger.

These specimens can be divided into two morphotypes. The first morphotype includes two teeth that do not show any distinct diagnostic characters. Therefore, morphometric analyses had to be performed to help identify them. The results of the DFA and of a scatter plot of the first and second canonical functions generated by the discriminant analysis suggested that they are from an allosaurid. The second morphotype includes a peculiar tooth that shows "spinosaurid-like" characters, such as subconical with textured enamel and many minute denticles. However, it is not as conical as typical spinosaurid teeth, and it does not bear any apicobasal ridges. Its position on the scatter plot is ambiguous, between basal tetanurans and spinosaurids. The mosaic characters and the scatter plot may make sense if this tooth pertained to a basal spinosaurid, which would show a transition between the archetypal theropod dental morphology and the apomorphic spinosaurid teeth. No Middle Jurassic spinosaurid is known so far, but the age of the specimen is not in conflict with this identification, as stratigraphically calibrated phylogenies of tetanuran theropods show.

If confirmed, the presence of the earliest known spinosaurid in the Middle Jurassic of Niger would support an African origin for the clade.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

OSTEOLOGY OF A NEW SPECIMEN OF AN ELASMOSAURID PLESIOSAUR (REPTILIA: SAUROPTERYGIA) FROM THE UPPER CRETACEOUS BEARPAW SHALE, MONTANA

SERRATOS, Danielle J., Univ of Alaska Museum, Fairbanks, AK, United States, 99775; DRUCKENMILLER, Patrick, Univ of Alaska Museum, Fairbanks, AK, United States

Elasmosauridae is a clade of long-necked plesiosaurians that existed throughout the Cretaceous. In North America, the clade is best known from Upper Cretaceous marine deposits of the Western Interior Basin (WIB). Although numerous specimens have been collected in the WIB over the past century, understanding of their morphology and diversity from this region remains poor. This is particularly true of the geologically youngest taxa that existed during the last transgressive-regressive cycle of the Western Interior Seaway, just prior to the end-Cretaceous extinction. At present, only two valid taxa of elasmosaurids are recognized from this interval, both from the Bearpaw Shale of southern Canada. Here, we report on a new, nearly complete skeleton of an elasmosaurid from the Bearpaw Shale of eastern Montana. The new specimen was found on the C. M. Russell National Wildlife Refuge in 2010 and preserves an obliquely crushed yet complete skull. Much of the postcranium is preserved in a single, large carbonate concretion that includes most of the dorsal and caudal vertebrae, coracoids, pelvic girdle and well preserved proximal forelimb and hind limb elements. At the time of discovery, the complete and articulated cervical series was preserved and photographically documented, indicating a total cervical count of 42-46 vertebrae; however, only the anterior 23 cervicals could be recovered. Preliminary comparative analysis of the skull and postcranium reveals that the new taxon is not conspecific with the other known Bearpaw elasmosaurids *Albertonectes* and *Terminonatator* on the basis of its extremely shortened preorbital region, small number of cervical vertebrae, and cervical vertebral dimensions (length versus width) that are very short when compared to other known elasmosaurids. The specimen represents one of the most complete and well-articulated elasmosaurids found to date in the WIB and provides important new morphological data for ongoing phylogenetic studies of the clade.

Technical Session IX (Friday, November 1, 2013, 8:45 AM)

A GIANT ABELISAURID THEROPOD FROM THE LATEST CRETACEOUS OF NORTHERN TURKANA, KENYA

SERTICH, Joseph, Denver Museum of Nature & Science, Denver, CO, United States, 80205; O'CONNOR, Patrick, Ohio University, Athens, OH, United States; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, United States; MANTHI, Fredrick Kyalo, National Museums of Kenya, Nairobi, Kenya

The African fossil record of Cretaceous non-marine vertebrates has expanded significantly over the past two decades. However, these discoveries have been limited to Lower and middle Cretaceous horizons with a conspicuous absence of fossils from the latest Cretaceous, an interval of prolonged African isolation. Recently recovered vertebrate fossils from the Lapurr Mountains of northwestern Turkana, Kenya, comprise the first definitive non-marine fauna from this critical terminal Cretaceous interval. This diverse fauna from the Lapurr sandstone ("Turkana Grits") has been dated to the Maastrichtian and includes crocodyliforms, pterosaurs, and dinosaurs. Though fragmentary, the dinosaur record includes at least two iguanodontian ornithopods, three macronarian sauropods, and two large theropods. Here we report on one of these theropods, a new abelisaurid that significantly expands the upper limits of body size in ceratosaurians and represents the youngest diagnostic dinosaur material yet reported from the Afro-Arabian continent.

The new taxon is known from multiple isolated specimens including portions of the skull, axial column, and appendicular skeleton. Referral of unassociated remains to a single taxon is based on morphological consistency and on the recovery of specimens from a narrow stratigraphic and geographic area. A comprehensive phylogenetic analysis substantiates referral of the new Kenyan taxon to Abelisauridae based, among other features, on the presence of a tall, rugose premaxilla, an anteroventrally inclined posterior border of the postorbital, and a prominent dorsal projection of the parietals and supraoccipital. An associated partial skull is strongly coossified, with a thickened but weakly sculptured skull roof. Unlike many other abelisaurids, no prominent cranial ornamentation is evident. As in other ceratosaurians, the astragalocalcaneum is completely coossified and displays a prominent transverse sulcus on the anteroventral surface. Like other abelisaurids, the ascending process is low and subrectangular, separated from the anterior surface of the astragalus by a distinct fossa. Comparison of preserved elements with those of other, more complete abelisaurids indicates that the new taxon likely exceeded 11-12 meters in length. Furthermore, the presence of a large-bodied abelisaurid in the Kenyan fauna parallels many other Late Cretaceous Gondwanan faunas, reflecting global early Late Cretaceous turnover from allosauroid and spinosaurid dominated ecosystems.

Symposium 2 (Thursday, October 31, 2013, 2:15 PM)

PERUSING TALARA: OVERVIEW OF THE LATE PLEISTOCENE FOSSIL VERTEBRATES FROM THE TAR SEEPS OF PERU

SEYMOUR, Kevin, Royal Ontario Museum, Toronto, ON, Canada, M5S 2C6

A.G. Edmund collected more than 28 000 fossil bones from the Late Pleistocene tar seep deposit near Talara, Piura, Peru, more than 50 years ago, in January 1958. Of the identified 27 064 specimens, 63.4% represent mammals, 34.5% birds and 2.1% reptiles, with trace amounts of amphibian remains. Two families of Amphibia and eight families of Reptilia have been tentatively identified, but not published. Fourteen non-passerine bird orders represented by 6342 identified specimens have been published, while the almost 3000 passerine bones remain under study. Considering the fossil bird remains, ducks (37.2%) and passerines (32%) predominate, in contrast to the similarly-aged Rancho La Brea, California, assemblage where diurnal birds of prey (60%) form the majority. Of the 17 150 mammal specimens, Carnivora represent over 79%, indicating a classic carnivore trap situation, as at Rancho La Brea. Eight species of Carnivora have been identified (Minimum number of individuals, MNI, in parentheses): the canids *Lycalopex sechurae* (101) and *Canis dirus* (51), the felids *Smilodon fatalis* (20), *Panthera onca* (3), *Puma concolor* (3) and *Leopardus* sp. (2), the mustelid *Conepatus talarae* (7) and a single bone of another as yet unidentified mustelid. The MNI is usually based on podial elements. Although *Panthera atrox* was reported from Talara, this report was in error. Within the herbivores only the deer and camel have been studied and published, so the species determination remains unresolved for most. There are two cervids, *Odocoileus* (18) and *Mazama* (1), a camelid, *Palaeolama* (3), a tayassuid, *Pecari* (1), an equid, *Equus* (6), a gomphotheriid, *Stegomastodon* (2) and at least five xenarthrans, *Holmesina* (2), *Eremotherium* (3), an unidentified nothrothere (1), *Glossotherium* (2) and *Catonyx* (12). Rodentia are represented by *Neochoerus* (1) and an undetermined number of smaller species, still under study. Finally there is a single bat specimen assigned to *Tonatia*, and two didelphids, *Didelphis* (1) and *Marmosa* (1). The mammalian remains compare well with the famous Rancho La Brea deposits; carnivorans dominate, a high proportion of juveniles and subadults are present (35% to 47% depending on the species), and a significant number of *Canis dirus* specimens show skeletal pathologies. A habitat with more water than is present today is indicated by this fauna, which has a distinctive South American component as well as a number of species in common with the Rancho La Brea assemblage.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

DOES SIZE MATTER? ISOMETRIC VS. ALLOMETRIC SCALING IN ARMADILLOS, PAMPATHERES, AND GLYPTODONTS (ORDER CINGULATA)

SHAW, Barbara, Colorado State University, Montrose, CO, United States, 81401

The Order Cingulata (armadillos, pampatheres, and glyptodonts) are generally power diggers. The extant species of Cingulata are tiny compared to their extinct relatives. They range in size from the 12 cm *Chlamyphorus* (fairy armadillos) to the more than 3 m glyptodonts, like *Panochthus*. One factor in evaluating the biomechanics of a species is to establish an accurate estimate of body mass, however armored organisms defy the usual estimates. To better understand the locomotion of glyptodonts and pampatheres, the best model, therefore, is using extant but small armadillos, which are also armored. This calls into question isometric vs. allometric scaling. If armadillos are closer to an isometric scale, the more fit the model, and thus better able to estimate the body mass and emulate the locomotion of their giant, extinct relatives. Because of the digging lifestyle, the bones in some of the small extant species are very robust. This study examines isometric and allometric scaling of humeri and femori among the extinct and extant cingulatans by comparing a morphometric analysis to a log transformed regression of these same specimens. The data indicate that *Priodontes* and *Cabassous* armadillos are a good isometric model when examining their larger extinct relatives.

Symposium 2 (Thursday, October 31, 2013, 3:45 PM)

THE ADDITION OF *SMILODON FATALIS* (MAMMALIA, CARNIVORA, FELIDAE) TO THE BIOTA OF THE LATE PLEISTOCENE CARPINTERIA ASPHALT DEPOSITS WITH ONTOGENETIC AND ECOLOGIC IMPLICATIONS FOR THE SPECIES

SHAW, Christopher, George C Page Museum, Los Angeles, CA, United States, 90036; QUINN, James, George C Page Museum, Los Angeles, CA, United States

A well preserved late Pleistocene flora and fauna was collected in 1927 from an asphalt quarry located southeast of the city of Carpinteria in Santa Barbara County, California. The fossils were chiefly found in two limited areas within alluvial sediments deposited on the now emergent Punta Gorda marine terrace (40–60 ka). A previous study concluded that the plant materials were deposited with the alluvial sediments and secondarily saturated with asphalt. However, it seems likely that some of the bones found in the Carpinteria asphalt deposits accumulated in or adjacent to asphalt seeps, similar to the chief mode of bone accumulation observed at the Rancho La Brea "tar pits," located about 7 miles west of the Los Angeles Civic Center. Fossil collections from the Carpinteria asphalt quarry were procured by the Santa Barbara Museum of Natural History, the University of California, Berkeley, and the California Institute of Technology (CIT). Since its purchase in 1957, the CIT collections have been housed at the Natural History Museum of Los Angeles County (LACM). During organization of the CIT collection at LACM in 1985, an edentulous left maxilla from a very young *Smilodon fatalis* was identified. This is the first and only *Smilodon* material identified from Carpinteria. But for 13 mm of the permanent canine (located deep within the bifurcated canine alveolus), all developing deciduous and permanent cheek teeth have been lost. The Carpintera specimen is from a much younger animal than any juvenile found in the Rancho La Brea collection and represents the first pre-weaned individual of this species to be identified anywhere. Previous studies of the biota indicated that the Carpinteria fossil deposits accumulated in a coastal closed cone pine forest with an understory consisting of lilac, manzanita and bay. In contrast, the biota at Rancho La Brea indicates an inland coastal environment, with more open areas close to the asphalt traps supporting coastal sage scrub, with wooded areas restricted to the occasional stream crossing the plain or distant upslope areas. *Smilodon fatalis* is represented by over 166,000 specimens at Rancho La Brea, dominated by subadult and juvenile specimens. We suggest the Carpinteria habitat, with its dense patches of undergrowth, may have been a desirable area for birthing or denning. The habitat at Rancho la Brea favored herds of open-country grazers, and apparently was a suitable area, with its low vegetation, for hunting prey.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW FOSSIL MEGAMOUTH SHARK (LAMNIFORMES: MEGACHASMIDAE) FROM THE OLIGO-MIOCENE OF THE WESTERN UNITED STATES

SHIMADA, Kenshu, DePaul Univ, Chicago, IL, United States, 60614; WELTON, Bruce, New Mexico Museum of Natural History and Science, Albuquerque, NM, United States; LONG, Douglas, Oakland Museum of California, Oakland, CA, United States

The extant megamouth shark, *Megachasma pelagios* (Lamniformes: Megachasmidae), is a large filter-feeding fish. Since the discovery of the extant *M. pelagios* in 1976, fossil megachasmids have been reported sporadically from several marine deposits worldwide. The fossil record includes a taxon from the Oligocene–Miocene marine deposits of western United States known at least since the early 1960s, but the fossil taxon has never been formally studied or described. Based on a large sample of isolated teeth housed in the Natural History Museum of Los Angeles County and the Museum of Paleontology of the University of California at Berkeley in California, we here describe the fossil form that is attributed to a new species within the genus *Megachasma*. These fossil teeth come from the Pyramid Hill Sand Member of the Jewett Sand and Skooner Gulch Formation of California as well as from the Yaquina Formation and Nye Mudstone of Oregon, and stratigraphically range from late Oligocene to early Miocene (late Chattian - Aquitanian). Our quantitative analysis indicates that extant *M. pelagios* tends to possess slender crowns compared to the fossil taxon that has crowns with more or less equal height and width. Although showing a megachasmid tooth design, teeth of the fossil species exhibit a wide morphological range and are reminiscent of those of odontaspidid sharks, suggesting that its dentition must have exhibited strong heterodonty, possibly like odontaspidids. The fossil taxon could have commonly measured approximately 6 m in total length and likely had a wide dietary range, possibly including small fishes and planktonic invertebrates. The fossil record indicates that the fossil taxon was broadly adapted to a wide bathymetric tolerance or was a nektopelagic feeder over both deep and shallow water habitats. The behavior of the fossil species can only be speculated on the basis of its teeth, but the present fossil record does not preclude the possibility that the fossil megachasmid was also a vertical migrator like the extant *M. pelagios*.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

USE OF SILICONE CAULK AS A SEPARATOR FOR FIELD JACKETS

SHINYA, Akiko, The Field Museum , Chicago, IL, United States, 60605-2496

In January 2012, the Field Museum teamed up with Universidad Maimónides, Buenos Aires and the Museo Earnesto Bachmann, Villa El Chocón and conducted a fieldwork to explore a terrestrial deposit from the Cretaceous era in the Neuquén province of Argentina. The team discovered a bone bed with partially articulated skeletons of at least four large dinosaurs lying between sandstone and mudstone. The sandstone is weather resistant and formed overhang ledges as the mudstone eroded away. The underside of the sandstone ledges contained fossil fragments and impressions that were exposed and ready to be collected. The traditional method of using wetted toilet paper as a separator was ineffective because the toilet paper would not adhere to the underside of the overhang. The team used silicone caulk as a separator because it would adhere to the underside of the overhang. The team found that a liberal application of consolidants and mold release agent prior to brushing on silicone caulk resulted in superb preservation of the fossil fragments and impressions and resulted in excellent separation between the specimen and matrix and the silicone caulk. The use of silicone caulk as a separator also proved to be effective for a specimen left in situ for future excavation because the silicone caulk created an anoxic environment, which is more resistant to weathering and erosion.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

DENTAL HISTOLOGY OF DIRE WOLF FOSSILS FROM TAR SEEP DEPOSITS: TAPHONOMIC CONSIDERATIONS FOR LIFE HISTORY STUDIES

SHOLTS, Sabrina, Stockholm University, Stockholm, Sweden; WÄRMLÄNDER, Sebastian, Stockholm University, Stockholm, Sweden; CARLSON, Joshua, University of California Berkeley, Berkeley, CA, United States; HLUSKO, Leslea, Univ of California Berkeley, Berkeley, CA, United States

Life history parameters play an important role in how animals respond to selective pressures. The ontogenetic development of tooth enamel provides a rich record of the timing of key life events, and as such, how these vary between extant and extinct organisms. Given that certain aspects of enamel variation cannot be seen or compared without damage to the tooth via sectioning, including fossils in such analyses is not done without careful consideration of the loss of a limited resource. This loss is minimized if samples for sectioning are taken from fossil assemblages that include large numbers of individuals from the same taxon.

From this perspective, natural traps such as the La Brea tar pits represent an ideal fossil resource. With the increasing interest in recent climate change and how animal lineages have responded to such changes, La Brea and other seeps provide some of the larger fossil assemblages of Rancholabrean age in the Americas. However, sectioning also requires careful consideration of how appropriate the tooth is for analysis, and whether taphononomic factors may limit or invalidate results. While the skeletal morphology of the fossils from tar seeps is often relatively complete and undistorted, it remains to be determined whether or not the tar has adverse effects on preservation or analysis at a microscopic/histological level.

To test whether or not teeth from tar seeps are useful for life history studies, we sectioned and compared dire wolf teeth from two samples of ten individuals from the La Brea tar pits (University of California Museum of Paleontology) and the Cutler Hammock site in Florida, a karstic deposit (Florida Museum of Natural History). Our results indicate that tar as a depositional environment does not distort or obscure fossil dental tissues and thus can preserve adequate histology for life history studies. Detailed comparisons between these two samples are presented. We conclude that tar pit deposits represent an important resource for future research into how mammalian life history strategies have evolved in response to climatic change, and given the large sample sizes, possibly also for assessing population level variation of life history traits within extinct organisms.

Symposium 4 (Saturday, November 2, 2013, 8:30 AM)

NEW DATA ON THE MIDDLE TRIASSIC TETRAPODS OF ANTARCTICA AND FAUNAL PROVINCIALIZATION ACROSS SOUTHERN PANGEA

SIDOR, Christian A., University of Washington, Seattle, WA, United States, 98195; HUTTENLOCKER, Adam K. K., University of Washington, Seattle, WA, United States; PEECOOK, Brandon R., University of Washington, Seattle, WA, United States; SMITH, Roger M.H., Iziko South African Museum, Cape Town, South Africa; VILHENA, Daril A., University of Washington, Seattle, WA, United States

Renewed field work in the Beardmore Glacier region of Antarctica has led to a new collection of tetrapod fossils from the upper member of the Fremouw Formation at Fremouw Peak. This locality records a sedimentary environment and taphonomic signature remarkably similar to that preserved at Gordon Valley, the first locality known to preserve *Cynognathus* Assemblage Zone-equivalent taxa from Antarctica. We use an apomorphy-based approach to document the occurrence of three previously unrecognized taxa from the upper Fremouw: the dicynodont *Angonisaurus*, an indeterminate therocephalian therapsid, and an indeterminate crown group archosaur. Combined with previous data, our work demonstrates that ten distinct taxa can be recognized from the upper Fremouw, including two endemic temnospondyls. Furthermore, our recognition of *Angonisaurus* in the upper Fremouw Formation provides a new piece of evidence in favor of a correlation with the *Cynognathus* C subzone (uppermost Burgersdorp Formation) of South Africa. To examine the effect of the end-Permian mass extinction on the distribution of tetrapods across southern Pangea, we applied novel network methods to compare pre- and post-extinction assemblages. More specifically, we collected presence/absence data for 65 Permian species and 68 Middle Triassic species in five regions: (1) Karoo Basin of South Africa; (2) Luangwa Basin of Zambia; (3) Ruhuhu Basin of Tanzania; (4) Chiweta beds of Malawi; and (5) Beacon Basin of Antarctica. We analyzed four components of biogeographic structure: connectedness, clustering, range size, and endemism, and for all four, we detected significantly increased provincialism in our Triassic dataset. In southern Pangea, a more homogeneous and broadly distributed fauna in the Late Permian (Wuchiapingian; ~257 Ma) was replaced by a provincial and biogeographically fragmented fauna by Middle Triassic times (Anisian; ~242 Ma). The use of descriptive network statistics provides insight into the underlying structure of biogeographic assemblages and bipartite network diagrams provide an easy-to-interpret means of representing similarities and differences between faunal assemblages at various localities. Until data from field work in Antarctica and other non-model regions are augmented, poor sampling will hamstring the attempts of vertebrate paleontologists to understand how the end-Permian mass extinction affected the broad-scale geographic distribution of tetrapods.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE GORGONOPSIAN BRAINCASE AND THE EVOLUTION OF THERAPSID BRAINS

SIGURDSEN, Trond, McGill University / NHM LA County, Los Angeles, CA, United States, 90007

The early evolution of the synapsid brain is of great importance to our understanding of the evolutionary origin of the mammalian biology. In this study, the skull of a gorgonopsian therapsid (*Lycaenops*) was CT-scanned, and compared it to the braincases of more basal synapsids as well as therocephalians, cynodonts and mammals. The gorgonopsian braincase is well-ossified. Although sutures are hard to determine from the scan, the main structures of the braincase are revealed in higher detail than most previous studies of therapsids. The orbitosphenoid resembles that described in basal synapsids such as *Dimetrodon*, although the olfactory bulbs appear to be more clearly outlined in the gorgonopsian skull than in most synapsids from the Permian. The olfactory bulbs were large and located in the anterior part of the orbitosphenoid. The narrow olfactory tracts passed through the posterior part of this bone, leading to relatively small and elongate cerebral hemispheres. The optic lobes (part of the tectum in the mesencephalon) were probably large and dorsolaterally situated. The shape of the brain appears to have been similar in gorgonopsians and *Dimetrodon*, with a relatively flat cerebellum (though this area is somewhat larger in *Lycaenops*), elongate cerebral hemispheres, and bulbous olfactory bulbs. Comparisons to other tetrapods suggest that many of these features are plesiomorphic for amniotes in general, and *Lycaenops* shows relatively little progress towards the mammalian condition. In comparison, the cerebellum is noticeably enlarged in therocephalians and cynodonts, and the cerebrum is greatly enlarged in true mammals. Thus, the incipient enlargement of the cerebellum appears to be one of the first mammalian features to appear in the therapsid brain.

Technical Session VI (Thursday, October 31, 2013, 8:15 AM)

A NEW FAMILY OF LARGE OMNIVOROUS BATS FROM THE LATE EOCENE OF EGYPT

SIMMONS, Nancy, American Museum of Natural History, New York, NY, United States, 10024; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, United States; GUNNELL, Gregg, Duke University Lemur Center, Durham, NC, United States

The Eocene was a time of explosive diversification for Chiroptera. The oldest known bats are early Eocene in age (~55—52MY BP). Twenty-eight families of bats are currently recognized, including eight known only from fossils. A combination of fossils and ghost-lineage reconstruction indicates that virtually all of these lineages were distinct by the end of the Eocene (~34 MY BP). Bats were present on all continents except Antarctica by the middle Eocene, and most archaic bat families (known only from fossils) had distributions spanning multiple continents. A new fossil from the BQ-2 locality in the Birket Qarun Formation in the Fayum Depression of northern Egypt (dated to ~37MY BP) does not fit within the diagnosis of any previously described family of bats from Africa or any other continent. Known from a partial maxilla, this taxon has molars with a well-developed W-shaped ectoloph lacking a distinct mesotyle but with a strong parastyle and shallow U-shaped ectoflexus - all traits that are found in most archaic bat families and which are probably plesiomorphic for bats. However, this taxon also has an M2 with a large metaconule cusp and a large, bulbous hypocone set low on the posterolingual corner of the tooth, neither of which occur in any other known bat family, living or extinct. Also notable is the size of the new BQ-2 bat, which appears to have been only slightly smaller than the largest extant bats with tribosphenic dentitions, falling well within the size range of modern megabats. The molars of the new bat lack the high, sharp crests and elongated preparacrista and postmetacrista common in large tribosphenic bats, features that are associated with an insectivorous/carnivorous diet. The combination of traits in the new BQ-2 bat suggests that it may have been more omnivorous than other known Eocene bats, perhaps including plant material in its diet.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ELONGATOOLITHID (DINOSAURIA: THEROPODA) EGGSHELL FROM THE LOWER CRETACEOUS CLOVERLY FORMATION, MONTANA: A TAPHONOMIC INVESTIGATION OF APPARENT EGGSHELL DIVERSITY

SIMON, D. Jade, Montana State University, Bozeman, MT, United States, 59717; BARTA, Daniel, Montana State University, Bozeman, MT, United States; MAXWELL, W. Desmond, University of the Pacific, Stockton, CA, United States; VARRICCHIO, David, Montana State University, Bozeman, MT, United States

The Cloverly Formation (Aptian-Albian) of Montana has yielded rare North American examples of Early Cretaceous dinosaur eggshell. The worldwide scarcity of Early Cretaceous dinosaur eggs and eggshell compels documentation of the microstructure and phylogenetic affinities of these specimens, thus filling, in part, a gap in our knowledge of the early evolution and diversity of Cretaceous ootaxa. The eggshell fragments under study were recovered from exposures of Unit VII of the Cloverly Formation, approximately five miles east of Edgar, Montana. The fragments, initially defined as three distinct types based on surface ornamentation, were examined using petrographic and scanning electron microscopy and cathodoluminescence.

Analysis reveals the three 'types' of eggshell are united by the presence of two structural layers of calcite separated by an undulating boundary. Additionally, the 1.5-2.3 mm thick eggshells exhibit straight pores and crystal splaying at the boundary of the mammillary and continuous layers, a feature similar to splaying observed in both the Asian theropod oogenus *Macroelongatoolithus xixiaensis* and extant guinea fowl. Strong fluorescence of portions of the mammillary layer and cracks throughout the eggshell under cathodoluminescence indicates some degree of diagenetic alteration of the specimens. Superficial differences in ornamentation among the three types are likely the result of dissolution or abrasion of the exterior surface of the eggshell, which may also be responsible for widening of the pores of one specimen.

The above microstructural features allow assignment of this eggshell to the theropod oofamily Elongatoolithidae, though without whole eggs preserved a more specific assignment is not possible. Phylogenetic analysis supports this result with the Cloverly eggshell placed within a polytomy with other elongatoolithid ootaxa. Additional microstructural comparisons reveal that the examined Cloverly eggshell is more similar to *Macroelongatoolithus* (possible oviraptorid) eggshell than the eggshell of *Deinonychus antirrhopus*, previously described from the Cloverly Formation. A co-occurrence of eggshell exhibiting a range of surface textures similar to those seen in the current study with skeletal remains of a neonate ornithopod was previously reported from Unit VII. The findings of this study argue against an ornithopod being the egg-layer.

Technical Session XI (Friday, November 1, 2013, 3:15 PM)

TEMPO OR MODE IN EVOLUTION? THE CASE OF MAMMALIAN BODY SIZE EVOLUTION

SLATER, Graham, Smithsonian Institution, Washington, DC, United States, 20013-7012

Paleontological studies have consistently shown that average mammalian body size and body size disparity increased rapidly after the Cretaceous-Paleogene (K-Pg) boundary. Phylogenetic comparative methods provide a powerful alternative way of addressing classic questions about tempo and mode of phenotypic evolution in the fossil record. However, recent phylogenetic studies based on extant taxa have failed to find evidence for a shift in mammalian body size evolution at the K-Pg boundary. A significant issue here is that, most often, these kinds of questions are addressed in the context of variation in evolutionary rates. However, shifts in the mode of phenotypic evolution provide an alternative and, in some cases, more realistic explanation for patterns of trait diversity. To test for these alternatives, I developed three novel models of mammalian body size evolution derived from paleontological theory and fit these to a time-calibrated phylogeny of living and fossil Mammaliaformes, including a number of Mesozoic taxa. Specifically, I asked whether the K-Pg extinction resulted in a shift in the rate of mammalian body size evolution or release from a constrained adaptive zone. I found that a model comprising a constrained evolutionary process until the K-Pg event and unconstrained Brownian motion process from the Cenozoic onwards was the best supported model for these data. Surprisingly, my results also indicate a lower absolute rate of mammalian body size evolution during the Cenozoic than during the Mesozoic. This can be explained by release from a stationary evolutionary process that limited realized disparity regardless of evolutionary rate. Despite a lower absolute evolutionary rate, body size disparity has in fact been increasing since the K-Pg event. The use of time-calibrated phylogenies of living and extinct taxa and realistic, process-based models provides unparalleled power in testing evolutionary hypotheses. However, these results suggest researchers should take care to ensure that the models they use are appropriate to the question being tested, and that the parameters estimated are interpreted in the context of the best-fitting model.

Technical Session X (Friday, November 1, 2013, 11:45 AM)

MIOCENE MAMMAL DIVERSITY IN RELATION TO TECTONIC AND CLIMATIC HISTORY OF THE BASIN AND RANGE PROVINCE

SMILEY, Tara, University of Michigan, Ann Arbor, MI, United States, 48104; BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States; FINARELLI, John, University College, Dublin, Ireland

Patterns of biodiversity on the modern landscape of North America reveal a striking geographic gradient in mammal species richness; areas of higher elevation and greater topographic complexity (e.g., the alternating mountains and desert basins in the Basin and Range Province) are more species-rich than areas of low topographic relief (e.g., the Great Plains). To test the hypothesis that increasing topographic complexity and changing climate stimulated diversification within montane regions, we evaluated the diversification history of mammals in the Basin and Range Province within the context of geologic and climate history during the Miocene. We compiled species-occurrence records from the NeoMap database of North American fossil mammals in order to calculate standing diversity and origination, extinction, diversification and turnover rates for 1-myr intervals from 30 to 2 Ma. Mammal diversity during the Miocene was dynamic, with the highest peak in diversity coinciding with an interval of increased tectonic extension and the Miocene Climatic Optimum from 18 to 14 Ma. Increases in area and topographic relief during tectonic extension, as well as the steepening of elevational gradients and generation of habitat heterogeneity during climate warming, likely decreased the continuity of bioclimatic zones, imposed barriers to dispersal, and fragmented geographic ranges of species; subsequent isolation of populations potentially promoted processes of speciation and extinction. Coeval with peaks in diversity from 18 to 14 Ma were significant increases in origination and extinction rates. The highest diversification rates and significantly high turnover rates also occurred during this interval. Small rodents and shrews responded differently than did large mammals to landscape change. Small mammal diversity increased significantly with area gain due to Miocene extension, and the proportion of small mammals within mammalian faunas of the Basin and Range Province increased substantially from ~0.20 at 12 Ma to ~0.5 by the end of the Pliocene. The Heteromyidae became one of the dominant rodent families by the end of the Miocene, with nearly half of the Basin and Range species first appearing during the middle Miocene interval of intensified landscape and climate change.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

RECONSTRUCTION OF THE BRAINCASE AND ASSOCIATED SOFT TISSUES OF THE NORTH AMERICAN THERIZINOSAUR *NOTHRONYCHUS MCKINLEYI*

SMITH, David, Northland Pioneer College, Show Low, AZ, United States, 85901

The basicranium of the North American therizinosaurian *Nothronychus mckinleyi* is redescribed with the ultimate goal of reconstructing soft tissues, including nerves, blood vessels, and craniocervical musculature. The resulting morphology is contrasted with *Falcarius utahensis*. The basicranium of *Falcarius* is nearly complete on one side or the other up to a partial prootic. Cranial nerve foramina V, VII?, IX, X, XI, and XII are preserved along with a possible middle cerebral vein. In *Nothronychus*, these same elements are preserved, but the prootic is more complete, possibly extending to the suture with the laterosphenoid. Cranial nerve foramina II, V, VI?, VII, VIII?, IX, X, XI, and XII are partially to completely present. There some indication of a possible middle cerebral vein canal and a probable carotid canal visible.

The therizinosaurian basicranium has undergone extensive modification from the plesiomorphic theropod condition. *Falcarius* exhibits an intermediate morphology whereas modification of the *Nothronychus* basicranium is far more extreme. The *Nothronychus* braincase contains some character states observed in many maniraptoran theropods, but is extensively pneumatized and foreshortened. The orbit is reconstructed as posteriorly displaced, resulting in a reduced lower temporal fenestra and small adductor chamber. Reconstruction of the major craniocervical muscles from the cervical vertebrae to the basicranium in *Nothronychus* and *Falcarius*, using the extant pigeon, alligator, caiman, and lizards as modern analogues and supplemented with recent muscle reconstructions of *Tyrannosaurus*, suggest small, often poorly defined, muscle attachment points. Insertion points for the craniocervical musculature are consistent with weak dorsiflexion and ventroflexion relative to carnivorous theropods. Lateroflexion in *Nothronychus* was probably stronger than dorsiflexion and ventroflexion. As in other studies, the bite forces are hypothesized as weaker than in obligatory carnivorous theropods.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EVOLUTION AND GENETIC DISTANCES OF NEANDERTAL AND ANATOMICALLY MODERN HUMAN (AMH) FOSSILS AS INDICATED BY BASICRANIAL MORPHOLOGY.

SMITH, Heather, Midwestern University, Glendale, AZ, United States, 85308

Fossils of early anatomically modern *Homo sapiens* display widely divergent patterns of cranial morphology. This phenomenon has led to numerous competing hypotheses as to which of these specimens are most closely related to extant humans, and which morphological form most closely resembles the ancestral form of all subsequent humans. Several studies have shown that three-dimensional morphology of the basicranium, including the temporal bone, reflects genetic relationships among hominoid species and modern human populations. These findings suggest that basicranial morphology may be used as a proxy for molecular data to assess the relative genetic distances and evolutionary processes among early human fossils. In this study, this knowledge was applied to early human fossils with the purpose of assessing their relative genetic distances to each other, modern humans, and Neandertals. Eighteen ectocranial landmarks from the basicranium were digitized on 14 early anatomically modern human fossils and casts from Africa and Europe, and nine Neandertals. A modern human sample of thirteen populations was also measured for comparative purposes. Procrustes distances were then calculated and evaluated. Compared to the modern sample, the early humans were more variable in morphology, and demonstrated larger average distances among specimens than was found within the entire modern human sample. This level of variation indicates that the fossil sample contained greater genetic diversity than humans today, who have since undergone a genetic bottleneck, and may also reflect the greater time depth represented by the fossil sample. The early human fossils did not cluster as a distinct group in a multidimensional scaling plot, but were instead dispersed around all sides of the cluster of modern human populations. Of the fossil specimens, LH18 was most similar in temporal bone morphology to modern humans, followed closely by Oberkassel1, Langwith Cave, Brunn3, and CroMagnon1. Based on the fact that temporal bone morphology reflects genetic distances in humans, these specimens were concluded to be more closely related to living humans, and their morphology most closely approximating that of the ancestral state. The Neandertals differed significantly in basicranial morphology from all modern human populations, but not from some of the early human specimens. European Neandertals were not more similar to modern Europeans than to any other modern human population, not supporting the multiregional model of human evolution.

Preparators' Session (Thursday, October 31, 2013, 8:45 AM)

CUTTING OUT THE MIDDLE MAN: ARCHIVAL SUPPORT CRADLE DESIGN FOR USE DURING PREPARATION

SMITH, Matthew, Petrified Forest National Park, Petrified Forest, AZ, United States, 86028

*In 2008 the Yale Peabody Museum (YPM) began annual excavations at Petrified Forest National Park (PEFO). One of their finds was a partial *Typothorax* skeleton YPM 58121. During preparation at YPM it was found that the skeleton included a well preserved skull. The skull was in soft, weathered claystone matrix and was very fractured and unstable. The left side of the skull was exposed and damaged on the erosional surface. Preparators at the YPM consequently exposed the right side of the skull and decided to curate the specimen in its field jacket. Subsequently the skull was temporarily returned to the park for study. To stabilize it during shipping the right side of the skull was coated with a layer of cyclododecane and it arrived undamaged at PEFO during the summer of 2012. It was decided that the fragile specimen should be prepared with both sides visible to facilitate research. This presented the problem of how to remove the field jacket and stabilize the specimen during preparation. In lieu of removing the cyclododecane and building a tight fitting, disposable support cradle we constructed an archival support cradle whose padding material was firm enough to support the specimen during preparation and could also expand slightly to support the specimen as the cyclododecane sublimated away. Deep undercuts were filled partly with damp tissue paper. A layer of mechanically softened Tyvek was placed over the specimen, followed by a layer of polyester fiber padding. Rigid polyethylene foam blocks were added to further fill shallow undercuts and uneven surfaces. Finally a layer of 1/8 inch polyethylene sheeting roughened with sandpaper was added to adhere the padding to the outer shell made of FGR-95 plaster and fiberglass. While the plaster cured the shell was weighted with sand to compress the padding. The ensemble was then wrapped with a tinfoil separator and strapped tight with rubber bands while a temporary plaster jacket was applied to keep compression on the assemblage during preparation. Starting in the center small sections of the original field jacket were then removed and the weathered left side of the specimen was consolidated and prepared until the entire field jacket was removed. During preparation the right side of the skull prepared by YPM remained in firm contact with the padding preventing breaks due to collapse while the cyclododecane sublimated away. This cradle technique allowed us to skip temporary support jackets and therefore avoid potential damage due to transferring the specimen multiple times.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

OSTEOLOGICAL HISTOLOGY OF THE PAN-ALCIDAE (AVES, CHARADRIIFORMES): CORRELATES OF WING-PROPELLED DIVING AND FLIGHTLESSNESS

SMITH, N. Adam, National Evolutionary Synthesis Center, Durham, NC, United States, 27705; CLARKE, Julia A., University of Texas at Austin, Austin, TX, United States

Although studies of osteological morphology, gross myology, myological histology, neuroanatomy and wing-scaling have all documented anatomical modifications associated with wing-propelled diving, the osteohistological study of this highly derived method of locomotion has been limited to penguins. We present the first osteohistological study of the derived forelimbs and hindlimbs of wing-propelled diving Pan-Alcidae (Aves, Charadriiformes). In addition to providing details of the differences between wing-propelled diving charadriiforms and non-diving charadriiforms, microstructural modifications to the humeri, ulnae and femora of extinct flightless pan-alcids are contrasted with those of volant alcids. Histological thin-sections of 4 species of pan-alcids and one non-alcid charadriiform (*Alca torda, Alca grandis, Pinguinus impennis, Mancalla cedrosensis, Stercorarius longicaudus*) were compared. The forelimb bones of wing-propelled diving charadriiforms were found to have significantly thicker (~22%) cortical bone walls than non-diving charadriiforms. Additionally, as in penguins, the forelimbs of flightless pan-alcids are found to be pachyostotic. However, unlike the pattern documented in penguins that display thickened cortices in both forelimbs and hind limbs, the forelimb and hind limb elements of pan-alcids display contrasting microstructural morphologies with thickened forelimb cortices and relatively thinner femoral cortices. Additionally, the identification of medullary bone in *Pinguinus impennis* suggests that osteohistological investigation could provide an answer to longstanding questions regarding sexual dimorphism of Great Auks. Finally, these results suggest that it is possible to discern volant from flightless wing-propelled divers from fragmentary fossil remains.

Symposium 4 (Saturday, November 2, 2013, 9:15 AM)

ANATOMY OF A NEW SAUROPODOMORPH DINOSAUR FROM THE EARLY JURASSIC HANSON FORMATION OF ANTARCTICA

SMITH, Nathan, Howard University, Washington, DC, United States, 20059; HAMMER, William, Augustana College, Rock Island, IL, United States; MAKOVICKY, Peter, The Field Museum of Natural History, Chicago, IL, United States

Recent field work in the Beardmore Glacier region of Antarctica recovered new dinosaur material from the Early Jurassic Hanson Formation. New U-Pb zircon dates of ~194.0 Ma help constrain the site's age. In addition to new material of *Glacialisaurus hammeri*, two new species of sauropodomorph were identified, one of which is represented by a nearly complete skeleton. Recent preparation has produced a skull, partial braincase, and articulated manus of this specimen. Lack of neurocentral fusion, highly vascularized fibrolamellar bone, and absence of distinct lines of arrested growth all indicate the specimen is a juvenile. Several features on the distal femur (an extensor fossa, absence of a medial epicondylar crest, transversely narrow tibiofibular crest) distinguish the new sauropodomorph from *Glacialisaurus*. Potential autapomorphies of the new Antarctic taxon include: the presence of enlarged foramina within the maxilla narial fossa, a pronounced proximal femoral sulcus, and a robust anteromedial fibular flange. Several characters imply a close relationship to *Ignavusaurus* from the Early Jurassic of South Africa, including: a transversely wide ventral ramus of the postorbital, elongate chevrons, and a bulbous, hemispherical femoral head. However, the fact that the new taxon and *Ignavusaurus* are known from juvenile specimens warrants caution in interpreting synapomorphic features that may vary ontogenetically (e.g., femoral size). The Antarctic taxon may fall outside of Massospondylidae, a ubiquitous sauropodomorph group (including *Glacialisaurus*) globally distributed in the Early Jurassic. Massospondylidae synapomorphies lacking in the new taxon include: a slot-shaped subnarial foramen, a weakly developed antorbital fossa on the maxillary ascending ramus, an extremely robust metacarpal I and elongate manual first digit, and elongate cervical centra. However, the skull of the Antarctic taxon displays a number of traits found in Massospondylidae or more inclusive clades (e.g., shortened lacrimal anterior ramus, elongate prefrontal ventral ramus, jugal contribution to the antorbital fenestra, finely wrinkled tooth enamel), providing additional evidence for high levels of homoplasy previously documented in sauropodomorph phylogenetic datasets. Coupled with the massospondylid *Glacialisaurus* and an additional new sauropodomorph closely allied to *Leonerasaurus*, this taxon adds to Hanson Formation dinosaur diversity, and provides new support for mosaicism in early sauropodomorph character evolution.

Technical Session IX (Friday, November 1, 2013, 11:00 AM)

TAPHONOMY OF A DINOSAUR BREEDING COLONY IN SOUTHERN PATAGONIA

SMITH, Roger, Iziko South African Museum, Cape Town , South Africa; MANCUSO, Adriana, CONICET, Mendoza, Argentina; POL, Diego, Museo Paleontológico Egidio Feruglio,, Trelew, Argentina; MARSICANO, Claudia, CONICET-Universidad de Buenos Aires, Buenos Aires, Argentina

The Late Triassic–Early Jurassic Laguna Colorada Formation of Patagonia contains a unique fossil assemblage dominated by the basal sauropodomorph *Mussaurus patagonicus*. This taxon was originally described from several well-preserved post-hatching specimens associated with egg remains found at the Laguna Colorada type section. Our recent expeditions to this locality have yielded 25 new specimens of this taxon, comprising skeletons of six different ontogenetic stages along with several complete “nests” of un-hatched eggs.

Detailed sedimentological investigation shows the skeletal remains and eggs occur in three distinct horizons within a 3 m- thick bed of mottled light reddish- brown/olive-grey massive siltstone. The bones are encrusted in brown weathering calcareous siltstone similar to the numerous spherically-shaped calcareous nodules that occur in the same horizons. The latter are interpreted as palustrine carbonate precipitated in loessic parent material around a floodplain pond under a seasonally warm climate.

The first *Mussaurus* hatchlings described from this site comprise 8 closely associated and notably small individuals (femoral length 3 cm). Their proximity to unbroken eggs and eggshell fragments clearly suggests an aggregation of nestlings rather than unhatched embryos, as their body size largely exceeds that of all the associated eggs, and the lack of size variation among them suggests they are from the same brood. A new aggregation of at least 11 articulated juvenile skeletons (femoral length 12 cm) was found in the vicinity of the type hatchlings. Taphonomic assessment of this aggregation rules out any post-mortem transport of the carcasses and suggests these are the result of synchronous death and burial of behaviorally aggregated individuals. These specimens are all the same size and histological data indicates that these individuals died together before reaching the first year of life.

Our latest field studies located several clusters of up to 24-27 unhatched dinosaur eggs close to the *Mussaurus* juvenile and nestling aggregations in the same horizons. The egg clusters lie in two layers within elongate depressions or tunnels that appear to have been deliberately excavated in the loess. We propose that the fertilized but unhatched eggs (at least one with an ossified embryo) were all laid at the same time, possibly by more than one female *Mussaurus*, and left half exposed to incubate. The unhatched clutches appear to have been asphyxiated by rapid deposition of a thick layer of aeolian silt loaded with volcanic ash.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

MAMMALIAN DENTAL ECOMORPHOLOGY AND DISPARITY ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY: A COMPARISON OF 3D METRICS

SMITH, Stephanie, University of Washington, Seattle, WA, United States, 98195; WILSON, Gregory, University of Washington, Seattle, WA, United States

Dental morphology offers insight into the dietary ecology of extinct mammals. Diet inferences from fossil mammal teeth can be especially useful in elucidating ecological responses to environmental perturbations, such as those causing mass extinction events. Various measures of dental morphology have been used in the prediction and analysis of feeding ecology in fossil mammals, including two-dimensional (2D) estimates of total shearing-crest length (TSCL) and blade sharpness, as well as three-dimensional (3D) estimates of dental complexity such as orientation patch count (OPC). The merit of previously used 2D metrics has not been fully evaluated in a 3D context.

Here, we used high-resolution 3D scans of mammalian cheek teeth across the Cretaceous-Paleogene boundary to test for congruence in patterns of dental ecomorphology and disparity as indicated by a 3D metric (OPC) and a historically 2D metric (TSCL) that we measured in three dimensions. To calculate TSCL, we summed linear measurements of the six principal shearing crests of the lower second molar of eutherians (15 species) and the lower third molar of metatherians (10 species). We compared TSCL with the corresponding OPC values taken from the same lower molar rows. Our results indicate that TSCL is negatively correlated with OPC, which positively correlates with herbivory in extant mammals. We also separately considered trigonid crests and talonid crests to further refine our understanding of the relationship of these

metrics to OPC. We find that the K-Pg extinction resulted in a significant reduction in the range of TSCL among local survivors, reflecting a loss of diversity in mammalian feeding ecologies. However, an immediate influx of archaic ungulate immigrants following the extinction recovered pre-K-Pg dental disparity and significantly decreased mean TSCL, suggesting a shift toward increased herbivory. These patterns are consistent with previous results from OPC, geometric morphometrics, and dental microwear that reveal K-Pg ecological selectivity and stress the importance of immigrants in the initial phase of post-K-Pg recovery.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DIVERSITY OF ARCHAEONYCTERID BATS IN THE EARLY EOCENE OF EUROPE

SMITH, Thierry, Royal Belgian Institute of Natural Sciences, brussels, Belgium; RUSSELL, Donald, National Museum of Natural History, Paris, France; HABERSETZER, Jörg, Senckenberg Forschungsinstitut, Frankfurt am Main, Germany; GUNNELL, Gregg, Duke University Lemur Center, Durham, NC, United States

Chiroptera is one of the few modern mammal orders for which no fossil record has been associated with the Paleocene-Eocene Thermal Maximum. Despite intensive collecting efforts, the earliest remains of bats are still elusive. *Archaeonycteris trigonodon* from the early Middle Eocene of Messel Formation (MP11) in Germany along with *Icaronycteris index* and *Onychonycteris finneyi*, both from the late Early Eocene Green River Formation (Wa7) in Wyoming, have been recognized as representing the most primitive bats based on skeleton morphology. Very few dental features of any of these taxa have been studied in detail because upper and lower dentitions are in occlusion. Nearly one century after its initial description it has become possible to digitally reconstruct the teeth of *A. trigonodon* using micro-CT scanning technology. This permits characterization of the complete dentition of *A. trigonodon* and for the first time enables dental comparisons with *A. brailloni* from the middle Early Eocene of Avenay (MP8+9) in France. The early Early Eocene French locality of Meudon (?MP8+9) has also yielded a few isolated bat teeth that have never been formally described. M1 is distinctly smaller than M2, both have a deep ectoflexus but M1 is more asymmetric than M2. The centrocrista does not extend far toward the labial border and both have a complete lingual cingulum and no paraconule. Lower molars are relatively wide, especially the trigonid of m2. The entoconid of m1 is distinct and individualized whereas it is more reduced and in line with the hypoconulid on m2 and m3. The new taxon from Meudon is similar in size to *Archaeonycteris? praecursor* from the early Early Eocene of Silveiriha (MP7) in Portugal but differs from that taxon in having lower molars with a relatively longer trigonid and shorter postcristid. These results indicate that the diversity of archaeonycterid bats is higher than previously recognized and that diversification of this lineage began early in the Eocene.

Technical Session XVII (Saturday, November 2, 2013, 3:15 PM)

NEW TETRAPOD AND FISH FAUNAS FROM THE EARLIEST CARBONIFEROUS OF SCOTLAND

SMITHSON, Timothy, University of Cambridge, Cambridge, United Kingdom; CLACK, Jennifer, University of Cambridge, Cambridge, United Kingdom

The early Carboniferous Tournaisian interval has long been considered as an almost blank period for vertebrate fossils, in particular tetrapods, and forms the earlier part of what has been called ‘Romer’s Gap’. Recent discoveries are now filling this gap with finds from southern Scotland and northern England in the Ballagan Formation. We report here the richness of the vertebrate assemblage from one locality in Scotland. Conformable vertical strata represent a time interval of about 15 million years. We recognise at least two new taxa of small tetrapod represented by skull and/or skeletal material. These specimens do not fall into any currently known taxonomic grouping, but suggest, along with tetrapod cranial material from other sites that likewise represent new taxa, that there was an explosive radiation of tetrapod morphologies in the Tournaisian. Along with the previously described earliest known articulated pentadactyl foot, from the CM palynozone of the Tourniasian, we have now discovered very small tetrapod elements from the base of the formation (VI palynozone) close to the Devonian-Carboniferous boundary. A variety of femoral morphologies are found within these collections, indicating diverse locomotory mechanisms. We have recovered from our key site a wealth of fish remains including actinopterygians, lungfishes, and a range of rhizodonts and gyrancanths that have yet to be studied. Tetrapods, rhizodonts, and gyracanths found so far show a remarkable increase in size from the base to the top of the sequence. These discoveries are building up a picture of the recovery of both terrestrial and aquatic vertebrate faunas following the end-Devonian mass extinction.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

PREDICTING TEMPORAL BINS FROM CENOZOIC MAMMAL COMMUNITY COMPOSITION

SMITS, Peter, University of Chicago, Chicago, IL, United States, 60615

Biodiversity through time has frequently been analysed by tracking changes across temporal units. However, how coherent community structure is within a temporal classification is relatively unknown. Using multiple machine learning approaches, more than 500 Cenozoic North American mammalian faunal sites with explicit abundance information were investigated in order to determine and quantify what temporal coherence was present. Unsupervised methods were used to assess any inherent structure across the communities, while supervised methods were used to measure the classification accuracy of geologic stage and North American Land Mammal Age (NALMA) from community composition. Unsupervised methods indicate little distinct underlying structure, though dissimilarity based evidence of accumulation clustering indicates that there are most likely fewer groupings than either the number of geological stages or NALMAs. Supervised methods show that overall there is approximately 60% test set predictive accuracy of both geologic stage and NALMA. While most misclassified sites are misclassified at random, many are misclassified as adjacent or nearly adjacent temporal bins. Additionally, class accuracy is more variable among older sites than in younger sites. This pattern may reflect high degrees of provincialism in older sites, while higher classification accuracy of younger sites may represent an increased amount of faunal homogeneity. However, there may be a strong formation effect biasing these results. These results indicate that current classification schemes do not necessarily reflect very coherent temporal communities. The equivalence in predictive accuracy between NALMAs and geologic stages indicates that NALMAs are unnecessary for capturing some degree of community coherence. Additionally, using fewer temporal bins may allow for equivalent or greater community coherence.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

BITE FORCE OF THE EOCENE WHALE *BASILOSAURUS ISIS* CONSISTENT WITH POWERFUL ANTERIOR SEIZURE AND POSTERIOR CRUSHING OF LARGE PREY

SNIVELY, Eric, Ohio University, Athens, OH, United States, 45701; FAHLKE, Julia M., Museum für Naturkunde, Berlin, Germany

Estimating bite forces of fossil whales is potentially informative about their trophic interactions and evolution. *Basilosaurus isis* was a large archaeocete from the late Eocene Birket Qarun Formation (Egypt). Juveniles of its fellow basilosaurid *Dorudon atrox* bear bite marks attributable to *B. isis*, suggesting high bite forces that crushed bone. To test the capability of *B. isis* to inflict these traces, isometric adductor forces were estimated with the dry skull method, and finite element (FE) analysis yielded reaction forces at cranial tooth positions and jaw joints. Several specific tensions were applied to estimate muscle forces. Varying thickness of plate elements tested the sensitivity of reaction forces in FE models with accurate external geometry, but different element characteristics. Results indicate that *B. isis* exerted 16,400-20,000 N at its upper P3, and relatively greater anterior bite forces than possible for crocodilians. Joint reaction force was greater on the balancing side than the active side in unilateral bites. Reaction force magnitudes were insensitive to model formulation, and stresses varied predictably with element thickness. Tooth forces in the *Basilosaurus isis* model are consistent with bite marks on *Dorudon* fossils, and seizing prey with the anterior teeth (as proposed for other archaeocetes and probable in river dolphins). Bite forces are slightly greater than expected for skull width from regressions for carnivorous mammals, but lower than estimated for some large reptiles. Uniform reaction forces from all models suggest that plate elements are useful for estimating bite force when only surface data are available. However, plate models are only heuristic for stress and strain in complex biological structures.

Technical Session VII (Thursday, October 31, 2013, 2:15 PM)

PATTERNS OF MIDDLE EAR AND BRAINCASE EVOLUTION IN DINOSAURIA

SOBRAL, Gabriela, Museum für Naturkunde Berlin, Berlin, Germany; MUELLER, Johannes, Museum für Naturkunde Berlin, Berlin, Germany

While well-documented in the fossil history of mammals, the evolution of the middle ear of archosaurs is still not completely understood. The development of a mechanism that avoids energy loss in sound transmission by subdivision of the metotic foramen is considered one of the key features for the improvement of amniote hearing, occurring in extant birds and crocodiles. Although it has been postulated to be either a plesiomorphy or a homoplasy of these two groups, these hypotheses have never been properly tested. In a first attempt to unveil the evolutionary patterns of middle ear and braincase evolution in archosaurs, relevant morphological characters retrieved from personal observations and previous published investigations were optimized onto a dinosaur phylogeny and analyzed in a comparative framework. Preliminary results show that the bony subdivision of the metotic foramen into a fenestra pseudorotunda and a vagus foramen appeared at least twice independently in ornithischians, sauropods, and theropods, with several reversals to a single foramen. However, whereas in some taxa the division is vertical, in others it is horizontal, and thus more similar to crocodylomorphs. In some taxa, not only the metotic foramen is sub-divided, but the resulting fenestra pseudorotunda is also pinched-off dorsally, a character already reported for pseudosuchians. These convergent transformations appear much later than in the synapsid lineage, and at different times in the Mesozoic, which may indicate different selective forces driving such changes. Further results include: 1) a separate foramen for the glossopharyngeal nerve appearing independently of the subdivision of the metotic foramen in neosauropods; 2) a separate foramen for the palatine ramus of the facial nerve not being exclusive for theropods, but occurring also in some ornithischian taxa; 3) the complete sub-division of the foramen of the trigeminal nerve for its ophthalmic and maxilla-mandibular branches occurring in theropods, sauropods and ceratopsids; and 4) a pinched-off trigeminal foramen occurring several times independently in the same clades. While it is still not clear how these different morphologies relate to behavior, physiology and ecology, merging these results with data already collected for pseudosuchians, and further expanding the data set, will provide a more complete overview of patterns of braincase and middle ear evolution in archosaurs.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A NEW MAMMAL ASSEMBLAGE FROM THE LATE PLEISTOCENE EL BREAL DE OROCUAL, NORTHEAST OF VENEZUELA

SOLORZANO, Andres, Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas, Venezuela; RINCON, Ascanio D., Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas, Venezuela; McDonald, H. Gregory, National Park Service Museum, Fort Collins, CO, United States

The paleontological potential of tar pit deposits has been recognized since the early 20th century starting with the discoveries at Rancho La Brea, United States of America. Similar bone-bearing deposits outside of the United States have been reported from Talara, Peru; Las Breas de San Felipe, Cuba; La Carolina, Ecuador; Pitch Lake, Trinidad and Tobago, and more recently Mene de Inciarte and El Breal de Orocual, Venezuela. El Breal de Orocual is located in Monagas State, in the northeast of Venezuela. This locality, an inactive tar seep, is informally named ORS-16. The known fauna includes 24 mammal taxa. The presence of *Smilodon gracilis* suggests it is Plio-Pleistocene in age. However, the fossils so far collected and described from this locality only represent a miniscule fraction of the total fossil material preserved there, considering the site may cover at least 18,000 m^2 of potentially fossil-bearing sediments. Three hundred meters west of the original site (ORS-16), in still active tar seeps, we found a new mammal assemblage named ORS-20. In this locality we have preliminarily identified at least 21 taxa: Xenarthra: *Eremotherium* sp., Mylodontidae gen. et sp. indet., Megalonychidae gen. et sp. indet., *Glyptodon* sp., *Pachyarmatherium* sp., *Pampatherium humboldtii*, *Holmesina occidentalis*, *Propraopus sulcatus*, Marsupialia: *Didelphis* sp., Perissodactyla: cf. *Tapirus*, Artiodactyla: *Platygonus* sp., *Tayassu pecari*, *Pecari tajacu*, *Palaeolama* sp., Rodentia: *Sigmodon* cf. *hispidus*, *Zygodontomys* sp., Hydrochaeridae gen. et sp. indet., Carnivora: *Protocyon* sp., *Smilodon populator*, *Panthera onca* and Notoungulata: *Mixotoxodon larensis*. This fauna is different from the fauna previously reported from ORS-16, being late Pleistocene in age. Therefore it is probable that the general area of El Breal de Orocual preserves multiple sites formed by successive episodes of natural oil seeping to the surface at different times along fractures caused by the displacement of tectonically controlled fault blocks and after reaching the surface which then migrated laterally and eventually became inactive, from the Pliocene through Pleistocene. This hypothesis is supported by the presence of the two different mammalian faunal associations of dramatically different ages ORS-16 (Plio-Pleistocene) and ORS-20 (late Pleistocene), and that the oldest site (ORS 16) is currently inactive in terms of active seepage of oil and the bones are embedded in a mixture of weathered hydrocarbons and sediments.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

VERTEBRATE COPROLITES FROM THE GURVAN EREEN FORMATION (LOWER CRETACEOUS) IN TATAL, WESTERN MONGOLIA

SONOBE, Hidetoshi, Hokkaido Unversity, Sapporo, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan; LÜ, Junchang, Institute of Geology, Chinese Academy of Sciences, Beijing, China; BARSBOLD, Richen, Institute of Geology, Mongolian Academy of Sciences, Ulan Bataar, Mongolia; CHIBA, Kentaro, Hokkaido University, Sapporo, Japan

Mesozoic deposits crop out in western Mongolia, but vertebrate fossils in this region are poorly understood. A stratigraphic sequence from the Middle Jurassic to Early Cretaceous is exposed near the largest city in western Mongolia, Kobdo, and is represented by the Jargalant, Dariv, Ihkes Nuur, Gurvan Ereen, and Zerik formations in ascending order. The Gurvan Ereen Formation (Berriasian–Valanginian) is composed of lacustrine to fluvial sediments and has yielded fish (*Stichopterus* and *Gurvanicthys*), turtles, lizards, pterosaurs (*Dsungaripterus* and *Noripterus*), and dinosaurs (a sauropod and theropod). In addition, coprolites have been reported from this formation in a previous study but poorly described. This previous study suggested that the producer of the coprolites was a champsosaur, despite the absence of body remains of this group from the formation. In 1998, two additional coprolites were discovered from a siltstone of the Gurvan Ereen Formation, which has yielded *Noripterus* skeletons. Both specimens are cylindrical, approximately 45 mm long and 20 mm in diameter. The outer surface has 0.5 mm wide folds, derived from mucosal folds of the producer. Based on a broad whorl, extending the entire length of the coprolites, and a distinct spiral structure in the cross sections, these specimens are categorized as amphipolar coprolites. The outer and inner spiral morphology of the specimens is probably generated by intestinal spiral valves, which are present only in non-teleost actinopterygians. Microscopic analyses reveal that numerous bone fragments (with bone lacunae) and ganoid scales of primitive actinopterygians are preserved in the coprolites, indicating a piscivorous diet of the producer. Coprolites from the Gurvan Ereen and Zerik formations described by the previous study are identical to our specimens in size and morphology, and the size and the spiral structure on their surface of our specimens. This suggests that large actinopterygians, such as *Stichopterus* (~1m long) discovered from the Gurvan Ereen Formation, are likely the coprolite producer instead of a champsosaur, revealing discrete predator-prey relationships of fishes in the Early Cretaceous paleoecosystem in western Mongolia.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

REDESCRIPTION AND PHYLOGENETIC ASSESSMENT OF THE BASAL ARCHOSAURIFORM *DOROSUCHUS NEOETUS* FROM THE MIDDLE TRIASSIC OF RUSSIA

SOOKIAS, Roland, University of Birmingham, Birmingham, United Kingdom; SENNIKOV, Andrey, Borissiak Paleontological Institute RAS, Moscow, Russia; BUTLER, Richard, University of Birmingham, Birmingham, United Kingdom

The basal archosauriform *Euparkeria capensis* from the Middle Triassic (early Anisian) of South Africa is a key taxon for the study of archosauriform evolution because it has been widely regarded as approaching the ancestral archosaur Bauplan, and falls immediately outside crown Archosauria in most phylogenetic hypotheses. Four other Early-Middle Triassic species are considered putative members of the family Euparkeriidae, although the monophyly and composition of this family has yet to be adequately tested. One putative euparkeriid species is *Dorosuchus neoetus* from the Anisian of Russia (Berdyanka I locality, Orenburg region, Donguz Gorizont). The holotype of *Dorosuchus* consists of the right ilium, femur, and tibia of a single individual. Additional specimens, including a braincase, from the same block as the holotype were also referred to *Dorosuchus* in the original description. A left posterior mandible and partial pterygoid from the same locality but from a different block from the holotype were subsequently referred. The holotype is diagnosable based on a unique combination of characters including a relatively short and distally rounded preacetabular process of the ilium and a strongly curved posterior margin of the proximal shaft of the tibia in lateral view. The referred braincase is also diagnosable based on a unique combination of characters including a low ridge on the anterior inferior process of the prootic and a subvertical orientation of the parabasisphenoid. The referred mandible and pterygoid possess characters of clades more crownward than *Euparkeria*, including a dorsomedial projection of the articular, and apparent absence of pterygoid teeth. A phylogenetic analysis based on all previously referred specimens places *Dorosuchus* as the sister taxon of crown Archosauria+Phytosauria, one node closer to the crown than to *Euparkeria*. An analysis excluding the mandible and pterygoid yields a similar result, with *Dorosuchus* in a polytomy with *Euparkeria* and proterochampsids. *Dorosuchus* therefore can be considered as a "*Euparkeria*-grade" taxon close to the base of Archosauria, but at present there is no strong evidence for a monophyletic Euparkeriidae including *Dorosuchus*. Phylogenetic analysis of the mandible and pterygoid alone recovers this material within Pseudosuchia. Given that this latter referred material may not have been recovered in close association with the holotype and apparently possesses crown group character states, we suggest that some caution with regard to its referral to *Dorosuchus* is warranted.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW CHONDRICHTHYAN FAUNA FROM MIDDLE MIOCENE (BARSTOVIAN), GADSEN COUNTY, FLORIDA, USA.

SOTO, Luis, University of Florida, Gainesville, FL, United States, 32610; MACFADDEN, Bruce, University of Florida, Gainesville, FL, United States

Chondrichthyes are among the most common fossils recovered from the Torreya Formation in Florida, but have received little attention relative to other taxa. The Torreya Formation crops out in southern Georgia and the Florida panhandle (approximately 30.6° N, 80.3° W) and is divided into two members, the Dogtown and Sopchoppy. Vertebrate fossils have been recovered from nearshore sediments of the Dogtown member. The primary fossil assemblage located in the Dogtown member is the Willacoochee Creek Local Fauna (LF) in Gadsden County, Florida. The date for this assemblage, based on Sr-ratios and magnetostratigraphy, is between 15.3 to 15.9 Ma, corresponding to the early Barstovian NALMA. Previous studies have concentrated on invertebrates and mammals, leaving the chondrichthyans heretofore unpublished. Here we report on the chondrichthyan assemblage from the Willacoochee Creek LF. Chondrichthyan materials at the Florida Museum of Natural History consist largely of teeth, along with some isolated vertebrae, tail spines, and mouth plates. This is a moderately diverse fauna with representation from at least 10 species of sharks, including *Galeocerdo contortus, Galeocerdo aduncus, Galeocerdo mayubensis, Negaprion brevirostris, Hemipristis serra, Isurus hastalis, Carcharhinus* spp, *Sphyra* sp., *Rhizopriodon* sp., *Carcharocles megalodon*, and some members of the superorder Batoidea, like *Myliobatis* sp., *Ginglymostoma serra* and *Aeobatus* sp. Three taxa are numerically the most abundant, including *Carcharhinus* sp. (~31%), *Myliobatis* sp. (18%), and *Negaprion* sp. (16%). The remaining species are relatively rare, each representing < 10%, with a collective total of 35%. The dominance of relatively small genera like *Carcharhinus* and *Myliobatis* indicates a shallow-water paleoenvironment, thus agreeing with previous reconstructions for this area. This is the first systematic description of sharks in the area, and along with the previous vertebrate studies, gives a comprehensive idea of the ancient biodiversity and paleoecological context of the Torreya Formation.

Technical Session X (Friday, November 1, 2013, 10:15 AM)

DECOUPLING BETWEEN MORPHOLOGY AND STABLE CARBON ISOTOPES IN PLIO-PLEISTOCENE HERBIVEROUS MAMMALS FROM THE SHUNGURA FORMATION (LOWER OMO VALLEY, ETHIOPIA)

SOURON, Antoine, Human Evolution Research Center, University of California, Berkeley, Berkeley, CA, United States, 94720-3160; BIBI, Faysal, American Museum of Natural History, New York, NY, United States; BOCHERENS, Hervé, Fachbereich Geowissenschaften, Biogeologie, Universität Tübingen, Tübingen, Germany; UNO, Kevin, Department of Geology and Geophysics, University of Utah, Salt Lake City, UT, United States; BOISSERIE, Jean-Renaud, IPHEP, UMR CNRS 7262, Université de Poitiers, Poitiers, France

The mammalian fossil record from the well-dated and quasi-continuous Shungura Formation forms the basis for many studies investigating the potentially causal relationships between climatic changes and faunal changes during the Plio-Pleistocene in Africa. However, up to now, only two studies (based on a very small sample of n=4: 1 equid, 1 giraffid and 2 hippopotamids) had tried to reconstruct the paleoecologies and paleoenvironments of Shungura fossil mammals using stable carbon isotopes of enamel, a methodology widely applied to mammals in other Neogene sites of Africa. Within the framework of the Omo Group Research Expedition, that reinitiated field work at Shungura in 2006, we therefore investigated changes in the isotopic composition of diets between 3 Ma and 1 Ma in two lineages of herbivorous mammals from the Shungura

Formation: the bovid *Tragelaphus rastafari* / *T. nakuae* (n=24) and the suid *Kolpochoerus limnetes* / *K. olduvaiensis* (n=60). We demonstrated a large increase in C_4 dietary intake around 2.8 Ma in these two lineages, in congruence with previous data on hippopotamids. Our data support an important and long-lasting vegetation change around 2.8 Ma in the Omo Valley, but the shift toward increased C_4 feeding appears to be decoupled from well-documented morphological changes traditionally associated with a diet increasingly rich in C_4 grasses. The suid lineage exhibits increases in third molar length, complexity and hypsodonty, but these are long-term trends taking place mostly gradually through 3 Ma–1 Ma. The bovid lineage, in contrast, displays no major morphological changes in its dentition indicative of increased grazing (all modern *Tragelaphus* are dominantly or exclusively browsers). In contrast, local paleosol and pollen records indicate longer term (and later) increases in grassland or C_4 vegetation. The cause of the isotopic shift in these herbivorous lineages is therefore difficult to interpret. One possibility is a replacement of pre-existing C_3 grasses by C_4 grasses, with little impact on herbivore feeding behavior, and is therefore congruent with the absence of major morphological changes synchronous with the changes in isotopic composition of enamel. This, coupled with recent paleoenvironmental studies, suggests interpretation of $\delta^{13}C$ values in the African Pliocene needs to be approached cautiously, especially for low $\delta^{13}C$ values. More data on the timing and patterns of the rise to hyper-dominance of C_4 grasses over C_3 grasses in African 'savannah' environments are definitely needed.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC ANALYSIS OF SOUTH AMERICAN GAVIALOIDS

SOUZA, Rafael Gomes, Universidade Federal de Uberlandia, Uberlandia, Brazil; RIFF, Douglas, Universidade Federal de Uberlandia, Uberlandia, Brazil; KELLNER, Alexander, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

The clade Gavialoidea was, among the extant groups of crocodylians, the most affected by Cenozoic extinctions, with just one species (*Gavialis gangeticus*) living in the rivers of the Indian sub-continent. Throughout the Tertiary, however, this clade flourished on several continents, especially in South America during the Miocene, when the Amazonian component of this fauna consisted of seven formally described species, plus a new species of the genus *Gryposuchus* currently under description, while the austral (Argentinian) component of this fauna includes one species, *Gryposuchus neogaeus*. Despite previous efforts to understand the phylogenetic relationships of the South American gavialoids, research on this subject is ongoing due to the incomplete sample of the taxa included in previous works. Here we present the results of a new analysis which included all the known taxa and a new form coded on three specimens coming from the Late Miocene Solimões Formation, which crops out in the Acre State, Northern Brazil. The matrix was built with the 185 characters from previous works plus 11 new cranial characters, 15 ingroup taxa and three basal Gavialoidea as outgroups (*Eothoracosaurus mississippiensis*, *Thoracosaurus macrorhyncus* and *T. neocesariensis*). The matrix was subjected to a maximum parsimony analysis using the software package TNT, one hundred heuristic searches were performed using tree bisection and reconnection (TBR) as the swapping algorithm. The result is only one most parsimonious tree with 103 steps, 0.51 consistency index and 0.72 retention index: ((*Eosuchus minor*, *E. lerichei*) (*Argochampsa, Ocepesuchus*)) (*Eogavialis* (*Aktiogavialis* (*Siquisiquesuchus* (*Ikanogavialis*, *Piscogavialis*)))) (*Gavialis* (*Hesperogavialis* (*Gryposuchus colombianus* (*G. neogaeus* (*G. croizati*, *Gryposuchus* new sp.))))). The genus *Gryposuchus* was recovered as a clade, with *Hesperogavialis* as its sister-group and with *G. colombianus*, from Middle Miocene deposits of Colombia, as the most basal species. In agreement with previous works, this cladogram show that an African clade is the sister group of the clade composed of species from South American and India. The extant *Gavialis* is deeply nested in a clade of South American taxa. With such ancestry rooted in South America, the presence of *Gavialis* in India suggests at least one dispersion event. Fossil finds in Madagascar and Antarctica are those most likely to change this scenario.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE BRAIN AND INTERNAL CRANIAL ANATOMY OF *VIVERRAVUS MINUTUS* (MAMMALIA: CARNIVORAMORPHA): DETERMINING THE TIMING OF ACQUISITION OF KEY CARNIVORAMORPHAN ENDOCRANIAL CHARACTERISTICS

SPAULDING, Michelle, Carnegie Museum of Natural History, Pittsburgh, PA, United States, 15206; HUGHES, Elijah, Carnegie Mellon University, Pittsburgh, PA, United States; FLYNN, John, American Museum of Natural History, New York, NY, United States

The clade Viverravidae repeatedly has been found to be the most basal monophyletic clade within Carnivoramorpha. Viverravids predominately occur in the Paleocene, but several species extend into the early Eocene, including *Viverravus minutus*, one of the smallest known carnivoramorphans. Here we present a digitally constructed endocast produced from a high-resolution computerized tomography (CT) scan generated by the American Museum of Natural History's Microscopy and Imaging Facility of an almost undistorted skull, AMNH 12621, recovered from the Bridger Formation of Wyoming, USA. This is not only the first virtual endocast of a viverravid but also the first non-distorted endocast known for any member of this clade. When the endocast of *Viverravus* is compared to taxa in their sister clade Carnivoraformes, the viverravid is found to display a much more limited cerebral expansion. The midbrain is almost completely exposed, there is no contact between the frontal poles and olfactory bulbs, and the dorsal profile of the cerebrum forms almost a straight line, rather than the sharply convex shape occurring in contemporaneous carnivoraforms such as *Oodectes*. No traces of the major cranial neocortical sulci are seen on the cerebrum, and the presence of a distinct rhinal fissure as well as traces of the paths of the sagittal and transverse sinuses indicate that these neocortical sulci were truly absent, rather than simply not preserved on the wall of the braincase. This confirms observations of the complete absence of these sulci described previously in a badly damaged endocast of the larger-bodied viverravid *Didymictis*. These features together indicate that the expansion and greater development of the cerebral cortex seen in modern Carnivora began at the base of Carnivoraformes within Carnivoramorpha. The new CT scan data also permit examination of the internal cranial anatomy of *Viverravus minutus*. There is no ossified tentorium, contra the condition known for *Oodectes* and carnivorans. As some degree of tentorium ossification is seen in both pangolin and creodont outgroups to Carnivoramorpha, we conclude this classical carnivoran synapomorphy was lost in the Viverravidae, and may represent a synapomorphy at a higher taxonomic level (Ferae or Ostentoria).

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

RESOURCE PARTITIONING AMONG LATE PLEISTOCENE HERBIVORES OF NATURAL TRAP CAVE, WYOMING

SPENCER, Lillian, Glendale Community College, Glendale, AZ, United States, 85302; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States

Natural Trap Cave (NTC) preserves abundant late Pleistocene herbivore remains including *Equus* and *Ovis*. The NTC sample of *Equus* contains two species, based on metric data and published molecular studies. Other large herbivores are represented by single species. In modern communities, sympatric herbivores partition resources by feeding on different plants or different plant parts. Previous dental isotopic studies indicated that most NTC herbivores consumed C3 plants, including grasses. To test the hypothesis that resource partitioning occurred among the grass-feeders at NTC, we collected mesowear data from three taxa. Assessed on upper cheek teeth, mesowear results from either attritional (tooth on tooth) or abrasional (tooth on abrasive food) wear. The paracone and metacone were examined to determine cusp shape (sharp, rounded, or blunt) and occlusal relief (high or low). A diet of less abrasive material yields high and sharp/rounded cusps, while more abrasive fodder yields increasingly low and blunt cusps. A large sample (N=143) of *Equus* teeth included two morphs. A small sample (N=10) of *Ovis* teeth provided comparison with the horse teeth. Both authors examined each specimen to reduce inter-observer error. We collected data consisting of individual variables of cusp height and shape, and also stages of mesowear combining both variables. Upper adult M1/2s and P4s were used. Results show three clusters in the *Equus* sample: 8% have high and sharp/rounded cusps, indicating little dietary abrasion; 58% had low and rounded cusps; and 34% had low and blunt cusps. The latter cluster is evidence for a highly abrasive diet. In the *Ovis* sample, the results are strikingly different: 40% had high and sharp cusps and 60% had high and rounded cusps. Even though mountain sheep are grass-feeders, their mesowear suggests they did not eat an abrasive diet at NTC. The distribution of *Equus* mesowear scores into three distinct clusters confirms the interpretation of multiple species at NTC, as well as supporting our hypothesis that these taxa partitioned grass resources. The very different nature of the mesowear seen in *Ovis*, compared to *Equus*, also supports our hypothesis that these grass-feeders consumed either different grasses with different overall levels of abrasion, or different parts of grass plants. As is observed in the Serengeti grazing succession, we propose that horses may have moved through the area first, consuming taller, older, more abrasive parts of grass plants, followed by mountain sheep eating softer, younger plants.

Technical Session III (Wednesday, October 30, 2013, 2:00 PM)

PHYLOGENETIC AND BIOGEOGRAPHIC ASSESSMENT OF ORNITHISCHIAN DIVERSITY THROUGHOUT THE MESOZOIC: A SPECIES-LEVEL ANALYSIS OF PHYLOGENY FROM ORIGIN TO EXTINCTION

SPENCER, Marc, University of Iowa, Iowa City, IA, United States, 52242

*Ornithischian dinosaurs form a diverse, globally-distributed clade including the dominant large land herbivores in many Mesozoic faunas. However, because we lack a well-resolved species-level phylogeny including basal and derived members, our understanding of the initial ornithischian radiation in the Late Triassic is unclear, which further complicates our ability to test biogeographic scenarios. A new species-level phylogenetic analysis, based on comprehensive empirical assessments of a wide sample of ornithischians with an emphasis on basal taxa, helps resolve the relationships of historically labile taxa. Heterodontosauridae is a monophyletic group outside of Genasauria, corroborating recent studies, though the current analysis did not recover distinct Laurasian and Gondwanan clades as has been previously reported. *Lesothosaurus*, traditionally considered one of the most basal ornithischians, is here recovered as the basalmost neornithischian more closely related to cerapodans than to thyreophorans. The resultant phylogeny shows good resolution among basal taxa; however, most members of Cerapoda collapse into a polytomy recovering only a monophyletic Iguanodontia, Marginocephalia, and a few other derived clades. The phylogenetic placement of these taxa is critical for assessments of character evolution for more derived clades and ancestral state reconstructions for Ornithischia in general, as well as determining areas of origination for clades across the tree. Building on the species-level phylogeny focused on basal taxa, I performed a detailed event-based quantitative biogeographic analysis based on a comprehensive composite phylogeny including more derived taxa from previously published studies. A few patterns can be explained by vicariance (e.g. Middle Jurassic) but numerous dispersal events are required to explain overall ornithischian biogeography, particularly in the Late Jurassic and Early and Late Cretaceous. Although the early record of ornithischians is sparse, it is clear that the clade originated in southern Gondwana and spread into Laurasia by the Early Jurassic and quickly diversified into the iconic groups that characterize Ornithischia. A well-resolved phylogenetic and biogeographic hypothesis of ornithischian diversity, particularly with basal taxa such as the heterodontosaurids and *Lesothosaurus*, provides a framework on which to test hypotheses of coevolution as well as the evolution of herbivory, ontogeny, physiology, and sexual dimorphism in the fossil record.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE NIEDERHÄSLICH TETRAPOD ASSEMBLAGE (EARLY PERMIAN, DÖHLEN BASIN) FROM GERMANY – NEW INSIGHTS TO ECOLOGY, REPTILIOMORPH DIVERSITY, AND THE BIOLOGY OF *PALAEOHATTERIA LONGICAUDATA* (BASAL SPHENACODONTIA)

SPINDLER, Frederik, Institut für Geologie, TU Bergakademie, Freiberg , Germany

For more than 130 years, the semi-lacustrine limestone horizon of the otherwise mainly fine clastic Niederhäslich Formation (Sakmarian) has been known for its outstanding tetrapod diversity and mostly well preserved specimens. New documentations of the main collections in Freiberg and Dresden (Saxony) lead to a quantitative inquiry of the assemblage, as well as revised determinations of reptiliomorph specimens. About 65% of the 1280 registered vertebrate fossils are smallish temnospondyls like *Branchierpeton* and *Melanerpeton*, building up the ecologically dominant class of small hunters that fed on invertebrates and amphibian larvae. The eryopid *Onchiodon* represents 22% of the assemblage, consisting mainly of juveniles and rare adult individuals of around 1.5m body length. These temnospondyls may have been ecologically ubiquitous in the food chain, sharing lower levels in concurrence with "branchiosaurs", while survivors of the first ontogenetic stages became the top predators, at least in the aquatic habitat. The "amphibian" fauna is completed by *Acanthostomatops*, Microsauria, Discosauriscidae, and Diadectidae. New specimens of the diadectid *Phanerosaurus*, historically designated as haptodont remains, confirm that this genus was also present in the limestone-building semi-lacustrine facies. A fragmentary specimen with a very large interclavicle, also once mistaken as a pelycosaur, belongs to an adult seymouriamorph, probably of a new species. Amniotes are represented by around 4% of the assemblage. A single specimen of *Kadaliosaurus* is the only reptile described so far. Re-evaluated limb elements increase the reptilian diversity by a few further specimens, not identical to *Kadaliosaurus*. Apart from a single skeleton of *Edaphosaurus*, all remaining amniotes belong to the basal sphenacodont *Palaeohatteria longicaudata*. After revised determinations, more than 40 individuals are known, showing a range of juvenile stages. This juvenile-only series, forming almost the total amniote presence, may indicate a nursery habitat for pelycosaurs growing up without parental care. A single slab containing jaws of two or three individuals may argue for pup gathering.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ENAMEL THICKNESS MEASUREMENTS AND RECONSTRUCTION OF ANCESTRAL MORPHOTYPES IN PRIMATES

ST CLAIR, Elizabeth, Duke University, Durham, NC, United States, 27708; BABBITT, Courtney, Duke University, Durham, NC, United States; WRAY, Gregory, Duke University, Durham, NC, United States; WALL, Christine, Duke Univ Medical Ctr, Durham, NC, United States

Enamel thickness (ET) contributes to the inference of diet, life history, and phylogeny for fossil primates, particularly hominoids. Reconstructing the direction of phenotypic change is of particular interest given increasing availability of genomic data on the genes linked to enamel formation and the opportunity to link genetic and paleontological perspectives on ancestral character states, dietary change, and dental evolution. Prior studies have used both absolute and relative measures of the amount of enamel. The effects of using absolute or relative measurements for assigning character states and for interpreting evolutionary patterns have not been addressed. We investigated whether different measurements of ET give different conclusions concerning ancestral state reconstructions, using two sets of published data for ET in extant primates. The first consists of measurements of 2D lower molar sections in 30 primates, from which we calculated Average ET (AET; enamel area/enamel dentine junction length) and Relative ET (RET; AET/square root of dentine area). The second consists of an absolute enamel measurement (Em) at one anatomical location in 38 catarrhines, which we converted to a shape variable using the cube root of body mass (Em.shape). We mapped these traits onto primate phylogenies using maximum likelihood to estimate ancestral states. We compared the nodal reconstructions for ET between the absolute measures and the relative measures.

In both datasets the node values for relative and absolute measures were correlated (AET with RET, $r=0.872$, $p<0.0001$; Em with Em.shape, $r=0.555$, $p<0.001$). Notably, nodes for which estimates differed between absolute and relative measures were clustered in particular clades. In AET and RET, estimates for hominoid nodes differed, with RET estimates low relative to AET, while for Em and Em.shape, most of the marked differences were seen within guenons with Em.shape estimates high relative to Em. These results suggest that conclusions concerning ancestral state estimation for enamel thickness will be broadly similar whether absolute or relative measures of enamel thickness are used, but differences were unevenly distributed across the tree. It may be that body size plays a role in the direction of difference, with absolute values leading to higher estimates in larger bodied species, while relative values lead to higher estimates in small bodied species. This may have significance for reconstructing changes in enamel thickness if they occur in the context of changes in body size.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE FIRST REPORTED RECORD OF OLIGOCENE IGUANIDAE (REPTILIA: SQUAMATA) FROM THE WHITE RIVER GROUP OF BADLANDS NATIONAL PARK, SOUTH DAKOTA

STARCK, E.N., Badlands National Park, Interior, SD, United States, 57750; WELSH, Ed, Badlands National Park, Interior, SD, United States

Despite the abundant taxa produced by the White River Group, the North American Oligocene herpetofauna has long been underrepresented in South Dakota. Although preservation biases have been attributed to the lack of herpetological material, herpetofauna from analogous vertebrate localities is well-described, including sites in Colorado, Nebraska, Wyoming, North Dakota, and Saskatchewan, Canada.

In 2012, an iguanid left dentary fragment was collected during quarry excavations at Badlands National Park. Recovered from the middle Scenic Member of the Brule Formation, the small dentary fragment was embedded in the calcareous-cemented mudstone of the "Abbey Mudstones" interval. Research to identify the 2012 specimen proved to be the catalyst to locate any other comparative Oligocene iguanid material; however, references and specimens regarding this particular family of reptiles were scant. Subsequently, this led to a review of the herpetological collection housed at the South Dakota School of Mines and Technology, which revealed an assortment of iguanid material from Badlands National Park previously unmentioned in the scientific literature.

The first documented iguanids from the Badlands were salvaged in 1963. Over the next 50 years, 20 Orellan and 17 Whitneyan specimens were collected. Consisting primarily of dentigerous cranial material, these fossils represent the only record of Oligocene iguanids attributable to the White River Group of South Dakota. Further examination has yielded new identifications for many of these 37 iguanid specimens. Due to their fragmentary condition, diagnostic characters were not often present, and some specimens could not be identified beyond the familial level. Among the revised identifications, several previously unrecognized genera are now acknowledged as present in central North America during the Oligocene, including *Cypressaurus*, *Ctenosaura*, and cf. *Dipsosaurus*. The presence of these genera forces reconsideration of past conventions, i.e. declining herpetofauna diversity. On the contrary, the Oligocene Iguanidae from South Dakota demonstrates an expansive diversity, particularly unexpected at the Orellan-Whitneyan boundary.

Technical Session XVI (Saturday, November 2, 2013, 3:15 PM)

EXCEPTIONAL MECHANICAL PERFORMANCE IN THE SHELLS OF TWO CENOZOIC TURTLES: *STUPENDEMYS* AND *CERREJONEMYS*

STAYTON, C. Tristan, Bucknell University, Lewisburg, PA, United States, 17837; CADENA, Edwin, Senckenberg Naturmuseum, Frankfurt, Germany

Among the numerous early Cenozoic fossil turtles of South America are specimens of *Stupendemys*, one of the largest turtles ever to have existed (3.3 m carapace length (CL)), and *Cerrejonemys*, a large species with an exceptionally thick shell (1 m CL, up to 35 mm carapace thickness). Both of these podocnemid specimens display morphological properties (size, thickness) that surpass those of any extant turtle; thus, their shells are also likely to have had exceptional mechanical strength. Indeed, given that one of the more important functions of the turtle shell is the resistance of forces imposed on the animal by predators, mechanical performance may have been one of the primary selective factors involved in the evolution of such unique morphologies. However, the structural properties and mechanical performance of these unusual shells have never before been modeled or quantified. We used finite element (FE) modeling methods to assess the mechanical performance of the shells of these taxa and to compare their performance to that of a contemporary relative: *Podocnemis expansa* (1 m CL). Geometric morphometric methods were used to reconstruct the morphology of missing regions of the shell, and to transform an existing FE model to match the morphologies of our focus species. Twelve load cases, each representing a different bite location for a potential predator, were modeled. We found that the shells of *Stupendemys* and *Cerrejonemys* do indeed show exceptional mechanical performance relative to the shell of *P. expansa*. Models of the shells of both extinct taxa experience very low stresses for a given load due to size and (for *Cerrejonemys*) shell thickness. However, the shells also experience relatively low stresses compared to their extant relatives when models are all scaled to the same length, volume, or cross-sectional area, indicating that the shapes of these shells are intrinsically strong as well. If bone material properties are assumed to be similar to those of extant turtles, then very high forces (over 150,000N for some load positions) would be required to cause failure (breaking) in these shells. Bite force modeling, using scaling rules from extant crocodilians, indicates that contemporary predators would have been unable to generate bite forces high enough to fracture the shells of adults of these taxa. However, evidence of predation on contemporary turtles raises the possibility that juvenile, rather than adult, morphology and performance may have driven the evolution of these remarkable shells.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

THE MESCAL CAVE FAUNA (SAN BERNARDINO COUNTY, CALIFORNIA): TESTING ASSUMPTIONS OF HABITAT FIDELITY IN THE QUATERNARY FOSSIL RECORD

STEGNER, M. Allison, UC Berkeley, Berkeley, CA, United States, 94720

The Late Pleistocene and Holocene vertebrate fossil record for the northern Mojave Desert (southern Great Basin), southwestern USA, is known primarily from largely unpublished information and only five cave sites: Quien Sabe Cave (UCRRV64-34; Holocene), Kokoweef Cave (SBC1.11.13; glacial), Antelope Cave (SBC1.10.10; glacial), Mitchel Caverns (LACM 3497; Late Wisconsin), and Mescal Cave (SBC1.10.12, UCMP V3864; presumed glacial, but radiocarbon dates here suggest an age of 34000-historical). Until now, only Kokoweef Cave has been radiometrically dated. The temporal placement of the others has been based on stratigraphic or biostratigraphic correlation, which to some extent has led to circular reasoning with regard to interpreting mammal extirpations in the Mojave. Mescal Cave, where woodrats have accumulated bone and plant material, is a limestone cave located in the Mescal Range. The site was excavated in 1938 by a University of California Museum of Paleontology party, and age was estimated to be Holocene, based on the overall faunal composition and stratigraphy. Since then, others have suggested that Mescal Cave is more likely between 20,000 and 10,000 ya.

Here, I report a revised and complete faunal list for Mescal Cave, along with 22 AMS radiocarbon dates from 5 vertebrate taxa recovered from its deposits. These results suggest time-averaging in Mescal Cave encompassing around ~34,000 years, and a maximum age more than 14,000 years older and minimum age 10,000 years younger than

previously thought. Furthermore, radiocarbon analyses suggest extirpation of *Marmota flaviventris*, a taxon indicative of cooler and more mesic climate, around 3600 ya: this is much younger than expected based on the regional patterns of warming and aridification in the Mojave and last appearance dates of this species in other Great Basin sites (generally around 8000 ya or earlier). Conversely, radiocarbon dates from another cool-climate species, *Neotoma cinerea*, are considerably older than expected, suggesting that climate and paleoenvironmental interpretations at this site are complex.

Technical Session VI (Thursday, October 31, 2013, 10:15 AM)

PRIMATE DIVERSITY IN THE LATE OLIGOCENE NSUNGWE FORMATION OF SOUTHWESTERN TANZANIA

STEVENS, Nancy, Ohio University, Athens, OH, United States, 45701; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, United States; ROBERTS, Eric, James Cook University, Townsville, Australia; O'CONNOR, Patrick, Ohio University, Athens, OH, United States

Primates are prominent components of modern tropical ecosystems, yet their Oligocene record in Africa south of the equator has remained largely undocumented. The paucity of data linking better known vertebrate faunas from the early Oligocene of northern Africa and Oman with the extensive early Miocene faunas of eastern and southern Africa presents problems for understanding the time of origin, or time of extinction, of several notable vertebrate clades. The late Oligocene of Africa is a particularly critical time and place for understanding a major taxonomic and ecological restructuring of primate communities. Here we document four distinctive primate taxa from late Oligocene sites in the Nsungwe Formation of southwestern Tanzania, represented by a small lorisiform, a diminutive parapithecid anthropoid, and two large-bodied catarrhine anthropoids. This unique combination of primate clades has not been documented previously in the African fossil record, and shows that parapithecids persisted through most of the Oligocene as catarrhines were diversifying. All of the specimens were recovered from precisely dated 25 Ma strata in the Rukwa Rift Basin, a segment of the Western Branch of the East African Rift in Tanzania. The diverse fauna of the Nsungwe Formation includes invertebrates, fish, anurans, snakes, lepidosaurs, crocodilians, and a broad diversity of mammals. Faunal composition, paleosols, and clay mineral analysis of fossil-bearing units indicate that although aquatic environments are well-represented in the Songwe Member of the Nsungwe Formation, they likely persisted within a seasonal/semi arid climatic regime. Nsungwe discoveries are beginning to fill gaps in our knowledge regarding the phylogenetic, ecological and body size diversity of primates in the late Oligocene of continental Africa.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

ALESTID FISHES FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

STEVENS, William, Ohio Univ, Athens, OH, United States, 45701; CLAESON, Kerin, , Philadelphia, PA, United States; Stevens, Nancy, Ohio Univ, Athens, OH, United States

Alestidae, a family of African characiform fishes, is known in the fossil record from the Eocene-Oligocene Jebel Qatrani Formation of Egypt, the Eocene Mahenge crater lakes of Tanzania, and early Oligocene to Miocene sites on the Arabian Plate. In recent work, we documented that alestid teeth comprise a prominent component of the ~25 My Nsungwe Formation fauna in southwestern Tanzania. Here we report on continued efforts to quantify variation within the Nsungwe alestid fauna using 92 measurable specimens reflecting a diversity of morphologies ranging from unicuspid teeth to teeth bearing up to seven cusps. Our comparative analysis is expanded to document tooth placement, formation, and jaw organization in modern representatives of the Alestidae, providing context for interpreting the Nsungwe alestid assemblage. Results indicate that based on size, cusp number, and overall morphology, a minimum of three alestid taxa are present (*Hydrocynus*, cf. *Micralestes* sp. and cf. *Alestes* sp.). *Hydrocynus* is identified based on the presence of specimens bearing a single, conical cusp. These specimens exhibit evenly sloping concave surfaces on both the labial and lingual sides of the tooth, with the crown overhanging the base both mesially and distally. Two other alestids in the fauna, cf. *Micralestes* and cf. *Alestes*, are distinguished from *Hydrocynus* based on multicuspid morphology (ranging in number from three to seven cusps), and crowns with a concave labial surface and convex lingual surface. These taxa are distinguished from one another using cusp number and aspects of cusp symmetry on the crown. The presence of these three alestid taxa in Nsungwe Formation localities provides key insights into freshwater fish faunas from the first described late Oligocene continental sequence from Africa below the equator. Furthermore, the new Oligocene specimens help bridge the geographical gap between Europe and Arabia, indicating that these fishes had a much more expansive habitat than previously thought.

Symposium 4 (Saturday, November 2, 2013, 8:15 AM)

TRIASSIC TEMNOSPONDYLS FROM ANTARCTICA ILLUSTRATE THE RECOVERY OF HIGH-LATITUDE FAUNAS AFTER THE PERMO-TRIASSIC EXTINCTION

STEYER, J. Sébastien, CNRS and MNHN, Paris, France; SIDOR, Christian, Burke Museum, Seattle, WA, United States; HAMMER, William, Augustana College, Rock Island, IL, United States

Paleontological fieldwork in the upper member of the Fremouw Formation of the Beacon Basin, Transantarctic Mountains, began in the 1980s. This led to the discovery of several important temnospondyl specimens, including a large, subcomplete skull of a new mastodonsaurid genus and species highlighted here. Recent fieldwork has increased temnospondyl diversity and indicates, thanks to biostratigraphic correlations with coeval rocks from the South African Karoo Basin, that the upper Fremouw Formation is early Middle Triassic (Anisian) in age. These recent investigations also allow an updated revision of temnospondyl material from Antarctica, which is now represented by *Kryostega collinsoni*, the new mastodonsaurid described here, as well as four indeterminate stereospondyl mandibles (one belonging to Brachyopidae indet.), a large *Parotosuchus* snout portion, and three other mastodonsaurid partial skulls (including "*Cryobatrachus kitchingi*", which is now considered an indeterminate juvenile mastodonsaurid). The temnospondyl fauna is rather diversified but also includes endemic species. This is also the case for the Triassic temnospondyl fauna from the South African Karoo Basin, which comprises brachyopoids (e.g., *Vanastega*) and mastodonsauroids (e.g., *Jammerbergia*), plus trematosaurids and *Laidleria*, which are not known from Antarctica so far. Together with the Karoo fauna, Antarctic temnospondyls show that several clades had diversified after the Permo-Triassic mass extinction, and that this diversification occurred locally in different areas. These Triassic Antarctic temnospondyls are mostly benthic freshwater ambush predators of giant sizes (estimated body length of more than three meters) and indicate that Antarctica may have served as a refuge during the Permo-Triassic mass extinction.

Technical Session XIV (Saturday, November 2, 2013, 11:15 AM)

REWRITING AVIAN BIOGEOGRAPHY WITH THE PALEOGENE FOSSIL RECORD FROM CHINA

STIDHAM, Thomas, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; NI, Xijun, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Paleogene birds are far less well known than their Cretaceous counterparts in China. Partly because of that disparity, discussions of Paleogene bird biogeography have focused on North America and Europe and have all but ignored the role of Asia in avian dispersal. However, new fossils from the Paleocene and Eocene of China demonstrate the (first) occurrence of many avian clades in Asia through the Paleogene. The late Paleocene Nomogen Formation in Inner Mongolia has produced a small avifauna of at least 4 taxa, including the first presbyornithids and stem galliforms from China. A middle to late Eocene tarsometatarsus from Xinjiang Province appears to be that of a large romainvilliine anseriform indicating both their occurrence in eastern Asia, as well as an earlier origin of large body size in the clade. Additionally, a small avifauna from the Middle Eocene Shanghuang fissure fillings had produced a variety of avian taxa allied to gruiforms and multiple higher neoavian clades. All of these Chinese fossils represent new species.

These fossils, their geographic distributions, and their ages coincide with intercontinental biogeographic patterns previously proposed using mammalian fossils. For example, the late Paleocene stem galliforms are older than their North American relatives, potentially indicating dispersal from Asia to North America penecontemporaneous with various mammalian clades (including rodents and plesiadapiforms). The late Paleocene presbyornithids from Inner Mongolia are roughly the same age as an unnamed species from the Tiffanian of North Dakota. The occurrence of protostrigid owls in both the early Eocene of Wyoming and Asia (and their absence in Europe during that time) further strengthens the link between North America and Asia during the early Paleogene. Together these Paleocene-Eocene fossils indicate the presence of a Holarctic avifauna similar to that known among mammals. However, by the later part of the Eocene and the Oligocene, that pattern seems to change. The Eocene Chinese romainvilliine indicates that dispersal occurred directly between Asia and Europe prior to the end of the Eocene, suggesting that Eurasian birds perhaps were not as restricted in their intercontinental movements as mammals were prior to the early Oligocene.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

CODING INDIVIDUAL SPECIMENS AS TAXA: TEST CASES AID IN RESOLVING THE RELATIONSHIPS OF BASAL NEOTHEROPODA, GAUGE TOPOLOGICAL SENSITIVITY TO TAXON SAMPLING, AND PRODUCE NOVEL TAXONOMIC HYPOTHESES

STIEGLER, Josef, The George Washington University, Washington, DC, United States, 20052; WANG, Shuo, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; CLARK, James, George Washington Univ, Washington, DC, United States

Most non-avian theropod taxa are known only from somatically immature specimens, and few taxa are known from large samples. This has caused concern that hypotheses of theropod relationships are strongly influenced by ontogenetic or individual variation. Individual specimens of taxa known from large samples were iteratively included as terminal taxa in a large phylogenetic analysis of theropod relationships to simultaneously test the referral of immature specimens to the correct taxon and the relative influence of intraspecific variation on the analysis. Unexpectedly, in some cases coding specimens of the same taxon separately improved resolution; however, adding young juveniles generally caused minor differences in the overall topology and sometimes strongly affected the placement of poorly known taxa.

All specimens of *Limusaurus inextricabilis*, as well as tentatively referred *Limusaurus* specimens of variable ontogenetic status were monophyletically recovered near the base of Ceratosauria despite significant ontogenetic transformation in facial anatomy. *Limusaurus* strongly influences consensus optimization of manual characters near the base of Averostra given the infrequent preservation of relatively complete hands in this region of the tree, highlighting its importance for questions of digital homology. Detailed anatomical study of this taxon is in progress and is discussed.

Specimens referred to *Coelophysis bauri* are polyphyletic, exposing the need for revision in a taxon that lacks autapomorphies. At least one specimen including a well

preserved skull from the Ghost Ranch locality is more closely allied with *'Megapnosaurus' kayentakatae*; and, specimens from the Painted Desert Member of the Petrified Forest Formation previously referred to *Coelophysis* are recovered among averostran stem taxa along with other previously proposed coelophysoids, albeit with weak support given their fragmentary nature. Former referrals of *M. rhodesiensis* and *'M.' kayentakatae* to species of *Coelophysis* are based on subjective interpretations of the anatomical disparity necessary for a new generic designation. However, this study finds that these species are paraphyletic within Coelophysinae, potentially necessitating a new name for *'M.' kayentakatae* or a referral to *Coelophysis*.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

USING AN EVOLUTIONARY MODEL TO INVESTIGATE THE ORIGINS OF WIDESPREAD ARTHRITIS IN RHINOCEROTIDAE (MAMMALIA, PERISSODACTYLA)

Stilson, Kelsey, University of Texas at Austin, Austin, TX, United States, 78712; HOPKINS, Samantha, Univ of Oregon, Eugene, OR, United States; DAVIS, Edward, University of Oregon, Eugene, OR, United States

Skeletal pathologies consistent with arthritis, including cysting and overgrowth, increase in frequency through the rhinocerotid lineage from 30% expression in early rhinocerotids to 100% expression in modern species, but the cause of this trend is still unexplained. We hypothesize that the increasingly graviportal body form and cursorial habits of rhinocerotids lead to increased joint loading and hence arthritis. We test this hypothesis by examining evidence for mass and cursoriality in extinct rhinocerotids. Cursoriality was measured using two established proxies: metatarsal length over femur length (MT/F) and hind-leg length (femur + tibia + metatarsal). We compared the evolutionary histories of arthritis, mass, and cursoriality for six extinct taxa spanning a long temporal range (*Hyrachyus eximus*, *Diceratherium*, *Trigonias osborni*, *Menoceras arikarensus*, *Aphelops*, *and Teleoceras*) as well as the five living species of rhinos. We used both standard and phylogenetically-informed analyses to test these potential drivers of arthritis.

A multiple regression of the character traits for these taxa showed a significant relationship between arthritis and all three hypothesized drivers (mass, MT/F, and hind leg-length). However, when phylogenetic relatedness was taken into account using an independent contrast analysis, we found no significant relationships. The driver(s) of arthritic expression may be more nuanced than a simple linear relationship with mass and cursoriality. The final verdict on this complex evolutionary system must wait for improved species-level sampling of rhino arthritis expression, rhinocerotid-specific proxies for cursoriality, and a species-level rhino phylogeny.

Romer Prize Session (Thursday, October 31, 2013, 11:30 AM)

CONTEXTUALIZING VERTEBRATE FAUNAL DYNAMICS: NEW PERSPECTIVES FROM THE TRIASSIC AND EOCENE OF WESTERN NORTH AMERICA

STOCKER, Michelle, The University of Texas at Austin, Austin, TX, United States, 78712-0254

Conceptualizations of actual biological patterns as preserved in the fossil record must accommodate the results of biotic and abiotic drivers of faunal dynamics. However, those conceptualizations also may reflect cognitive biases resulting from foundational philosophical stances. Whether fossils are conceptualized as the remains of biological entities or as geological objects will affect both taxonomic identifications and secondary inferences derived from those identifications. In addition, operational research bias centered on relativistic views of 'importance' of particular components (i.e., taxonomic or skeletal region) of the assemblage results in preferential documentation of some taxa and marginalization of others. I explored the consequences of those specific cognitive and operational biases through examination of Triassic and Eocene faunal assemblages in western North America. For the Triassic I focused on taxonomic and systematic treatments of *Paleorhinus*, a group of phytosaurs important for the establishment of biochronologic correlations. Specimen-level reexamination of *Paleorhinus* supported a restricted usage of *Paleorhinus* as a clade, dissolved a biochronologic connection between terrestrial and marine deposits, and indicated a prior compression of the early part of the Late Triassic as a result of previous conceptualizations of species. For the Eocene I focused on undocumented terrestrial reptiles from the late Uintan fauna of West Texas. Specifically I discovered new taxa and new geographic occurrences of amphisbaenians and caimanine crocodylians. The amphisbaenians represent the southernmost record of the clade in the North American Paleogene, and, when combined with other amphisbaenian records, document that the clade responded to late Paleogene climatic changes in ways different from the inferred mammalian response. The new taxon of caimanine crocodylian represents a new geographic and temporal record of that clade. That new record indicates that the biogeographic range of extant caimans represents a climate-driven restriction from a formerly more expansive range, and suggests that the previous geographic and temporal gap in paleodistribution data is related to sampling biases and is not solely a biological phenomenon. Together, these data indicate that reliable characterization of vertebrate faunal dynamics demands open acknowledgment and appropriate documentation of the cognitive and operational biases that affect interpretations of paleontological data.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

TRACKS OF DINOSAURS, SYNAPSIDS, AND ARTHROPODS IN THE AZTEC SANDSTONE OF SOUTHERN NEVADA: A FINAL REPORT

STOLLER, Heather, University of Nevada, Las Vegas, Las Vegas, NV, United States, 89183; ROWLAND, Stephen, Univ of Nevada Las Vegas, Las Vegas, NV, United States

The Aztec Sandstone is a 700-m-thick, erg deposit. Until very recently, southern Nevada exposures of the Aztec Sandstone have yielded few fossil tracks, although correlative strata in eastern California and Utah are quite fossiliferous. That situation has changed dramatically within the past two years, and now approximately twenty separate Aztec tracksites are known in southern Nevada. Most of the recently discovered tracksites occur in Red Rock Canyon National Conservation Area, immediately west of Las Vegas, although several are located in Valley of Fire State Park, and one is in the Gold Butte area.

Dinosaur tracks occur at eight of the sites, sometimes in combination with arthropod and/or synapsid tracks. The dinosaur tracksites are widely variable in terms of preservation and animal behavior. One site consists of a single, well-preserved footprint; another tracksite consists of a distinct trackway of seventeen closely-spaced tracks; another consists of multiple trackways, oriented in various directions, in which the individual footprints are very far apart; a fourth tracksite consists of dozens of poorly preserved undertracks, most of which are oriented in the same direction. Other dinosaur tracksites display variable numbers of tracks in variable states of preservation. All of the dinosaur tracks are relatively small– 14 cm or less in length– and are inferred to have been made by small, bipedal, carnivorous theropod dinosaurs. These dinosaur tracks have been analyzed using techniques such as photogrammetry and silicone molds, and their speeds have been determined using Alexander's method for trackway speed. These dinosaurs were traveling various speeds ranging from 0.37 m/s to 1.8 m/s.

We have found three types of non-dinosaur mammaloid tracks. The most abundant of these are assigned to the ichnogenus *Brasilichnium*. Two other types of non-dinosaur vertebrate tracks are not yet identified and may belong to undescribed ichnotaxa. These track-makers were probably therapsids.

Arthropod tracks are present at several sites. These include several examples of the scorpionid track *Paleohelcura*, some which display tail drag. The ichnogenus *Octopodichnus*, made by a scorpion as well, is present at only one of our sites.

As we develop a better understanding of the variety, relative abundance, and stratigraphic distribution of fossil tracks in the Aztec Sandstone, we will be better able to reconstruct the structure the Jurassic desert ecosystem in which the track-makers lived.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

DIVERSITY AND ABUNDANCE OF LATE PALEOCENE/EARLY EOCENE MULTITUBERCULATA FROM THE SOUTHEASTERN BIG HORN BASIN, WYOMING

STRAIT, Suzanne, Marshall University, Huntington, WV, United States, 25755; BLOCH, Jonathan, Univ of Florida, Gainesville, FL, United States; MORSE, Paul, , Gainesville, FL, United States; BOYER, Doug, Duke University, Durham, NC, United States

Intensive screen washing and surface prospecting in the Fort Union and Willwood Formations in the Honeycombs area of the southeastern Big Horn Basin has yielded a substantial collection of vertebrate fossils. This sample spans the Paleocene-Eocene Thermal Maximum (PETM) and ranges from the late Paleocene [Clarkforkian North America Land Mammal Age (NALMA); Cf-3 faunal zone] to early Eocene (Wasatchian NALMA; Wa-2 faunal zone). These collecting efforts have resulted in the recovery of many small-bodied mammals, including over 500 specimens of multituberculates.

A few relatively large specimens that likely represent two species of *Neoliotomus* are present in the latest Paleocene (Cf-3). Despite well-sampled microsites from several stratigraphic levels in the PETM (including Wa-0), *Neoliotomus* is conspicuously absent from much of this interval, and does not reappear until higher in the section. The single Wa-0 multituberculate, *Ectypodus tardus*, is represented by over 400 specimens. This large sample allows documentation of intraspecific variation in multituberculate dental morphology. Specimens are completely within the previously reported size range for *E. tardus* and are smaller than potentially sympatric *Parectypodus lunatus*. While the cusp number and shape of anterior upper premolars has been used to distinguish between these two taxa, our sample suggests that this morphology of at least the upper second and third premolars is instead extremely variable and not diagnostic. *Ectypodus* specimens have also been recovered from both Wa-1 and Wa-2 localities but not from the Clarkforkian in this area.

Although this multituberculate fauna is not very diverse, it is very abundant. Multituberculate abundance begins a steady decline relative to other mammals during the late Paleocene-early Eocene. Most early Eocene localities that have been quarried or screen washed have a relative abundance of multituberculates in the 1–8% range. However, when comparing our relative abundance to previously published literature, our well-sampled Wa-0 localities have a species abundance more comparable to that of late Paleocene faunas (around 12%).

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

***MOSASAURUS LEMONNIERI* DOLLO, 1889: A DISTINCT AND DIAGNOSABLE TAXON OF MOSASAURINE MOSASAUR**

STREET, Hallie, University of Alberta, Edmonton, AB, Canada, T5K 0Z4; CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada; KONISHI, Takuya, Univ of Alberta, Edmonton, AB, Canada

The mosasaurine mosasaur, *Mosasaurus lemonnieri* Dollo, 1889 (Lower Maastrichtian, Ciply, Belgium), has recently been suggested to be a junior synonym of *Mosasaurus hoffmannii*, (Upper Maastrichtian, Maastricht, Netherlands), on the basis that *M. lemonnieri* individuals are juveniles of *M. hoffmannii*. *M. lemonnieri* is currently recognized from numerous articulated specimens that are significantly older than the *M. hoffmannii* type and associated materials. However, several specimens of a *Mosasaurus hoffmannii*-like animal were found at Ciply, and together with the *M. hoffmannii* type material and *M. lemonnieri*, have been used to form the proposed growth series. To properly assess the strength and accuracy of this hypothesis requires a rediagnosis of the stratigraphically younger type material of *M. hoffmannii*, a comparison of the type to the presumed *M. hoffmannii* specimens from the older Ciply chalks, and a rediagnosis and assessment of *M. lemonnieri* and the materials assigned to that taxon from Ciply. For the purpose of this study, we present the preliminary results of our investigations into the varied diagnoses, taxa, specimens, and their morphological features, focusing here on overall size, characters of the teeth and tooth-bearing elements, quadrates, and humeri. *M. lemonnieri* is notably smaller than *M. hoffmannii*; while there is good evidence that *M. lemonnieri* is assignable to *Mosasaurus*, sharing such characters as a dorsally convex maxilla, a nearly quadrilateral quadrate with a short suprastapedial process, and a short, robust humerus, there is also sufficient evidence to indicate that *M. lemonnieri* is not a junior synonym of *M. hoffmannii*. The teeth differ in both morphology and number in the two species, and the dentary of *M. lemonnieri* tapers and extends anteriorly to the first tooth rather than terminating bluntly as is the condition in *M. hoffmannii*. The morphology of these two species supports their continued separation and suggests that the ecosystem of the Ciply Basin supported several species of mosasaurs, assuming the Ciply '*M. hoffmannii*' specimens are indeed *M. hoffmannii*. We find no compelling evidence for linking the various specimens and species from Ciply and Maastricht into a growth series of a single taxon.

Technical Session VI (Thursday, October 31, 2013, 9:45 AM)

THE ROLE OF DIETARY COMPETITION IN THE ORIGINATION OF EUPRIMATES IN NORTH AMERICA.

STROIK, Laura, Arizona State University, Tempe, AZ, United States, 85287-2402

*Leading origins hypotheses assert that traits involved in food acquisition underlie euprimate origination and early diversification. However, the precise role that dietary competition played in establishing euprimates as successful members of mammalian communities at the Paleocene-Eocene boundary is unclear. This is because the degree of niche overlap between euprimates and all likely mammalian dietary competitors is unknown. Three major competition hypotheses, each characterized by a unique temporal pattern of dietary niche overlap between euprimates (adapids, omomyids) and their potential non-euprimate competitors, were evaluated: absence of competition, strong competition, and weak competition.

The degree of dietary niche separation among taxa was evaluated across a series of fossil samples from the Bighorn Basin, Wyoming just prior to (sub-NALMAs Cf2-3), during (Wa0), and after (Wa1-2) euprimate origination. Dietary niches were reconstructed for 13 mammalian families (N=245) using molar morphological measures known to discriminate dietary regimes in extant mammalian communities. Specifically, seventy-four point landmarks were digitally placed on three-dimensional renderings (created from micro-CT scans) of either first or second mandibular molars. Measures of cusp height and sharpness, crest length, talonid basin depth, and trigonid and talonid basin area were calculated and scaled by two-dimensional molar occlusal area. Statistical overlap between each pair of euprimate and non-euprimate dietary niches was determined using ANOVA, where the F-statistic was calculated using Euclidean distances in multi-dimensional principal components space.

Results indicate that before euprimate origination, only the dietary niches of Clarkforkian plesiadapids (Cf2-3 Plesiadapidae, Wa0 Adapidae (p=0.147); Cf2-3 Plesiadapidae, Wa0 Omomyidae (p=0.565)) and carpolestids (Cf2-3 Carpolestidae, Wa0 Omomyidae (p=0.154)) overlapped those of later euprimates. In addition, euprimate families were the only taxa to occupy their particular dietary niches from their origination until Wa2. As carpolestids and plesiadapids essentially go extinct at the beginning of the Wasatchian in the Bighorn Basin, this pattern of niche overlap is consistent with the hypothesis of non-competition. Thus, the euprimate dietary niche is not unique within the mammalian community over time but is only occupied by euprimates upon their origination in North America.

Technical Session IV (Wednesday, October 30, 2013, 2:45 PM)

WHERE HAVE ALL THE GRASSES GONE?: NEW MIDDLE MIOCENE PHYTOLITH RECORDS REVEAL THAT GRASSLANDS PLAYED A MINOR ROLE IN HYPSODONTY EVOLUTION IN SOUTHERN SOUTH AMERICA

STROMBERG, Caroline, University of Washington, Seattle, WA, United States, 98195-1800; DUNN, Regan, University of Washington, Seattle, WA, United States; MADDEN, Richard, University of Chicago, Chicago, IL, United States; Kohn, Matthew, Boise State Univ, Boise, ID, United States; CARLINI, Alfredo, Universidad Nacional de La Plata, La Plata, Argentina

The incremental evolution of high-crowned (hypsodont) and ever-growing (elodont) cheek teeth in numerous herbivore lineages in southern South America, starting in the middle Eocene, was long thought to signal the spread of savanna vegetation 20 million years earlier than on any other continent. In contrast, recent pollen and plant silica (phytolith) data have indicated that Patagonia was covered in forests for much of the Cenozoic, and that grasslands emerged sometime after the early Miocene. These results contradict the notion that hypsodonty initially evolved in response to a shift from forest to open, grass-dominated vegetation. However, they do not preclude that a subsequent, middle or late Miocene spread of grasslands influenced crown-height evolution in Patagonian meridiungulates, rodents, and marsupials. We sought to test this hypothesis by reconstructing vegetation using phytolith assemblages sampled from several, late early-middle Miocene (16.87–11.78 Ma) faunal sites along the Argentine and Chilean Andes. Phytoliths are appropriate for tracking the spread of grasslands as they can provide information about both the relative abundances of grass and woody vegetation, as well as the types of grasses present. Plant silica recovery from many sampled sections was poor, but enough sediment samples yielded phytoliths to allow for reconstruction of vegetation history in this region. Specifically, we found that woody plants, including palms, continued to dominate vegetation through the middle Miocene. Although grass phytoliths are abundant in some samples (~30–45%), there is no convincing evidence for plant communities dominated by open-habitat grasses such as pooids and PACMADs. Instead, bamboos or similar forest-dwelling grasses appeared to have comprised a substantial part of the grassy understory. This pattern suggests that, unlike for North American and Eurasian ungulates, grass-dominated habitats likely played a minor role in Cenozoic hypsodonty evolution in South American herbivores. Instead, the availability of inorganic dietary abrasives (e.g., volcanic ash) may have driven evolutionary changes in cheek tooth crown heights in southern South America.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

QUANTIFYING HISTORICAL PATTERNS IN THE STRATIGRAPHIC COMPLETENESS OF THE DINOSAUR FOSSIL RECORD

STUBBS, Alyssa, North Carolina State University, Raleigh, NC, United States, 27606; BOYD, Clint, , Rapid City, SD, United States; KSEPKA, Daniel, American Museum of Natural History, Raleigh, NC, United States

Dinosauria was officially coined in 1842 by Sir Richard Owen, but dinosaur fossils were being discovered before that time, with *Megalosaurus* being the first dinosaur to be formally described and named in 1824, and *Iguanodon* following soon after in 1825. Over the nearly two century history of dinosaur paleontology, discoveries have led to sometimes dramatic extensions of the stratigraphic ranges of major dinosaurian clades. However, these discoveries have not occurred with clockwork regularity and quantifying the relative completeness of the dinosaur record across historical time, between clades, and in the context of major locality discoveries may be of interest to paleontologists.

In order to explore these patterns we expanded upon a recently developed method for comparing the Minimum Implied Gap (MIG) across a phylogeny over a given historical interval. MIG is one of many ways of quantifying the completeness of the fossil record and is useful because it can be calculated easily from a time-calibrated phylogeny and changes in these values can be tracked through time by holding present day values constant. This allows the MIG reduction that results from new range extensions to be quantified. To assess temporal patterns of MIG reduction within Dinosauria (excluding extant avian dinosaur clades), we collected first and last appearance data (FADs and LADs) for 32 major dinosaur clades for each decade from 1820 to the present (20 total time bins). Each fossil was assigned to a geological stage or stages, depending on the quality of the temporal resolution. Using the program ASCC, we analyzed each temporal bin for one million replicates during which the oldest and youngest fossils of each clade were randomly assigned a numerical age from within the defined age uncertainty range and MIG was calculated both for each clade and globally across the phylogeny.

The resulting MIG values show an average reduction of around 100 million years of missing fossil record per decade. Around two-thirds of MIG reduction occurs within Saurischia, with one-third occurring in Ornithischia. A majority of the MIG reduction results from new FADs for known clades, rather than LADs, as the latter are limited by the K-Pg boundary. While discovery of new FADs was relatively constant through time, the majority of new LADs were identified between 1880 and 1929. These results show that the rate of stratigraphic range extensions for major dinosaurian clades was relatively constant over the past 200 years despite the increased interest in dinosaur paleontology over the past few decades.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

PRESERVATION OF LARGE THEROPOD AND SAUROPOD TRACKWAYS FROM THE LOWER CRETACEOUS DEQUEEN FORMATION, ARKANSAS USING LIDAR: CREATING A VIRTUAL TRACKWAY LAB FOR USE IN TEACHING INTRODUCTORY AND UPPER DIVISION LABORATORIES

SUAREZ, Celina, University of Arkansas, Fayetteville, AR, United States, 72701; BOSS, Stephen, University of Arkansas, Fayetteville, AR, United States; PLATT, Brian, University of Mississippi, University, MS, United States; SHELL, Ryan, University of Arkansas, Fayetteville, AR, United States; WILLIAMSON, Malcolm, University of Arkansas, Fayetteville, AR, United States

Numerous dinosaur (theropod and sauropod) trackways were discovered in a gypsum mine in June, 2011. The trackways were preserved in the limestone marl of the Lower Cretaceous DeQueen Limestone of southwest Arkansas and covered an area of 4,200 m^2. The site was reported to the Department of Geosciences at the University of Arkansas and a rapid salvage effort was put into place. The mine was, and still is, an active mine and researchers were given three weeks to generate and enact a plan for documentation before demolition of the trackway commenced. Based on the resources available, wide-field, ground-based LIDAR instruments (including Z+F 5006i and Leica C10 laser scanners) were utilized to scan the site to 0.006 m resolution. Scanners were mounted on hydraulic boom lifts providing downward-looking, circular, 25 m radius, overlapping scans of the trackway surface, allowing generation of a LIDAR point-cloud and a hill-shaded relief map of the entire trackway site. Digital tools were also integrated to allow measurements and analysis of individual tracks and trackways. A beta-test version of the trackway is now available at http://trackways.cast.uark.edu/index.html. Additional tools will be integrated in the future for more detailed measurements. Field measurements as well as 32 plaster casts were also generated. We compare measurements taken in the field, on casts, as well as measurements taken from the website to compare error and consistency of the different preservation methods. The trackway website is also freely available and can be used for teaching purposes. We present a trackway lab exercise generated from various other trackway labs that are available online. The lab can

be used with the online "virtual" trackway at a variety of levels to teach students how to measure trackways, how to calculate speed, and introduce them to how to calculate error. LIDAR and other surface scanning methods are a valuable tool to quickly document sensitive and at-risk sites for both research and educational purposes.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEW SEA TURTLE SKULL FROM THE LATE CRETACEOUS OF CHILE AND THE BIOGEOGRAPHY OF *EUCLASTES*

SUÁREZ, Mario, Universidad de Chile, Santiago, Chile; PARHAM, James, John D. Cooper Archaeological and Paleontological Center, California State University, Fullerton, CA, United States; OTERO, Rodrigo, Universidad de Chile, Santiago, Chile; RUBILAR-ROGERS, David, Museo Nacional de Historia Natural, Santiago, Chile; VARGAS, Alexander, Universidad de Chile, Santiago, Chile

Fossil discoveries from Chile are providing new insights about the biogeography of Late Cretaceous marine reptiles. Here we report the skull of a durophagous chelonioid sea turtle from the Late Cretaceous (Maastrichtian) Quiriquina Formation of Caleta Cocholgüe, central Chile. Previous reports of turtles from the Quiriquina Formation include two other specimens: 1) a lower jaw of a durophagous chelonioid; 2) a durophagous turtle cranium that was initially considered a chelonioid, then later referred to the Baenidae, an otherwise entirely North American freshwater clade (a claim that requires further investigation). The new specimen reported here is a nearly complete skull, including most of the cranial roof, palate, and basicranium. The skull is similar to those previously reported from durophagous stem cheloniids referred to the genus *Euclastes* in the extent of its secondary palate and dorsally directed orbits; these features allow us to assign the skull to the genus *Euclastes*. This genus is reported from the Late Cretaceous and Early Paleocene of Chile, USA (California, Maryland, New Jersey, Virginia), Angola, and Morocco. The genus *Euclastes* is the first widespread stem cheloniid to be found outside of the Western Interior Seaway of North America. This is the first widespread radiation of pancheloniids, foreshadowing the subsequent Cenozoic radiation of the clade. The dispersal of *Euclastes* predates the K-Pg boundary, coincident with a time of global cooling.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A REMARKABLE ASSEMBLAGE OF LADINIAN-AGE VERTEBRATES FROM SOUTHERN GERMANY: A NEW WINDOW ON LATE MIDDLE TRIASSIC CONTINENTAL TETRAPOD BIODIVERSITY

SUES, Hans-Dieter, National Museum of Natural History, Washington, DC, United States, 20560; SCHOCH, Rainer, Staatliches Museum für Naturkunde Stuttgart, Stuttgart, Germany

Our knowledge of the global record of late Middle Triassic continental vertebrates is still very limited. This time interval is critical to our understanding of the changes in Triassic tetrapod communities as well as the origin and initial diversification of many tetrapod clades. We report here on a major new occurrence that will shed new light on this interval. The Schumann quarry is a limestone quarry near Vellberg (Eschenau) in the Hohenlohe region of Baden-Württemberg (Germany). In the early 1980s, avocational collectors first discovered a wealth of vertebrate fossils in deposits of the Lower Keuper (Erfurt Formation; Middle Triassic: Ladinian: Longobardian) exposed along the upper rim of the quarry. Because only the marine limestones of the underlying Muschelkalk are of commercial interest, the Keuper deposits are usually quickly removed during quarrying operations. Thus, articulated skeletons have been collected primarily during systematic excavations on pristine outcrop.

The principal fossil-bearing horizon forms part of a 1.5 m thick sequence of dark grey mudstones (Untere Graue Mergel). The fossiliferous bed is located near the top of the mudstone sequence, formed by 5–15 cm-thick grey mudstones. It is particularly rich in skeletal remains of fishes and aquatic tetrapods (capitosauroid, plagiosauroid, and trematosauroid temnospondyls and a choristoderan-like reptile). In addition to these presumably autochthonous aquatic faunal elements, the mudstones have also yielded numerous remains of terrestrial tetrapods, including rhynchocephalians, an unexpected diversity of non-archosaurian archosauriform reptiles (including a doswelliid), and a large paracrocodylomorph. The sequence of the Untere Graue Mergel probably formed under estuarine conditions, representing the brackish paludal settings in much of conterminous southwestern Germany during Ladinian times. The bivalve and ostracod assemblages suggest fluctuating salinity levels within the studied section, with the most fossiliferous strata having been deposited under low-salinity conditions. Some of the tetrapods from the Lower Keuper have close relationships to taxa from Carnian-age strata of several rift basins of the Newark Supergroup in eastern North America.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE STRUCTURE OF THE PELVIS IN TRITYLODONTIDS (SYNAPSIDA, EUCYNODONTIA) AND ITS PHYLOGENETIC AND FUNCTIONAL IMPLICATIONS

SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; LIU, Jun, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ROBERTS, Eric, James Cook University, Townsville, Australia; HUANG, Timothy, National Chung Hsing University, Taichung, Taiwan; YANG, Chuanwei, Lufeng County Dinosaur Museum, Lufeng, China

*Tritylodontids are a distinctive clade of herbivorous, mainly Jurassic non-mammaliaform cynodonts whose relationship to Mammaliaformes is controversial. Recent debate has focused on whether tritylodontids are close relatives of mammaliaforms or alternatively fall within Traversodontidae, a clade distant from Mammaliaformes within Eucynodontia.

A key issue has been the validity of various purported postcranial synapomorphies shared by tritylodontids and mammaliaforms. Among the most controversial portions of the postcranium is the pelvis, which is poorly known but has been reconstructed as having a rod-like, anteriorly directed ilium as in mammaliaforms rather than an expanded one with a substantial posterior process as in both traversodontids and basal cynodonts. However, this view of the tritylodontid pelvis has been challenged based on the incompleteness of all described material, which leaves open the possibility that the ilium is much less mammaliaform-like.

A new tritylodontid specimen from the Lower Jurassic Lower Lufeng Formation of China demonstrates that at least some tritylodontids do indeed resemble mammaliaforms in their pelvic anatomy. The specimen comprises only postcranial elements, and is indeterminate below the level of Tritylodontidae, but can be securely referred to this group based on femoral morphology, size and provenance. Nearly complete examples of the ilium, pubis, and ischium are present, and the ilium resembles the mammaliaform condition in having a narrow, anteriorly directed blade with only a vestigial posterior process.

Iliac morphology alone is insufficient to determine the placement of tritylodontids, but the new specimen resolves an important point of debate and adds to the case that tritylodontids display close postcranial similarities to mammaliaforms. The hip anatomy of the new specimen implies a mammaliaform-like mechanism of femoral retraction driven partly by gluteus musculature, probably still incipient but better-developed than in traversodontids. Finally, a small depression on the pubis may indicate the attachment of an epipubic bone, a feature previously reported in tritylodontids but never adequately documented.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW ANKYLOSAURID DINOSAUR (ORNITHISCHIA, ANKYLOSAURIA) FROM THE UPPER CRETACEOUS KIRTLAND FORMATION, SAN JUAN BASIN, NEW MEXICO, USA

SULLIVAN, Robert, New Mexico Museum of Natural History and Science, Albuquerque, NM, United States, 87104; ARBOUR, Victoria, University of Alberta, Edmonton, AB, Canada; BURNS, Michael, University of Alberta, Edmonton, AB, Canada; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, United States

A nearly complete skull and first cervical half ring of an ankylosaurid dinosaur, NMMNH (New Mexico Museum of Nature and Science) P-64484, from the upper Campanian (Kirtlandian) De-na-zin Member of the Kirtland Formation, represents a new genus and species. The skull has cranial ornamentation subdivided into a mosaic of polygons similar to Late Cretaceous ankylosaurines from Alberta and Montana, such as *Euoplocephalus*. It can be distinguished from these taxa by the triangular median nasal osteoderm, anteroventrally directed squamosal horns, a mixture of flat and weakly bulging frontonasal osteoderms, strong bilateral symmetry of the cranial osteoderm pattern, and deep fossae on the ventral surface of the basioccipital. *Nodocephalosaurus*, also from the De-na-zin Member, has circular-based, and more widely-spaced, bulbous frontonasal osteoderms that differ from the hexagonal to rectangular-based, closely-spaced frontonasal osteoderms of NMMNH P-64484.

Both of the New Mexican species possess bulbous cranial osteoderms, a morphology otherwise found only in derived Asian ankylosaurids. There are two potential explanations for the presence of bulbous osteoderms in NMMNH P-64484: 1) they evolved independently in NMMNH P-64484 and *Nodocephalosaurus*, and *Nodocephalosaurus* represents an Asian ankylosaurid dispersal into North America; or 2) southern Laramidian and Asian ankylosaurids convergently evolved bulbous osteoderms. Preliminary phylogenetic results show a close relationship between NMMNH P-64484 and Albertan and Montanan ankylosaurines, but not *Nodocephalosaurus*. In contrast, *Nodocephalosaurus* has affinities with Late Cretaceous Mongolian ankylosaurines, although its position on the tree is more labile due to missing data. The conical, widely-spaced morphology of the bulbous cranial osteoderms of *Nodocephalosaurus* is most similar to that of the Mongolian taxon *Talarurus*. *Nodocephalosaurus* is best interpreted as representing a dispersal of Asian ankylosaurids into North America, and the bulging cranial osteoderms of NMMNH P-64484 apparently evolved convergently.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW INFORMATION ON THE HINDLIMB STRUCTURE OF THE EARLY PERMIAN BOLOSAURID REPTILE *EUDIBAMUS CURSORIS*, THE EARLIEST KNOWN FACULTATIVE BIPED

SUMIDA, Stuart, California State University San Bernardino, San Bernardino, CA, United States, 92407; BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, United States; JEFCOAT, Brian, DreamWorks Feature Animation, Glendale, CA, United States; HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, United States; MARTENS, Thomas, Museum der Natur, Gotha, Germany

The Early Permian bolosaurid reptile *Eudibamus cursoris* is known from the Bromacker locality of central Germany. Initial description based on a single, well preserved specimen suggested it is the earliest known facultative biped predating archosaurian bipeds by nearly 60 million years. Its hind limbs are approximately equivalent to snout-vent length and nearly twice the length of the forelimbs. A new specimen that includes the caudal portion of the presacral column, pelvic girdle, and complete left hind limb sheds new light on the hind limb structure of *Eudibamus*. Although all elements of the limb are well ossified, the pubis and ischium are fused neither to each other nor their contralateral mates, yet medial and lateral centralia are fused. Distal tarsals 1-3 are unusually elongated proximodistally. In ventral view the astragalus shows a strongly developed ventrally projecting lip at the margin where the tibia articulates. Features supporting the interpretation that *Eudibamus* was a facultative biped include: a moderately developed lip along the dorsal margin of the acetabulum for reception of a near-vertically oriented femur; digits 1 and 2 are reduced relative to

extremely elongate digits 3-5, indicative of potentially digitigrade foot posture; and penultimate phalangeal elements are not significantly elongate, suggesting it was not a vertical clinger and leaper. Three-dimensional laser surface scanning allowed a digital model of hind limb elements to be transferred into the animation and modeling software package Maya. Differing positions of the femoral head relative to acetabular surface were tested. The range of potential postures does include a parasagittal orientation of the hind limbs.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW DATA ON THE MORPHOLOGY OF *ADOCUS BOSTOBENSIS*, AN ADOCID TURTLE FROM THE SANTONIAN–EARLY CAMPANIAN OF KAZAKHSTAN

SYROMYATNIKOVA, Elena, Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia; DANILOV, Igor, Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia

**Adocus bostobensis* is a poorly known Asiatic representative of the genus *Adocus* (Adocidae), known from the Cretaceous and Paleogene of Asia and North America. This species was described based on a few isolated shell plates from the several localities (Akkurgan, Baybishe I, Buroynak I and II, Shakh-Shakh) of the Bostobe Formation, Santonian–early Campanian, of Aral Sea area, Kazakhstan. Previously, material of this species was attributed to *A. foveatus* described from the early Santonian Yalovach Formation of Tajikistan. In 2012, new material of *A. bostobensis* was collected from Shakh-Shakh locality. This material consists of about 30 shell fragments, an ilium fragment and a complete ischium, probably, from a single individual. This species can be diagnosed by the following emended series of characters: relatively wide neurals (ratio of the neural width to its length is 0.8); anterior peripherals with upturned free edges that are angled in cross-section; peripherals 2 and 8 with strongly developed bulges in place of the attachment of plastral buttresses; marginals overlapping onto the costals beginning with marginal 4; inframarginal 1 not extending onto the peripherals; long metischial process. The overlapping of the marginals onto the costals beginning with marginal 4 suggests a position of *A. bostobensis* in a clade with *A. aksary* (late Turonian of Uzbekistan) and *A. amtgai* (late Turonian–Santonian of Mongolia) (hereinafter clade A). Other species of *Adocus* in Asia are characterized by the overlapping of the marginals onto the costals beginning with marginal 5 (*A. foveatus*) or unknown for this character. In all North American *Adocus* in which this character can be observed, the marginals overlap onto the costals beginning with marginal 5. Thus, new data confirm the specific status of *A. bostobensis*, extends the temporal range of the clade A to the Santonian–early Campanian and demonstrates existence of representatives of two different lineages of *Adocus* (*A. bostobensis* and *A. foveatus*) in the Santonian of Western Asia.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

REANALYSIS OF *NIPPONOSAURUS SACHALINENSIS* (ORNITHOPODA: DINOSAURIA) FROM UPPER CRETACEOUS OF SOUTHERN SAKHALIN AND ITS PHYLOGENETIC STATUS WITHIN LAMBEOSAURINAE

TAKASAKI, Ryuji, Hokkaido University, Sapporo City, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo City, Japan; CHIBA, Kentaro, Hokkaido University, Sapporo City, Japan

Definitive members of lambeosaurine hadrosaurids were widely distributed in North America and Asia during the Late Cretaceous. The phylogentic relationships of this group are relatively well understood, but the phylogenetic position of some lambeosaurines, including *Nipponosaurus sachalinensis* from southern Sakhalin Island in Russia, remain problematic. Some studies advocate the monophyly of *Nipponosaurus* and *Hypacrosaurus*, but others support a more basal position of *Nipponosaurus*. Previous studies noted that this conflict is caused by incompleteness and immaturity of the type specimen. Here we reanalyze the phylogenetic position of *Nipponosaurus* based on a data matrix with 20 taxa (three outgroups) and 118 characters. In order to minimize ontogenetic effects, 37 characters are verified to change ontogenetically by comparing different ontogenetic stages of *Hypacrosaurus stebingeri* and using previous studies. Phylogenetic analysis produced seven most parsimonious trees (MPTs), placing *Nipponosaurus* within Corythosaurini. The strict consensus tree shows a polytomy among *Nipponosaurus*, *Olorotitan*, *Lambeosaurus magnicristatus*, *L. lambei*, and the clade of *Corythosaurus* and *Hypacrosaurus*. One of the MPTs shows that *Nipponosaurus* is positioned at the base of the clade Corythosaurini, supported by two unambiguous synapomorphies (presence of S-loop nasal vestibule and 14 cervical vertebrae or more). The other MPTs indicate that Corythosaurini shares six unambiguous synapomorphies in crania, cervical, and antebrachium and that *Nipponosaurus* is placed higher in the tree. In previous studies, the angular tip of ventral flange of the jugal supports the monophyly of *Nipponosaurus* and *Hypacrosaurus*, but re-examination of the type specimen indicates it is questionable in *Nipponosaurus* because of its poor preservation. Our phylogenetic analysis demonstrates clearly that *Nipponosaurus* does not form a clade with *Hypacrosaurus* because the clade of *Hypacrosaurus* and *Corythosaurus* is well supported by four unambiguous synapomorphies (vertical groove on lateral surface of premaxilla, W-shaped nasal-premaxilla contact, expanded prepubic process, and triangular and dorsoventrally broad and caudally directed caudolateral process of premaxilla). *Nipponosaurus* lacks the premaxillary ventral groove shared by the other two.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE LATE MIOCENE RODENT FAUNA FROM NAKALI FORMATION, NORTHERN KENYA.

TANABE, Yoshiki , Kagoshima Univ., Kagoshima, Japan; NAKATSUKASA, Masato, Kyoto Univ., Kyoto, Japan; KUNIMATSU, Yutaka, Kyoto Univ., Kyoto, Japan; ONODERA, Mayu, Kagoshima Univ., Kagoshima, Japan; NAKAYA, Hideo, Kagoshima Univ., Kagoshima, Japan

The Nakali Formation (the early late Miocene) is located at the eastern shoulder of the central Kenya Rift. Alhough a number of mammal fossils, Carnivora, Proboscidea, *Hipparion*, Rhinocerotidae, Artiodactyla, and Primates, had been found from the Nakali Formation, only a single rodent species, *Nakalimys lavocati* (Rhizomyidae) was known from Nakali previously.

The Japan-Kenya Expedition team has carried out paleontological field-works in Nakali since 2002. Through the excavations conducted by the team since 2007, a large amount of mammal fossils, especially rodent fossils, have been recovered.

These new rodent specimens have enabled us to recognize six additional families. Among the families, the most abundant are Rhizomyidae (Myomorpha), then come Cricetidae (Myomorpha), Thryonomyidae (Hystricomorpha), Sciuridae (Sciuromorpha), a small number of Gerbillidae (Myomorpha), and Hystricidae (Hystricomorpha). The identification was mainly based on the dental morphology of those fossils. Based on the ecological information of the extant rodents, whose cheek tooth morphology is similar to the fossil specimens, the paleoenvironments of the Nakali Formation are estimated to have included a watery environment and upland forests. This reconstruction of the paleoenvironments generally agrees with the results from geological studies, mesowear analysis and other studies.

The present findings indicate that one of the oldest hystiricids, which has small-sized and low-crowned cheek teeth, is recorded in Africa and that the oldest record of *Thryonomys* (Thryonomyidae) dates back to the early late Miocene. Based on the resemblance of its lophodonty, *Thryonomys* is thought to have evolved from *Paraulacodus*. This revised record indicates that *Thryonomys* had been differentiated from *Paraulacodus* by the early late Miocene.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EGGSHELL POROSITY REVEALS NEST TYPES AND INCUBATION BEHAVIOR IN ARCHOSAURS

TANAKA, Kohei, University of Calgary, Calgary, AB, Canada, T2N 1N4

Nest architecture is rarely preserved in the fossil record but it provides significant insight into incubation behavior of archosaurs. Among living archosaurs, nest type is strongly related to incubation behaviors in that all eggs laid in uncovered, open nests are incubated via brooding, whereas eggs in covered nests are always incubated with external heat sources. Nest types (i.e., open and covered nests) of dinosaurs have been previously inferred from calculations of water vapor conductance of their eggs (i.e., diffusive capacity of eggshell), estimated in part from eggshell porosity. This method, however, requires various assumptions and it has never been statistically tested whether water vapor conductance is correlated to nest types in living species. Furthermore, dinosaur nest types have been interpreted arbitrarily. Here a more direct and statistically rigorous method is proposed for predicting nest types and associated incubation behaviors of archosaurs based on a dataset from over 100 species of living birds and crocodilians. For these species, eggshell porosity (i.e., total pore area in an egg divided by pore length) and egg mass were estimated and nest types/ incubation behaviors were documented. An analysis of covariance revealed that eggshell porosity, relative to egg mass, is significantly higher in species with covered nests (non-brooders) than in those with open nests (brooders), indicating eggshell porosity is correlated to nest types and thus incubation behavior in living species. A phylogenetic flexible discriminant analysis was applied to dinosaur taxa in order to infer their nest types from estimates of eggshell porosity and egg mass, which indicates titanosaurs and *Lourinhanosaurus* incubated their eggs in covered nests, whereas oviraptorosaurs and *Troodon* incubated in open nests. This novel method provides a statistically reliable prediction for nest types of extinct dinosaurs, and can potentially shed light on the evolution of nest types and associated incubation behaviors in archosaurs.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

AN ISOLATED FEATHER IN AMBER FROM THE LATE CRETACEOUS OF NORTHEAST JAPAN

TANAKA, Tomonori, Hokkaido University, Sapporo, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; SASAKI, Kazuhisa, Kuji City Hall, Kuji, Japan; CHIBA, Kentaro, Hokkaido University, Sapporo, Japan

Fine structures of fossilized feathers are commonly degraded in carbonized impressions. However, fossilized feathers in amber preserve microstructures in three-dimensions. An amber piece with inclusions of feather fragments was discovered from the Upper Cretaceous (Santonian) Uge Member of the Taneichi Formation in Taneichi City, in northeastern Honshu Island, Japan, in 1993 and has been referred as 'a feather in amber from Kuji' in previous literature. The amber-bearing horizon is composed of non-marine siltstone and lignite beds. The amber is triangular in shape, 18 mm wide and 5 mm thick. Six barbs (1.02 to 2.49 mm long) with barbules (bipinnate secondary branched structure, 0.10 to 0.81 mm long) are preserved. Because the barbs project the same direction, these belong to a single feather. The presence of barbules indicates the Taneichi feather is a Stage IIIb or later stage morphotype of feathers. The preserved regions are identified as the tips of pennaceous, distal plumulaceous, or afterfeather barbs based on the straight distal ends of barbule cells, gradual decrease of barbule lengths from the base to tip of barb, wide spacing between barbules, and laterally compressed cross section of all barbs and barbules. There are 1 to 2 coils with wide spacing (0.08 mm

interval) in the middle to tip portion of the barbules of at least two barbs. This coiled structure is also present in the base of barbules of Canadian feathers from the Late Cretaceous and in modern birds (e.g., grebes), differing from the Taneichi feather in its position, and helps to absorb water into the feathers for diving. The Taneichi feather is the oldest record of a feather with coiled barbule structure and suggests that this structure (and diving behavior) may be common in the Late Cretaceous because it also occurs in Canadian feathers in amber from the Late Cretaceous (late Campanian).

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

TOOTH REPLACEMENT PATTERN IN MAXILLARY DENTITION OF BASAL NEOCERATOPSIA (ORNITHISCHIA, DINOSAURIA)

TANOUE, Kyo, Fukuoka University, Fukuoka, Japan; LI, Daqing, Gansu Geological Museum, Lanzhou, China; YOU, Hai-Lu, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Neoceratopsia was one of the dominant herbivorous dinosaur clades in Cretaceous terrestrial ecosystems of Asia and western North America. Neoceratopsians thrived throughout the Cretaceous. Jaws of ceratopsids, the derived neoceratopsians, contain large numbers of teeth, which are mesiodistally compressed for close packing in dental batteries in which files of teeth interlock both vertically and horizontally. Ceratopsids have multiple replacement teeth in each tooth position. In contrast, basal neoceratopsians lack dental batteries. The closely-spaced teeth merely erupt in a single horizontal line with only one replacement tooth for each functional tooth. The replacement pattern of ceratopsian dentition has attracted very little attention. In this study, the maxillary dentitions of basal neoceratopsians from the Lower Cretaceous of Asia were examined to understand the tooth replacement pattern in the early stage of neoceratopsian evolution. The replacement tooth developed on the lingual side of the functional tooth. In order for a replacement crown to reach the size of functional crown prior to eruption, resorption of the root of the functional tooth is necessary. In the final stage of tooth replacement the apical portion of the functional crown caps the replacement tooth, indicating that there has been a loss of both the root and the basal portion of the crown from the functional tooth. The resorption of the base of the functional tooth is also seen in modern crocodilians, and may be the plesiomorphic state of tooth replacement pattern in archosaurs. In ceratopsids, the crown of each replacement tooth fits between the bifid roots of the preceding tooth. This relationship between the replacement tooth and the roots of the functional tooth renders resorption unnecessary during tooth replacement in ceratopsids. Having only one replacement tooth for each tooth position and involving resorption of the functional tooth for it to erupt, tooth replacement of basal neoceratopsians was inefficient compared to ceratopsids.

Symposium 4 (Saturday, November 2, 2013, 9:45 AM)

THE ULTRA-WARM ARCTIC CA. 90 MILLION YEARS AGO: CONSTRAINTS ON PALEOCLIMATE AND BIOGEOGRAPHY FROM VERTEBRATE FOSSILS

TARDUNO, John, University of Rochester, Rochester, NY, United States, 14627; BRINKMAN, Donald, Royal Tyrrell Museum, Drumheller, AB, Canada; CLARKE, Julia, The University of Texas at Austin, Austin, TX, United States; BONO, Richard, University of Rochester, Rochester, NY, United States; HIGGINS, Pennilyn, Univ of Rochester, Rochester, NY, United States

A spectacular assemblage of vertebrate fossils, including large-bodied crocodile-like champsosaurs, turtles and fish provides evidence for an excursion within the Cretaceous greenhouse world to ultra-warm conditions, ca. 90 million years ago. The fossil vertebrates are from a key Arctic site on Axel Heiberg Island at 79° N. Our ongoing efforts are focused on obtaining additional paleotemperature estimates to test hypotheses relating the ultra-warm climate to magmatic outgassing. The fossil champsosaurs suggest a minimum mean annual temperature of 14 °C when paleomagnetic data indicate that the site was at Arctic paleolatitudes (approximately 71° N). Fish fossils record an expansion of ranges toward the poles. Turtles are abundant and diversity is unusually high compared with other high latitude vertebrate assemblages, consistent with warm temperatures. The fossil champsosaurs define a population dominated by juveniles, incompatible with freezing. *Aurorachelys gaffneyi*, a large macrobaenid fossil turtle with affinities to Asia, suggests the possibility of migration over a warm, brackish Arctic Ocean. Isotopic analyses of bone apatite using a multiple taxon approach can be used to obtain quantitative estimates of paleotemperature. The availability of multiple species of fossil fish and turtles, and bones from champsosaurs and at least one bird species, afford the possibility of multiple consistency tests (to gauge both taxon specific fractionation and diagenesis). Scales from the fossil gar *Lepisosteus* yield an average $\delta^{18}O$ of 7.0‰ relative to Vienna Standard Mean Ocean Water. The fossil vertebrates overlie continental flood basalts of the Strand Fiord Formation, which may be the on-land expression of magmatism that formed the Alpha-Mendeleev Oceanic Ridge of the Arctic Ocean. Together, these features may form one of Earth's most voluminous large igneous provinces. CO_2 outgassing related to this volcanism, together with outgassing at several other sites of coeval magmatism, may have been responsible for the interval of extreme climatic warmth, a linkage supported by new radiometric age data.

Technical Session IV (Wednesday, October 30, 2013, 2:30 PM)

EVOLUTION OF MIOCENE AMAZONIAN ECOSYSTEMS: CAN OLD MAMMALS REVEAL SOMETHING NEW?

TEJADA LARA, Julia, University of Florida, Gainesville, FL, United States, 32601; MACFADDEN, Bruce, University of Florida, Gainesville, FL, United States; ANTOINE, Pierre-Olivier, Université Montpellier 2, Montpellier, France; FLYNN, John J., American Museum of Natural History, New York, NY, United States; SALAS GISMONDI, Rodolfo, Museo de Historia Natural UNMSM, Lima, Peru

The Amazonian tropical rainforest is a complex ecological system supporting the greatest biodiversity in the world. Although many attempts have been made to examine the origin and evolution of this biodiversity, the history of Amazonia is still far from fully elucidated. Most previous efforts to reconstruct Amazonian paleoecosystems have used living-based models. For example, the region was broadly interpreted as an open-landscape during the Pleistocene based on the presence of hypsodont mammals. It also was interpreted as transitional between savanna and forest-dominated habitats during the middle Miocene, using the relationship between mammalian macroniche structure and rainfall in modern tropical mammalian faunas. However, considering that most Amazonian Tertiary faunas lack modern ecological analogs, models based only on modern parameters can lead to flawed interpretations. An example of how extrapolating extant macroniche specializations to the past might be misleading is found in dietary studies of Pleistocene toxodonts. Those hypselodont mammals, long thought to be exclusively grazers, were C3 forest browsers when living in Amazonia.

Here, isotopic analyses ($\delta^{13}C$, $\delta^{18}O$) of tooth enamel carbonate were performed on two major clades of endemic herbivorous mammals (Astrapotheria, Toxodontia) from the late middle Miocene of Peruvian Amazonia to investigate canopy structure, niche partitioning, and seasonality following the Middle Miocene Climatic Optimum. Results obtained from both bulk and serial sampling indicate that: (1) the area was forested and bordered on closed canopy; (2) there was resource partitioning among native ungulates; and (3) seasonal variation was virtually nonexistent. Isotopic $\delta^{13}C$ values from Astrapotheria and Toxodontia show significantly different ($\rho = 0.01$) mean $\delta^{13}C$ values of -10.62 and -12.67 ‰ respectively. This difference indicates resource partitioning within a C3 plant ecosystem. Future research will include extant Amazonian mammals to constrain modern parameters of isotopic fractionation, as well as fossil taxa within extant lineages, particularly those with high diversity in ancient ecosystems (e.g., Xenarthra, Rodentia). This could also provide information about niche conservatism in endangered extant lineages. Stable isotope analyses have the potential to unveil many unknown ecological aspects of extinct tropical biotas, however, they are also challenging given the methodological and ecological constraints posed by many taxa in ancient non-analog systems.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A VERTEBRATE FAUNA FROM THE SANTONIAN – LOWER CAMPANIAN MENEFEE FORMATION, SAN JUAN BASIN, NEW MEXICO

TEMPLEMAN, Tara, University of New Mexico, Albuquerque, NM, United States, 87109; WILLIAMSON, Thomas, New Mexico Museum of Natural History, Albuquerque, NM, United States

Few early Campanian terrestrial vertebrate faunas have been described from western North America. Consequently, it is not known if the pattern of high diversity and high provinciality that characterized middle and late Campanian biotas also prevailed in the early Campanian. Here we provide an updated list from the Armijo Draw local fauna, a vertebrate assemblage from the Santonian – lower Campanian Menefee Formation from near the southeastern margin of the San Juan Basin, New Mexico. Vertebrate fossils of the Armijo Draw local fauna were recovered through a combination of surface prospecting and from screenwashing of bulk samples. New macrovertebrate fossils include a partial ceratopsian braincase, bones of a hadrosauroid, and fragmentary postcrania of a theropod. Microvertebrate fossils from several localities include “typical” Campanian age taxa including osteichthyan scales and teeth representing several taxa (e.g., lepisosteid genus et sp. indet, amiid gen. et sp. indet., and *Paralbula* sp.), teeth representing numerous fresh water chondrichthyan taxa (e.g., *Lissodus* sp., *Hybodus* sp., Orectolobidae gen. et sp. undet., cf. *Myledaphus* sp., *Ischyrhiza* sp., *Protoplatyrhina* sp., *Ptychotrygon* sp.), teeth of crocodilians, teeth of ornithischian dinosaurs, and tooth fragments of therian mammals. The Armijo Draw local fauna resembles other Campanian age, coastal plain vertebrate assemblages of western North America.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

COMPARATIVE ECOMORPHOLOGY OF ORNITHOPOD AND RUMINANT SNOUTS - A GEOMETRIC MORPHOMETRIC APPROACH

TENNANT, Jonathan, Royal School of Mines, London, United Kingdom

Rostrum shape is a prominent aspect of herbivore ecology concerning feeding strategy, affecting forage selectivity and intake rate. Within ruminants, feeding classes are partially delimited based on snout shape, with grazing species typically attributed ‘blunt’ and browsing species ‘pointed’ snouts. Here, this aspect of functional ecology is analysed in a statistically rigorous, geometry-based framework, principally testing whether feeding strategy is consistent with snout morphology using a two-dimensional profile of the premaxilla in ventral aspect. A secondary objective is to assess this approach using ornithopod dinosaurs, the putative extinct analogues of modern ruminants. When ruminants are classified based on assigned feeding strategies according to secondary criteria (e.g., % grass consumption), species cannot be discriminated accurately on the basis of their shape profile. Conversely, ornithopods are found to exhibit a well-structured pattern of shape variation with clear differentiation between ‘blunt’ and ‘pointed’ shapes. This pattern exists in both a phylogenetic and temporal context, and may relate to browsing height and forage selectivity.

Technical Session X (Friday, November 1, 2013, 9:00 AM)

DYNAMICS OF HOLOCENE ABUNDANCE AND RESOURCE USE IN DESERT MICE

TERRY, Rebecca, Oregon State University, Corvallis, OR, United States, 97331; KOCH, Paul, Univ of California Santa Cruz, Santa Cruz, CA, United States

Paleontologists and neontologists alike have long recognized abundance as a key variable for identifying species vulnerable to environmental change. Abundance, however, reflects complex interactions of both abiotic and biotic factors. For example, species abundances may respond to changes in climate, while niche breadth flexibility may buffer species against environmental change. We analyzed small mammals from Two Ledges Chamber - a Holocene fossil record in the Great Basin, USA - to disentangle how the temporal dynamics of climate and a species' niche breadth influence its abundance. Sample-standardized abundance dynamics for 18 species were estimated from fossil specimens spanning the last 8,000 years, and evaluated against a local high-resolution climate record for the same time-interval. We used partial correlations to account for the impact of climate on the abundance of three focal species (*Chaetodipus formosus*, *Perognathus longimembris*, and *Peromyscus cf. maniculatus*) given concomitant changes in the abundances of the other species in the community. Using stable isotopes ($\delta^{13}C$ and $\delta^{15}N$), we then estimated the niche breadth of these three species, which encompass a range of physiological, morphological, and behavioral adaptations of mice to desert environments. Species' abundances exhibited marked taxonomic and temporal variation. Climate remained the primary driver of abundance dynamics even after accounting for the impact of biotic interactions. Isotopic niche-breadth among species revealed strong niche partitioning both in the past and today, but the relative positions of species to one another in isotopic niche space was variable over time. Importantly, each species' modern $\delta^{13}C$ and $\delta^{15}N$ values fell well outside their ranges of Holocene variability. Over the past two centuries, obligate granivores show a trend in $\delta^{13}C$ towards the incorporation of cheatgrass (an introduced invasive) into the diet. *P. longimembris*, however, shows marked enrichment in $\delta^{15}N$ at the same time, perhaps indicating a shift towards incorporation of animal tissue into its diet. These results suggest that both biotic and abiotic factors must be considered when assessing species responses to environmental change, and that the modern world is strikingly different from the Holocene for these mice. Work is currently ongoing to determine whether temporal changes in isotopic niche-breadth reflect changes in vegetation, diet preferences, or the isotopic composition of mouse food.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

MAXIMUM BODY SIZE EVOLUTION OF CENOZOIC MAMMALIAN HERBIVORES

THEODOR, Jessica, University of Calgary, Calgary, AB, Canada, T2N 1N4

Numerous traits of herbivores scale allometrically, and large size is generally assumed to provide a digestive advantage for herbivores, thus the maximum size reached within trophic groups is likely to reflect ecological or physiological limits. We compiled the maximum body size within large herbivores on the three largest continents (Africa, Eurasia, and North America) for all sub-epochs during the last 55 million years, and a sub-NALMA resolution datset for North America. As previously established, the maximum size of mammalian herbivores has been an order of magnitude higher than the maximum size for carnivorous mammals. Even after the evolution of grazing, browsing mammals represented the largest herbivores until the latest Miocene in Africa and the Pliocene in Eurasia and North America, when grazing proboscideans reached their maximum size. This suggests that grazing megaherbivores faced a constraint on size evolution until at least the latest Miocene on these continents. The relaxation of this constraint may well be tied to the spread of the mammoth steppe ecosystem in Eurasia and North America. Comparing herbivores using an extant phylogenetic bracket for gut fermentation style shows that once foregut fermentation evolved, the maximum size of foregut fermenters increased, but remained lower than the maximum size of hindgut fermenters. Within the terrestrial artiodactyls and the perissodactyls, perissodactyl maximum size was greater until the Pliocene. The higher resolution North American dataset shows that artiodactyls contained subclades with more varied diets and a wider range of maximum body sizes than did perissodactyls, and the largest artiodactyls in North America through the Eocene and Oligocene were not folivores. During this time, the largest artiodactyl folivores in North America were anthracotheres, which were replaced by camelids in the Miocene. Perissodactyl maximum body sizes increased through the Eocene, after which rhino and tapiroid maximum sizes leveled off and equid maximum size continued to increase. Since the middle Eocene, no perissodactyl clade has had a maximum size lower than 10 kg, and by the end of the Eocene, all had maxima above 100 kg. By contrast, terrestrial artiodactyls continued to occupy the smaller size ranges, with a number of clades with maximum masses below 10 kg, and dominating in the 10-100 kg maximum mass ranges.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NOT BY SIZE ALONE: INVESTIGATIONS OF SHAPE, ALLOMETRY, AND PHYLOGENY IN CERVID ECOMORPHOLOGY

THOMSON, Matthew, University of California Santa Barbara, Goleta, CA, United States, 93117; CURRAN, Sabrina, Cleveland Natural History Museum, Cleveland, OH, United States

Size is well understood to be a confounding factor in morphological studies, such that shape often changes as a function of size (allometry) rather than changing congruently (isometry). This is an especially large problem in fossil contexts, where taxa are sometimes differentiated on the basis of size alone. For many studies attempting to compare morphology, size should be explored, accounted for and (if necessary) factored out. Here, we investigate size as a confounding factor in studies of Cervidae post-cranial ecomorphology. Previous studies have shown that size can account for as much as 95% of the morphological variation in some Bovidae post-cranial elements. This study expands on past research, incorporating a variety of Cervidae post-cranial elements and exploring how size dominated variation may affect discriminant function reclassification rates. We applied Mosimann shape variable methods and found that for each post-cranial element, 57-95% of the variance in raw measurements is attributed to size. Linear regressions and principal component analysis were used to explore and confirm the effects of size on the measurements and their principal components. Discriminant function analysis shows that any attempt to remove or otherwise diminish the effects of size results in lower resubstitution and cross-validation rates when grouping known individuals into habitat categories. However, some measurements designed specifically to adjust for size still resulted in relatively high resubstitution rates (77-83% in a four-group discrimination). The implication is that even though size is dominating the variance in the raw metric dimensions, the ability of shape alone (i.e. non-size correlated dimensions) to discriminate among Cervidae post-cranial elements based on habitat category is still robust. If accuracy is the goal of these kinds of analyses, our results also implicate that removing or otherwise obscuring size information may not be appropriate since it generally results in weaker discriminant functions.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FIRST OCCURRENCE OF REPTILE TRACKS (*PROCOLOPHONICHNIUM*) FROM THE LOWER TRIASSIC MOENKOPI FORMATION (SHNABKAIB MEMBER) OF SOUTHWESTERN UTAH WITH PALEOENVIRONMENTAL IMPLICATIONS

THOMSON, Tracy, University of California-Riverside, Riverside, CA, United States, 92521

The Lower-Middle Triassic Moenkopi Formation of the Colorado Plateau preserves a high-diversity track assemblage (e.g., *Chirotherium*, *Rotodactylus*, *Rhynchosauroides*) produced by a variety of reptilian trackmakers. Many of these trackmakers are not represented by skeletal remains and therefore they are an important record of Early Triassic reptilian biodiversity. Reported here is the first occurrence of vertebrate tracks from the Lower Triassic Shnabkaib Member (upper Olenekian) in southwestern Utah. The tracks show diagnostic characteristics of the small reptilian ichnogenus *Procolophonichnium* including broad trackways with low pace angulations and overstepping of the proximal portion of the manus by the pes. A specimen comprising several tracks is reposited at the Natural History Museum of Utah (UMNH). *Procolophonichnium* is common from the Middle Triassic Muschelkalk Formation (Anisian) in Germany and together with *Rhynchosauroides* it is predominantly associated with upper intertidal to lower sabkha facies. Although *Rhynchosauroides* commonly occurs in the Moenkopi Formation, *Procolophonichnium* is rare and tracks have only recently been identified on a specimen at the University of California Museum of Paleontology (UCMP) that was collected from the Wupatki Member (upper Olenekian) near Meteor Crater, Arizona. Both the UCMP and UMNH specimens show multiple trackways with preferred orientations indicating the unidirectional travel of multiple individuals over a relatively short period of time. The UCMP specimen also preserves the manus and pes impressions of *Chirotherium sickleri*, a much larger reptile track, overprinting the *Procolophonichnium* tracks. The UMNH specimen preserves tracks imprinted on symmetrical ripples with the predominant trackway direction subparallel to longitudinal ripple crests. Symmetrical ripple marks, mudcracks, gypsum nodules, and associated laminated and contorted bedding, are indicative of an intertidal to sabkha/supratidal paleoenvironment for the Shnabkaib Member and the discovery of *Procolophonichnium* from this unit supports an association of this ichnogenus with tidal flat/sabkha paleoenvironments as indicated from the German fossil record. *Procolophonichnium* has been considered a wastebasket ichnotaxon and although revision is needed the examples from Germany, coupled with this new discovery from Utah, support the hypothesis that these tracks constitute a distinct ichnotaxon produced by a small Early Triassic reptile adapted to tidal flat and sabkha environments.

Romer Prize Session (Thursday, October 31, 2013, 11:45 AM)

CONCORDANCE AND DISCORDANCE OF DIVERSITY DYNAMICS ACROSS MAMMALIAN TROPHIC GROUPS IN THE MIDDLE EOCENE OF COASTAL SOUTHERN CALIFORNIA

TOMIYA, Susumu, University of California Museum of Paleontology, Berkeley, CA, United States, 94720

The diversity dynamics of carnivoraforms and their contemporary mammalian carnivores during the middle Eocene is poorly understood, owing to limited taxonomic work and lack of ecological approach that would place the carnivores in the context of regional faunal succession. Using the exceptionally dense fossil record of the Uintan through Duchesnean mammals in coastal southern California, I address whether changes in the ecomorphological diversity of carnivores at the macroevolutionary timescale are associated with compositional shifts in non-carnivorous mammals. I compiled taxonomic occurrence data for middle-Eocene mammals from San Diego and Ventura Counties based on 33,000+ specimens representing at least 93 genera. The fossil occurrences were grouped into meta-assemblages belonging to 9 time bins. For each meta-assemblage, morphological-compositional matrices were constructed separately for carnivores and non-carnivores by tallying the number of taxa in morphotypic categories defined by body mass and diet. I assessed the degree of concordance between compositional shifts in carnivores and non-carnivores by computing the pairwise Manhattan distances for all pairs of carnivore assemblages and all pairs of non-carnivore assemblages, and then testing for rank-order correlation between the two sets of pairwise distances. A minimum of 16 carnivorous taxa (including 11 carnivoraforms) are recognized in the regional fauna. The numbers of carnivorous taxa and morphotypes increased substantially from the early Uintan to the Duchesnean ages, resulting in broader body-size ranges and greater representation of hypercarnivores. This trend coincided with decline of arboreal non-carnivores (mainly primates) and rise of terrestrial herbivores, which suggest major changes in the available habitat types. The magnitude of morphological-compositional shifts in carnivores was significantly correlated with that in non-carnivores (Mantel $r = 0.382$, $P = 0.045$). However, the turnovers in the two groups were notably decoupled in the early part of faunal succession. The rich fossil record of southern California illustrates a broad association between the morphological diversity of the two trophic groups within the regional fauna, and that it is possible to detect such linkage even with

limited information on trophic interactions. Nevertheless, the carnivore component of the fauna is overall more stable, suggesting that environmental context may determine the coupling of turnovers.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

ONTOGENETIC VARIABILITY IN UPPER CRETACEOUS THEROPOD TEETH

TORICES, Angelica, University of Alberta, Edmonton, AB, Canada, T6G 2E9; BRADLEY, Gavin, University of Alberta, Edmonton, AB, Canada; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

The ontogenetic, individual and positional variability of theropod teeth makes it difficult to estimate theropod diversity through the study of isolated specimens. Although the description of new taxa based solely on isolated teeth is no longer ubiquitous in paleontology, diagnostic tooth species have persisted since the latter half of the nineteenth century. A taxonomic classification that does not take into account dental differences among individuals of a species could result in an overestimation of the species present in the sample. Contrarily, it is also possible to underestimate species diversity if different species present identical morphologies.

Ontogenetic series are difficult enough to recognize even when there are complete skeletons, and this problem is greatly magnified when taxa are only known from isolated teeth. Some authors claim that theropod teeth show little ontogenetic variation, and that the teeth of young theropods are simply scaled-down versions of more mature individuals, although the juveniles have fewer but relatively larger denticles. However, other researchers suggest that denticle size and density depends on the height of the crown; larger teeth have larger denticles and therefore lower density of denticulation.

Ontogenetic variation in teeth was assessed for several Late Cretaceous theropods to determine whether or not current tooth-denticle ratio characters are correct and can be used to confidently distinguish Late Cretaceous taxa based on isolated teeth.

Juvenile and adult specimens of *Bambiraptor feinbergi*, *Daspletosaurus torosus*, *Gorgosaurus libratus*, *Saurornitholestes langstoni* (as an approximate corresponding adult for *Bambiraptor*) and *Velociraptor mongoliensis* were studied. The results suggest that although there is considerable variation in tooth size, the changes in denticle density are minimal in growth series of dromaeosaurids and tyrannosaurids; juvenile denticles are slightly smaller or the same size as they are in adult teeth. The number of denticles per millimeter seems to remain nearly constant through ontogeny and, therefore, may be characteristic of a taxon. Some differences, however, can be observed. In the case of *Daspletosaurus*, denticles are absent in the premaxillary teeth of juveniles, but are fully developed in adults, whereas in *Gorgosaurus*, denticles are present in all dental positions, at all life stages. These results comment on the validity of the practice of taxonomic classification of theropod dinosaurs, based solely on isolated teeth.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

REDESCRIPTION OF THE INTERMEDIATE BILL MORPHOLOGY OF THE OLIGOMIOCENE FLAMINGO *HARRISONAVIS CROIZETI* BASED ON HIGH RESOLUTION X-RAY COMPUTED TOMOGRAPHY

TORRES, Christopher, UNC Wilmington, Wilmington, NC, United States, 28403; DE PIETRI, Vanesa, Natural History Museum Basel, Basel, Switzerland; LOUCHART, Antoine, Institut de Genomique Fonctionnelle de Lyon, Lyon, France; VAN TUINEN, Marcel, UNC Wilmington, Wilmington, NC, United States

Flamingos (Phoenicopteriformes) are a highly specialized lineage with a filter-feeding strategy entirely unique among modern birds. Though extant flamingo ecology and feeding behavior has been well-studied, the evolutionary history of this ecomorph remains poorly understood. No ancestral cranial or rostral fossil material has ever been formally described for crown clade flamingos (Phoenicopteridae). The most closely-related extinct taxon (Palaelodidae) has been described as possessing a straight, blunt bill, markedly different from that of modern flamingos. Thus, no intermediate form is known. *Harrisonavis* (‘*Phoenicopterus*’) *croizeti* has been described from the late Oligocene-early Miocene of the Auvergne region in central France and assigned to Phoenicopteridae based on, among other elements, a skull with clear affinities to the modern flamingo ecomorph. However, a thorough description is lacking and the original material has been lost. Here, new phoenicopterid cranial material is described from the Saint-Gérand-le-Puy area in central France which is tentatively assigned to *H. croizeti*, including a nearly complete cranium with articulated proximal upper rostrum, a distal rostral tip, and two pieces of mandibular material. High resolution X-ray computed tomography (CT) is used to describe the internal as well as external morphology, including a digitally reconstructed brain endocast which is compared with brain reconstructions from modern flamingos and palaelodids. CT data are used to create a three-dimensional reconstruction of the skull of *H. croizeti* to show that this taxon possessed a rostral ecomorph intermediate to those of the palaelodids and of modern flamingos. These data fill an important gap in understanding the evolution of this ecomorph and may inform the tempo and course of specialization in this unique lineage of birds.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

"WHAT ROCK IS THAT?" (AND OTHER COMMON 4TH GRADE QUESTIONS)- A FREE PROFESSIONAL DEVELOPMENT OPPORTUNITY FOR TEACHERS WITH NHMU

TOTH, Natalie, Natural History Museum of Utah, Salt Lake City, UT, United States, 84111; SEPPI, Jessica, Natural History Museum of Utah, Salt Lake City, UT, United States

Through our yearly interaction with students statewide, we, as scientists and outreach educators, observe a major disparity between the geology component of the 4th Grade Utah State Science Core Curriculum, and what teachers are conveying to their students in the classroom. This disparity resulted in consistently low scores in the geology portion of the State Core Test. To address this discrepancy, we created "What Rock Is That?" (and other common 4th grade questions)- a free professional development opportunity for classroom teachers throughout the state of Utah.

During this Geology Workshop, teachers are provided the opportunity to come to a greater understanding of geologic processes by interacting with museum-quality geology and paleontology specimens. After working with these specimens, we provide teachers with the content and background information necessary to build upon the foundation of this hands-on experience.

By working alongside museum educators who use and model inquiry-based learning techniques throughout the duration of the workshop, teachers are able to construct knowledge about the Earth Sciences from the perspective of their students, an opportunity that helps them empathize greatly with the struggles and frustrations their own students may encounter. Additionally, this empathy allows teachers to hone their science process skills by addressing discrepant events as learning opportunities, rather than a barrier to achieving a deeper understanding of geology. We found that by approaching complex science topics, such as geology and paleontology, in this way, teachers are able to break down previous misconceptions, which then, in turn, allows for the construction of new knowledge with a solid foundation of accurate and engaging ideas.

Even though "What Rock Is That?" is still in its infancy (with the first workshop offered in July 2012), these 3-hour long Geology Workshops have successfully reached 7 school districts across Utah. Out of these 7 districts reached, 85% of teachers ‘strongly agree’ that the workshop has made them feel more comfortable teaching geology in their classrooms. Additionally, 93% of teachers ‘‘strongly agree' that the w
was presented in an easily accessible and understandable manner.

It is through "What Rock Is That?" that we are able to emphasize that authentic and experiential learning opportunities, rather than simple memorization of facts about rocks, minerals, and fossils, are necessary for students and teachers to come to a greater understanding of the Earth Sciences.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

AN EXPANDED ANALYSIS OF DENTAL MICROWEAR IN CAVIOMORPH RODENTS

TOWNSEND, K.E. Beth, Midwestern University, Glendale, AZ, United States, 85308; CROFT, Darin, Case School of Medicine, Cleveland, OH, United States

Caviomorph rodents have been significant components of South American ecosystems for more than 30 million years. How such rodents partitioned dietary resources with other groups of mammals, such as endemic South American ungulates, remains a little-explored question. Our research goal is to investigate this topic by characterizing enamel microwear in extant caviomorph rodents and using those data to interpret diets of extinct caviomorphs. Our 2008 pilot study of enamel microwear in extant caviomorph rodents demonstrated a correspondence between microwear and broad dietary groups but was based on relatively small samples. We here report results of a much-expanded analysis that includes 42-50 wild caught individuals of eight of the 13 taxa examined in our prior study. These new results support some aspects of our earlier analysis but also reveal patterns not evident previously. For example, the grass-leaf consumers, *Hydrochoerus* and *Cavia*, have high scratch counts typical of other grazers (e.g., ungulates, murid, sciurid rodents). Similarly, the fruit-seed consumers, *Proechimys cuvieri* and *Thrichomys*, have high pit counts similar to other seed predators. In contrast to our previous study, *Dasyprocta*, a fruit-leaf consumer, has unexpectedly high scratch counts (particularly fine scratches) more similar to grass-leaf consumers than typical frugivores. Additionally, *Hydrochoerus* has more gouges than other grazers, almost identical to what is seen in seed predators. The etiology of these gouges is not clear and merits investigation. Microwear of the grass-leaf consumer, *Ctenomys*, includes many pits and few scratches. Thus, it is more typical of a hard object feeder (hard fruit consumer or seed predator) than a grass feeder. This discrepancy is likely related to the fossorial habits of *Ctenomys*, which digs with its incisors as well as its forelimbs. This chisel-tooth digging could result in soil in the oral cavity and thereby affect enamel microwear, potentially resulting in the highly pitted microwear of *Ctenomys*. This would parallel the pattern seen in ungulate “dirty browsers” such as *Camelus*, which also have highly pitted microwear. The correlation between dietary grit and highly pitted microwear in both *Ctenomys* and *Camelus* implies that the abundant scratches characteristic of grazers probably results from the consumption of opal phytoliths rather than exogenous dietary grit. The lack of scratches in *Ctenomys* may simply be due to overprinting of the grazing microwear signal by a dietary grit signal.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THERMOREGULATORY STATUS OF MOSASAURS FROM THE WESTERN INTERIOR SEAWAY OF KANSAS, USA

TREVETHAN, Ian, Fort Hays State University, Hays, KS, United States, 67601

During the Late Cretaceous, the central portion of the North American continent was occupied by the Western Interior Seaway. The fauna of the Western Interior Seaway was segregated into distinct habitats, based on physical, chemical, and geographic factors.

Mosasaurs (Squamata: Mosasauridae) were a diverse group of secondarily aquatic marine reptiles derived from varanid-like lizards that radiated into marine niches 98-65 Ma, during the latter half of the Cretaceous. Over 3000 specimens of mosasaurs have been described from the Late Cretaceous strata of the Western Interior Basin of North America. Although studies of mosasaur relationships, distribution, and diversity continue to add to the growing body of knowledge, little is known about other key aspects regarding the ecology of this family.

Recent analyses comparing oxygen isotope values of phosphate from the teeth of marine reptiles to those of coeval fish estimated mosasaur body temperature to be in the range of 35° ± 2°C to 39° ± 2°C. In addition to these findings, other researchers recently examined oxygen isotope composition in bioapatite within coeval turtle and fish fossils from Kansas and Mississippi indicating that paleoenvironmental zones of the Western Interior Seaway were latitudinal and likely a result of both temperature and salinity variation throughout the Late Cretaceous.

Presented here are the results of an isotopic analysis of phosphate within core skeletal elements (cervical, dorsal and caudal vertebrae) of the North American mosasaurs, *Platecarpus, Tylosaurus*, and *Clidastes* from western Kansas. The purpose of this study is to estimate the core body temperatures of these mosasaur specimens and compare them to ocean water temperature calculated from coeval fish from the same area. These results show core body temperature of mosasaurs to be substantially higher than that of ocean water. High, stable core body temperature values indicate endothermic regulation and establish baseline body temperature estimates for mosasaurs found in Kansas. With these temperature estimates, it will now be possible to pursue a larger scale investigation correlating body temperature of mosasaurs to water temperatures within the Western Interior Seaway of North America on a latitudinal gradient.

Symposium 3 (Friday, November 1, 2013, 9:45 AM)

THE MORRISON FORMATION U/PB DATING PROJECT: USING HIGH-PRECISION, CHEMICAL ABRASION (CA-TIMS), SINGLE ZIRCON, ASHFALL DATES FOR CHRONOSTRATIGRAPHIC CORRELATIONS

TRUJILLO, Kelli, University of Wyoming, Laramie, WY, United States, 82071; CHAMBERLAIN, Kevin, University of Wyoming, Laramie, WY, United States

The Upper Jurassic Morrison Formation of the Western Interior of North America is one of the most prolific fossil-bearing rock units in the world, and it has been studied in detail across its vast depositional area. Long-distance correlations of the formation have been difficult, however, due to the inherent variability of terrestrial systems, the lack of biostratigraphically useful fossils, and the lack of definitive marker horizons in this rock unit. Radiometric dating has the potential to help overcome these issues and to aid in correlations across the depositional area.

This project focuses on dating individual vertebrate fossil quarries in the Morrison Formation in order to place them into temporal context. The resulting ages can then be used to create a radiometrically based stratigraphic framework for the formation as a whole. Many researchers have already contributed matrix from their quarries as well as funding to support the dating of their individual sites.

As a result of this ongoing project, new U/Pb ages from geographically diverse vertebrate fossil localities in the Morrison Formation have been produced. These ages, along with legacy 40Ar/39Ar ages (recently recalculated due to the recalibration of the Fish Canyon Tuff sanidine standard to the astronomical timescale), are allowing better long-distance correlations than previously were available. In addition, techniques such as chemical abrasion (CA-TIMS) and ultra-low Pb lab blanks are allowing the University of Wyoming Geochronology Lab to date single, small, ashfall zircons with greater precision and accuracy. These crystals often have such a low level of radiogenic lead that only ultra-low blank methods can produce robust data.

Several ages from geographically widespread fossil localities in the Morrison Formation are now available, and they are being used to test previously published correlations of fossil-bearing localities. These new data support the concept that long-distance correlations of the Morrison Formation based on lithostratigraphy, including a change in the dominant clay mineralogy, should be used with caution when radiometric dates are not available.

Technical Session XV (Saturday, November 2, 2013, 10:45 AM)

EARLY EVOLUTIONARY RADIATION IN BALEEN WHALES (CETACEA: MYSTICETI) FROM THE OLIGOCENE OF NEW ZEALAND

TSAI, Cheng-Hsiu, University of Otago, Dunedin, New Zealand; FORDYCE, R. Ewan, University of Otago, Dunedin, New Zealand

Early stages of evolutionary radiations often show numerous cladogenetic speciations, rapid ecological occupancy, and high morphological disparity. In filter-feeding or baleen whales (Cetacea: Mysticeti), their earliest history in Oligocene times is particularly problematic because of the rarity of fossils. Recently, several studies have considered the early radiation and later diversification of mysticetes, but many aspects of history are poorly understood. Here, we consider the early evolutionary scenario of baleen whales based on the complex anatomical features of the earbones (tympanic bulla and periotic), elements that preserve well because of their dense structure. A character matrix (59 morphological characters) from earbones was constructed and analysed in both cladistic and phenetic ways. Taxa included 9 undescribed toothless late Oligocene mysticetes (Geology Museum, University of Otago) from the Kokoamu Greensand and Otekaike Limestone (28 - 23 mya) of New Zealand, plus *Balaena mysticetus*, *Balaenoptera bonaerensis*, *Caperea marginata*, *Eomysticetus whitmorei*, *Eschrichtius robustus*, *Eubalaena* spp., *Herpetocetus* spp., *Mammalodon colliveri*, *Megaptera novaeangliae*, and an archaeocete (*Zygorhiza kochii*; outgroup). TNT (Tree analysis using New Technology) and PAST (PAlaeontological STatistics) were used to analyse and measure the morphological disparity in the NZ Oligocene taxa cladistically and phenetically, respectively. Cladistic and phenetic results both show considerable morphological disparity, with cladistic branch lengths ranging from 6 to 10 (branch lengths for modern mysticetes families ranging from 3 to 8) and distance in phenetic cluster analysis spanning from 4.56 to 7.306 (distance for modern mysticete families spanning from 5.837 to 9.963) in NZ Oligocene taxa. The disparity arises partly because of some marked plesiomorphies: the presence of accessory ossicle and fovea epitubaria on the anterior process of the periotic, position of Eustachian outlet ventral to the mid-dorsoventral height of tympanic bulla, the presence of a cavity inside the ventral part of sigmoid process, and the presence of an elliptical foramen. Results are consistent with the notion that the early morphological radiation of baleen whales was linked to evolutionary and ecological experimentation during the Oligocene.

Technical Session VII (Thursday, October 31, 2013, 3:00 PM)

ANATOMY OF SAURISCHIAN HIP JOINT SOFT TISSUES AND ITS SIGNIFICANCE IN BODY SIZE EVOLUTION

TSAI, Henry, University of Missouri, Columbia, MO, United States, 65212; MIDDLETON, Kevin, University of Missouri, Columbia, MO, United States; HOLLIDAY, Casey, Univ of Missouri - Columbia, Columbia, MO, United States

Reconstructing joint anatomy and function is critical to understanding posture, locomotor behavior, ecology, and evolution of extinct vertebrates. Major changes occurred in hip joint morphology during archosaur evolution, resulting in a spectrum of postures. However, the lack of joint soft tissues in fossil taxa, as well as limitations of two-dimensional analyses, makes inferences of joint function difficult. Previous studies have shown that archosaur hip joint subchondral surfaces vary widely in joint congruence. Incongruent hip joints of gigantic dinosaurs suggest the presence of large volumes of soft tissue. Furthermore, the proximal femur and acetabulum exhibit corresponding osteological correlates for soft tissue attachments, which inform hip articulation during stance and locomotion. This study describes the relationship between hip joint dimensions and anatomical characters associated with body size evolution in extinct archosaurs. Using photogrammetry techniques, length, height, depth, and circumference of the proximal femur and the acetabulum of over 40 archosaur taxa were analyzed for relationships with body mass using phylogenetically corrected correlation. Among saurischians, gigantic theropods (i.e., *Tyrannosaurus*) and sauropods (i.e., *Apatosaurus*) convergently evolved highly incongruent hip joints, medially deflected femoral heads, reduced supraacetabular crests, and cranially facing antitrochanters. However, widespread homoplasy in epiphyseal characters of archosaurs complicates reconstruction of evolutionary transformations. In particular, the rugose proximal femoral subchondral surface of sauropods is similar to that of phytosaurs, lepidosaurs, and stem-suchians. On the other hand, theropods exhibit smooth, lightly striated femoral subchondral surfaces, suggesting increased reliance on acetabular soft tissue to maintain articular surface congruence. These data suggest that the archosaur hip underwent major evolutionary transformations in soft tissue morphology, which impact our hypotheses of character homology and joint function.

Romer Prize Session (Thursday, October 31, 2013, 12:00 PM)

A SPECIMEN-BASED PHYLOGENETIC ANALYSIS OF DIPLODOCIDAE (DINOSAURIA, SAUROPODA)

TSCHOPP, Emanuel, Faculdade de Ciências e Tecnologia - Universidade Nova de Lisboa, Lourinhã, Portugal

Since the late 1800s, numerous diplodocid species were and continue to be described from the Jurassic of the USA, Tanzania, Europe, and possibly Asia. More than 30 different species have been proposed, some now regarded as invalid. Recent phylogenetic analyses of Diplodocoidea resolved intergeneric relationships, but by using *Apatosaurus* and *Diplodocus* as terminal taxa, they relied on earlier identifications of single specimens, which are not all beyond doubt. In order to test the validity of these previous referrals, a specimen-based phylogenetic analysis was conducted. This approach was previously done for *Apatosaurus*, but is here applied for the first time for the entire clade of Diplodocidae.

The present phylogeny includes all diplodocid holotypes (including the recently described *Kaatedocus siberi*), as well as the more complete non-type specimens that provide overlap of skeletal elements between fragmentary holotypes (e.g. *Barosaurus* American Museum of Natural History [AMNH] 6341). The data-matrix counts more than 40 ingroup specimens, and nearly 30, mostly species level, outgroup taxa, ranging from more basal Diplodocoidea (e.g. *Dicraeosaurus*) to titanosauriforms (e.g. *Brachiosaurus*), and early eusauropods (e. g. *Shunosaurus*). The character list amounts to nearly 500 characters, which makes the analysis one of the most detailed studies of sauropod phylogeny performed to date.

The resulting cladogram yields the classical arrangement of diplodocid relationships, but also detects cryptic taxa previously included in well-known genera, which are generically different (e.g. '*Diplodocus*' *hayi*). Counting the number of autapomorphies for different diplodocids allows for a relatively objective way to decide if genus-level separation is warranted. It thereby shows that diplodocine diversity has been underestimated, and that the sauropod fauna of the Morrison Formation (Western USA) in particular was even more diversified than previously thought. Based on individual specimens, the study furthermore shows that skulls previously referred to *Diplodocus* might actually belong to different diplodocine genera, as none of the included diplodocid skulls consistently groups with the *Diplodocus* types, which all consist of exclusively postcranial material. Such a specimen-based phylogenetic analysis thus proves to be a valuable tool to validate historic species and specimen identifications in sauropods, and in paleontology as a whole.

Technical Session II (Wednesday, October 30, 2013, 8:00 AM)

PROFILING THE DUROPHAGE: CONVERGENT SKULL SHAPE EVOLUTION BETWEEN BONE AND BAMBOO SPECIALISTS

TSENG, Zhijie Jack, American Museum of Natural History, New York, NY, United States; MARTÍN-SERRA, Alberto, Universidad de Málaga, Málaga, Spain; FIGUEIRIDO, Borja, Universidad de Málaga, Málaga, Spain

Consumption of hard and tough organic tissues represents biomechanically demanding tasks that are often associated with unique morphological modifications to the masticatory apparatus. The high muscle forces involved in performing such tasks are

implicated as an important factor in shaping the evolution of durophagous specialists in the mammal order Carnivora. Recent morphometric analyses have clarified the great extent of convergent evolution in carnivoran bone-crackers (canids and hyaenids), and separately for the shared skull shape evolution of bamboo feeding carnivorans (ailurids and ursids). However, it is unclear whether a more general set of evolutionary changes in skull shape correlated with a durophagous diet are present across these different ecomorphs. In this study, we investigate convergent evolution of durophagous (bone-cracking and bamboo-feeding) carnivorans using geometric morphometrics analysis on a sample of living and extinct species. Principal components and discriminate analyses of the skull shape data indicate that the two groups of durophages partially overlap in skull shape morphospace. However, the evolutionary pathways of shape changes leading to durophagous species differ according to the phylogenetic origin of each specialist species. Furthermore, cranial and mandibular shape changes differed in the level of their correlation with dietary categories; cranial shape variables better correlate with the distinction between soft or hard/tough food items, whereas mandibular shape is able to distinguish between bamboo and bone specialists. Nonetheless, the shapes of the cranium and mandible are highly integrated for carnivorans as a whole, consistent with previous findings. As already demonstrated with bone-cracking hyaenids and canids, the biomechanical capability in convergent bamboo specialists *Ailuropoda* and *Ailurus* exhibits remarkable similarities; this observation holds even after accounting for their large differences in body size.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

A PALEOGENE MAMMALIAN FAUNA FROM THE IWAKI FORMATION, JAPAN, AND IMPLICATIONS FOR AGE AND PALEOBIOGEOGRAPHY

TSUBAMOTO, Takehisa, Hayashibara/Okayama University of Science, Setouchi, Japan; KODA, Yoshiki, Ibaraki Nature Museum, Bando, Japan; HASEGAWA, Yoshikazu, Gunma Museum of Natural History, Tomioka, Japan; NABANA, Satoshi, Iwaki City Coal and Fossil Museum, Iwaki, Japan; TOMIDA, Yukimitsu, National Museum of Nature and Science, Tsukuba, Japan

Paleogene land mammals have been rarely found in the Japanese Islands. Nevertheless, recent fieldwork and analytical studies have increased our understanding of Japanese Paleogene land mammals. These studies have indicated that Japanese Paleogene land mammals can contribute to the age determination of terrestrial deposits in Japan and also to our understanding of mammalian biochronology and evolution in continental Asia. Here, the mammalian fauna and geologic age of the Iwaki Formation of the Paleogene Shiramizu Group (Iwaki City, Fukushima Prefecture, northeastern Japan) are reviewed. The Iwaki mammalian fauna consists of three artiodactyl species: *Bothriogenys* sp. cf. *B. hui* (Anthracotheriidae), *Entelodon gobiensis* (Entelodontidae), and cf. *Notomeryx* sp. (Ruminantia). All of these three genera indicate a late Eocene (Priabonian) correlation for the Iwaki Formation, although the formation has been traditionally correlated to the early Oligocene. These three genera have never co-occurred in a single formation, although in Asia they have been recorded only in the late Eocene: *Bothriogenys* has been recorded in the southern and middle regions; *Entelodon* has been mostly recorded in the northern and middle regions with one alleged exception from the southern region; and *Notomeryx* has been recorded in the southern region. The co-occurrence of these three genera in the Iwaki Formation confirms that *Bothriogenys*, *Entelodon*, and perhaps also *Notomeryx* can be useful late Eocene indicators in terrestrial eastern Asia. It also implies that the Iwaki mammal fauna was paleobiogeographically located between the northern and southern late Eocene faunas of eastern Asia, showing a faunal mixture. The Iwaki fauna is also unique in yielding diverse faunas of marine sharks and seashore birds together with terrestrial mammals. The Iwaki vertebrate fauna is a key fauna to reconstruct the faunas of the eastern coastal margin of the Asian Continent during the late Eocene.

Technical Session XVI (Saturday, November 2, 2013, 4:00 PM)

THE FIRST PROCOLOPHONID FROM THE MANDA BEDS OF SOUTHERN TANZANIA AND ITS IMPLICATIONS FOR MIDDLE TRIASSIC BIOGEOGRAPHY

TSUJI, Linda, University of Washington, Seattle, WA, United States, 98195-1800; SIDOR, Christian, University of Washington, Seattle, WA, United States; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa; ANGIELCZYK, Kenneth, Field Museum of Natural History, Chicago, IL, United States

The Middle Triassic Lifua Member of the Manda beds in southern Tanzania has produced a remarkable diversity of archosaurs and therapsids, but no parareptiles. Procolophonids were the last surviving members of the Parareptilia and were broadly distributed across all continents in the Triassic, which makes their absence in Manda rocks especially noteworthy. Fieldwork in 2012 recovered the complete skull and partial postcranium of a new procolophonid taxon. The fossil can be clearly identified as a procolophonid based on the morphology of the teeth, with highly labiolingually expanded crowns and two clear cusps. There are six maxillary teeth with bulbous bases, and clear, tooth-like denticles on the palate. The orbits are particularly large and posteriorly emarginated, and this, along with the small size of the skull, suggests that it could represent a subadult individual. In contrast to contemporaneous South African forms characterized by quadratojugal horns, the new Tanzanian species has two raised bosses on the posterior and ventral surfaces of the quadratojugal, an autapomorphy of the taxon.

A phylogenetic analysis including all adequately known procolophonid taxa confirms that the Tanzanian taxon is indeed a procolophonid, however there is very little resolution in the resulting cladogram. After removing the most problematic, primarily basal and poorly known procolophonids, a more resolved phylogeny has the Manda procolophonid grouping more closely to the Procolophoninae, which is a primarily African clade, than to the Leptopleuroninae, which includes primarily European and North American species. Parareptilia was a diverse clade in the Permian, but only two lineages persisted into the Triassic, the owenettids and the procolophonids. Recent museum research has led to the identification of an owenettid from the Manda beds, which, combined with the specimen from 2012, demonstrates the first known co-occurrence of the two surviving parareptile clades in the Middle Triassic. Previous research has shown a pattern of a more cosmopolitan Gondwanan tetrapod fauna in the Permian as opposed to more endemic faunas in the Middle Triassic. The parareptiles of Tanzania conform to this pattern, with more widespread taxa in the Late Permian (e.g., pareiasaurs such as *Pareiasuchus* and *Anthodon*) contrasted with an entirely endemic Middle Triassic fauna.

Symposium 3 (Friday, November 1, 2013, 12:00 PM)

TEMPORAL CALIBRATION OF THE BRIDGERIAN NORTH AMERICAN LAND MAMMAL AGE (NALMA): MAGNETOSTRATIGRAPHY AND HIGH PRECISION U-PB ZIRCON GEOCHRONOLOGY OF THE MIDDLE EOCENE BRIDGER FORMATION, WYOMING

TSUKUI, Kaori, Columbia University, New York, NY, United States, 10034; FLYNN, John, American Museum of Natural History, New York, NY, United States; RAMEZANI, Jahandar, Massachusetts Institute of Technology, Cambridge, MA, United States; MACHLUS, Malka, Lamont-Doherty Earth Observatory, Palisades, NY, United States; BOWRING, Samuel, MIT, Cambridge, MA, United States

A new magnetostratigraphy and high-precision U-Pb zircon dates from the Middle Eocene Bridger Formation (Bridger Basin, WY) provide an enhanced temporal context for the Bridgerian aged mammalian fauna as well as the Bridgerian/Uintan NALMA transition. Our new magnetostratigraphy correlates the fossiliferous "Bridger B" (upper Blacks Fork Mb.) through "Bridger E" (Turtle Bluff Mb.) interval to the Geomagnetic Polarity Time Scale (GPTS). Paleomagnetic analyses were conducted on samples from 92 stratigraphic levels in six overlapping stratigraphic sections spanning ~550 meters, using thermal and alternating field demagnetizing methods. Four polarity zones were identified, and our correlation of the polarity sequence to the GPTS places the upper Blackforkian subage (Br2) in Chrons C22n and C21r, the Twinbuttean subage (Br3) in Chrons C21r and C21n, and importantly, the Bridgerian/Uintan transition within Chron C21n. The proposed magnetostratigraphic calibration of the Bridgerian NALMA is at odds with a previous age model and indicates a younger chron assignment for the Bridgerian/Uintan transition in the Bridger Basin.

In addition, three distinctive volcanic ash beds from the Bridger Formation were dated with high-precision U-Pb zircon geochronology, to calibrate the numerical age and duration of the Bridger Formation and Bridgerian faunas. The ash beds are magnetostratigraphically correlated, and thus their U-Pb dates can serve to improve the calibration of the GPTS for the study interval. The weighted mean $^{206}Pb/^{238}U$ zircon dates of the Henrys Fork and Church Butte tuffs overlap with previously published $^{40}Ar/^{39}Ar$ ages (normalized to FCs of 28.2 Ma) within fully propagated 2-sigma uncertainties, whereas the U-Pb and $^{40}Ar/^{39}Ar$ dates of the Sage Creek Mountain tuff do not overlap within 2-sigma uncertainties. In all three cases, the U-Pb dates are younger than the corresponding $^{40}Ar/^{39}Ar$ ages. The new geochronologic data place the Bridgerian NALMA just subsequent to a transient drop and rise in temperature after the Early Eocene Climatic Optimum with the entire Bridgerian occurring during the early stages of a long middle Eocene cooling trend.

Finally, the magnetostratigraphic placement of the Henrys Fork tuff generally agrees with the 2012 calibration of the GPTS. However, the U-Pb dates of the Church Butte and Sage Creek Mountain tuffs are in disagreement with the current GPTS calibration for the correlated magnetochrons, suggesting that the presently accepted age for Chrons C21r and C20r in standard time scales may be too young.

Symposium 3 (Friday, November 1, 2013, 10:30 AM)

ADVANCES IN DATING THE LATE CRETACEOUS VERTEBRATE RECORD OF NORTHEASTERN AUSTRALIA USING U-PB LA-ICMPS DETRITAL ZIRCON GEOCHRONOLOGY

TUCKER, Ryan, James Cook University, Townsville, Queensland, Australia; ROBERTS, Eric, James Cook University, Townsville, Australia; SALISBURY, Steven, Univ of Queensland, Brisbane, Australia

A number of studies have recently focused on U-Pb detrital zircon geochronology for maximum depositional age constraints in geologic applications; however this approach is still underutilized in paleontology. Detrital zircon geochronology has particular advantages for refining the age of terrestrial floras and faunas, which are often notorious for their poor temporal and stratigraphic resolution due to ambiguous biostratigraphy. Here we present the results of a recent investigation that utilizes this approach to refine the depositional age and faunal correlations of the poorly understood Winton Formation. The Winton Formation is vital to our understanding of Australia's late Mesozoic terrestrial biota, which includes but is not limited to dinosaurs, crocodyliforms, aquatic squamates, turtles, lungfish, teleosts, and a flora that has been considered to include some of the world's earliest flowering plants. However, the formation lacks identifiable ash beds and has only been dated broadly as mid-Cretaceous via palynology. Fortunately, the Winton Formation is ideal for the application of detrital zircon geochronology for refining the maximum depositional age because of its relative proximity to coeval volcanic and plutonic source rocks along Australia's east to northeastern coast (e.g.,Whitsunday Volcanic Province). We dated detrital zircon samples (n=12 samples [~1000 grains]) from throughout the stratigraphy and at key fossil localities. Our results suggest that sedimentation commenced no earlier than the latest Albian (~103.0-100.5 Ma) and that deposition of the upper vertebrate-rich portion of the stratigraphy began no earlier than the Cenomanian-Turonian boundary (~94.0- 92.5 Ma). The utilization of these methodologies has also facilitated stratigraphic correlation between key fossil localities. Specifically, distinct changes in the maximum depositional

age of nearby fossil localities from similar elevation deposits led to closer geologic inspection and the identification a previously unrecognized normal fault between these sites. Hence, the detrital zircon data was also critical to identifying cryptic structural complexities in the field and recognizing temporally distinct faunal assemblages in the Winton Formation. These results provide a significant advancement in understanding the age of the Winton Formation's flora and fauna, and emphasize to the utility of detrital zircon geochronology for better constraining other terrestrial faunas.

Technical Session IX (Friday, November 1, 2013, 12:00 PM)

MORPHOMETRIC EXPLORATION OF THE EVOLUTION OF WIDE GAUGE FEATURES IN THE STYLOPODIAL LIMB ELEMENTS OF TITANOSAURIFORM SAUROPODS

ULLMANN, Paul, Drexel University, Philadelphia, PA, United States, 19104; BONNAN, Matthew, Stockton College, Galloway, NJ, United States; LACOVARA, Kenneth, Drexel University, Philadelphia, PA, United States

Titanosauriform sauropods were a diverse group of Cretaceous herbivores, including both the largest terrestrial vertebrates that have ever existed and clear examples of insular dwarfism. Despite their great range in body size, all titanosauriforms shared a suite of appendicular specializations collectively termed wide gauge posture. Qualitative summaries of this novel morphology have previously been noted, such as possession of a widened sacrum and laterally flared ilia, but no attempts have yet been made to quantify patterns in shape differences. Here, we have used two-dimensional geometric morphometrics and thin plate splines analyses to quantitatively analyze differences in shape among sauropodomorph humeri (N=89) and femora (N=73). Analyses have identified multiple statistically significant trends for both elements. For the humerus, results demonstrate that titanosauriforms possess proportionately gracile humeri in comparison to other sauropods, with relatively more medially oriented humeral heads and proximally located deltopectoral crests. Canonical variates analyses, which identify shape differences that define groups assigned *a priori*, concur by finding a pattern which characterizes long term macronarian evolution as involving increasing medial displacement of the humeral head and proximal migration of the deltopectoral crest. For the femur, titanosauriforms were identified to possess femora that were significantly broader mediolaterally than other sauropods, with comparatively dorsally directed femoral heads and proximally and slightly laterally displaced fourth trochanters. These shape changes are expressed to the greatest degree by titanosaurians. Regarding other sauropodomorphs, prosauropod humeri and femora are easily distinguished from those of sauropods in canonical variates analyses, an expected consequence of their common bipedality. Brachiosaurids present elongate and gracile humeral and femoral morphologies significantly differing in multiple respects from other analyzed groups. In summation, our results corroborate previous qualitative assessments and afford new insights into statistically significant small scale shape changes that are not visually obvious. With these osteological modifications now identified, our future research will bridge bones with soft tissues to interpret their myological and biomechanical repercussions.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

INTRA-TOOTH VARIATION IN MULTI-ELEMENTARY ISOTOPE ANALYSES ALONG GROWTH-LINES OF TOOTH ENAMEL OF *DESMOSTYLUS* (MAMMALIA, AFROTHERIA)

UNO, Hikaru, National Institute for Agro-Environmental Sciences, Tsukuba, Japan; TARU, Hajime, Kanagawa Prefectural Museum of Natural History, Odawara, Japan; KOHNO, Naoki, National Museum of Nature and Science, Tsukuba, Japan

The enigmatic tethythere *Desmostylus* of the Miocene North Pacific realm has not been well understood in feeding and habitat preferences because this animal has many peculiar features in cranial, dental and postcranial morphologies. Because of these peculiarities, independent investigations from morphology such as geochemical analyses have been conducted in *Desmostylus*. Based on our recent examination, the $\delta^{13}C$ value of *Desmostylus* was higher than that of terrestrial mammals, suggesting that *Desmostylus* foraged in aquatic ecosystem. The $\delta^{18}O$ showed, on the basis of the patterns in the mean and variability, that they lived in brackish water or spent much time in fresh water although their fossils have been collected only from shallow marine strata. Thus, *Desmostylus* was considered to be an estuarine dweller that foraged aquatic food. However, it has not yet clarified how *Desmostylus* lived in brackish water or wandered around nearshore region.

To examine biological events during the lifetime in *Desmostylus*, we analyzed carbon and oxygen isotope values from time-series sampling along the longitudinal axis of their molars from Japan and California. As a result, isotopic values of carbon and oxygen showed regular oscillations with synchronous variety. The trend is identically found in individuals from both Japan and California. Thus, the oscillation is considered to be rather species-specific trend that reflected the ecological nature of *Desmostylus* than location-specific cause. Although the present result cannot identify the peculiar ecological adaptation in *Desmostylus*, it indicates some physiological and/or ecological pattern that happened in *Desmostylus* in a regular interval.

Technical Session XVI (Saturday, November 2, 2013, 2:00 PM)

AN ANALYSIS OF THE BIOGEOGRAPHIC HISTORY OF PTEROSAURS

UPCHURCH, Paul, University College London, London, United Kingdom; ANDRES, Brian, University of South Florida, Tampa, FL, United States; BUTLER, Richard, University of Birmingham, Birmingham, United Kingdom; BARRETT, Paul, The Natural History Museum, London, United Kingdom

Some key aspects of pterosaur macroevolutionary history, such as biogeography, have received relatively little attention. The small number of biogeographic studies of pterosaurs have identified 'centers of origin' and postulated long-distance dispersal (e.g. origin of tapejarids in China in the Barremian-Aptian and their subsequent dispersal to South America in the Albian). To test these and other hypotheses, we constructed a data set comprising the phylogenetic relationships and spatiotemporal distributions of 108 pterosaur species. These data were analyzed as a whole and in time-slices using the event-based parsimony method TREEFITTER. The results provide no statistical support for continent-scale vicariance or coherent dispersal, undermining previously proposed scenarios. In contrast, all analyses (with the exception of the Late Jurassic time-slice) yield statistical support for elevated levels of sympatry. Such patterns might be artefacts produced by taxonomic over-splitting and/or uneven sampling of different habitat types. However, the pervasiveness of sympatry, irrespective of the presence/absence of Lagerstätten, suggests that there is a real biogeographic signal that requires explanation. We therefore propose a new hypothesis to account for pterosaur spatial distributions. Powered flight enabled certain pterosaur lineages to cross geographic barriers, but such events were apparently comparatively rare (though frequent enough to overprint any vicariance signals generated by Pangaean break up). The rarity of successful dispersal might relate to ecological rather than locomotor requirements: that is, pterosaurs might have found it relatively easy to cross a barrier, but might have had difficulties in founding viable populations once they reached a new area because of differences in food sources or other ecological parameters. On those rare occasions when pterosaur lineages successfully dispersed into new regions, they apparently tended to diversify within those areas, perhaps specializing for a variety of different niches defined by body size, feeding preferences and/or habitat types. This view is supported by the observation that, despite their volant abilities, very few pterosaur species have widespread geographic distributions. Thus, pterosaur biogeographic history can be characterized as a series of occasionally successful 'sweep-stake' dispersal events, several of which led to regionally restricted sympatric radiations.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

EVOLUTIONARY TRENDS IN BODY SIZE OF THE SYNAPSID LINEAGE LEADING TO MESOZOIC MAMMALS

URBAN, Daniel, University of Illinois at Urbana-Champaign, Urbana, IL, United States, 61801; BECK, Allison, , Moline, IL, United States; MARCOT, Jonathan, Univ of Illinois, Urbana, IL, United States; SEARS, Karen, University of Illinois at Urbana-Champaign, Urbana, IL, United States

Body size influences an individual's entire existence, from its morphology to its ecology. Body size decreased during synapsid evolution until the origin of mammals, and this reduction is often linked to the evolution of mammal-like traits (e.g., endothermy). Body sizes are also assumed to have stayed relatively small and constant during the evolution of early mammals in the Mesozoic. However, despite the importance of these patterns to our understanding of mammalian evolution, the particular evolutionary mechanisms that underlie them are less clear. Previous studies have tested models across synapsid phylogeny prior to the origin of mammals, and found little evidence for a pervasive direction bias in body size evolution. However, whether the rate or mode of body size evolution changed among particular subclades, or after the origin of mammals, has not been explored quantitatively.

In this study, we used two proxies for body size (humerus and femur length) to model the pattern of body size evolution in a diverse suite of non-mammalian synapsids and Mesozoic mammals. We constructed a phylogenetic framework of non-mammalian synapsids and Mesozoic mammals compiled from various literature sources, and then used these to test standard models of trait evolution. Specifically, we statistically tested for shifts in the rates or modes of body size evolution at specific times or nodes of the phylogeny.

Results indicate that in the lineage leading to mammals, body size reduced gradually, starting ~270 mya and coincident with the appearance of therapsids. Evidence suggests that stabilizing selection significantly influenced this process. We found strong support for both different rates and modes of evolution at or near the origin of mammals, depending on the particular phylogenetic relationships used. Body size tended to evolve at a slower rate in mammals than in their ancestors, and the evolution of body size in mammals was likely influenced by directional selection. These results indicate mammals exhibited significantly different evolutionary dynamics than their synapsid ancestors, suggesting there was likely a selective advantage for small body size in these groups.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

A NEW DWARF SEAL FROM CHILE REVEALS A HIDDEN MORPHOLOGICAL DIVERSITY OF PINNIPEDS FROM THE NEOGENE OF SOUTH AMERICA

VALENZUELA-TORO, Ana M., Universidad de Chile, Santiago, Chile; GUTSTEIN, Carolina S., Universidad de Chile, Santiago, Chile; COZZUOL, Mario, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil; PYENSON, Nicholas, UCMP, Washington, DC, United States; SUAREZ, Mario E., Universidad de Chile, Santiago, Chile

Fossil phocids (true seals) from the southeastern Pacific Ocean are known from middle Miocene to early Pliocene localities of Peru and Chile. Two genera of phocids have been formally described: *Acrophoca* and *Piscophoca*, both from the late Miocene to early Pliocene of the Bahia Inglesa Formation (BIF) in Chile and Pisco Formation in Peru. *Acrophoca* and *Piscophoca* share broad cranial similarities with living phocids from the Southern Ocean and sub-Antarctic (e.g., *Lobodon*), and are relatively medium to large in body size, compared to living pinnipeds. Recent field studies (2009-2012) in sediments of the BIF have revealed the presence of remains of a new, diminutive phocid, among a large assemblage of marine vertebrates, including bony fish, sharks, cetaceans, and aquatic sloths. The new phocid specimens (SGO.PV 22105, SGO.PV 22016,

SGO.PV 21569, SGO.PV 22100, and SGO.PV 22101) consist of postcranial remains from at least three different BIF localities. SGO.PV 21569 correspond to a left humerus very small in size (~62% and ~66% of the total length of *Acrophoca longirostris* and *Piscophoca pacifica*, respectively), from the late Neogene levels of the Cerro Ballena locality. From a second locality of the same age, Norte Bahia de Caldera, an isolated left astragalus (SGO.PV 22105) and right tarsal elements (astragali, calcaneus and cuboid bone, SGO.PV 22106) from the same individual also belong to this diminutive taxon. The total length of both astragali represent an average of ~86% of *Piscophoca* and 69% of *Acrophoca* size. From a third locality, Mina Fosforita, were collected a complete left femur, also small in size (SGO.PV 22101), and a complete left juvenile femur (SGO.PV 22100) which is probably the juvenile form of the new taxon presented here. All material (except SGO.PV 22100) exhibit fused epiphyses, slight porosity, and well-developed muscle insertion scars, which are all indicative of physical maturity, even at their relatively small size. Thus, we can now report three different pinnipeds from the BIF, suggesting a community composition in the late Neogene without analog to current pinniped community in the eastern South Pacific Ocean. These new materials constitute the smallest seal found in South America, even smaller than the living pinniped, *Pusa*, based on comparative limb proportions.

Preparators' Session (Thursday, October 31, 2013, 9:00 AM)

A FINE KETTLE OF FISH: PREPARATION OF A LARGE CRETACEOUS FIELD JACKET CONTAINING MULTIPLE ASIPENCERIFORMES

VAN BEEK, Constance, Field Museum, Chicago, IL, United States, 60605

Sturgeons and their relatives, the paddlefish, belong to the order of primitive ray-finned fishes known as Asipenceriformes. True sturgeons and paddlefish first appeared in the Upper Cretaceous fossil record about 200 million years ago. They have changed little since then; and they are notable for being primarily cartilaginous, lacking a vertebral column, lacking teeth, and being partially covered with ornate bony scutes, rather than scales. These very characteristics make preparation of a single specimen a delicate, difficult and time-consuming effort.

When a quite large field jacket from the Hell Creek Formation of South Dakota was brought to the Field Museum and opened, it contained at least eight exposed complete specimens of Late Cretaceous sturgeons and paddlefish, as well as fragments and scutes. There were more fish fossils underneath the top layer, as well. The matrix was a very unconsolidated, friable and crumbly mudstone. Some of the top layer specimens had already been exposed and over-prepared before arrival to our Collections.

Once it was determined how many individuals might be in the jacket, the first step was to figure out how to consolidate such a copious amount of material, both fossil and matrix, to keep all from collapsing. The challenge would then be to remove the extensive consolidation without damaging fossil material. Preparation of these ephemeral specimens could then proceed.

A low-tech strategy was determined to be the best way to go. Continuous application of various consolidants was necessary to keep specimens and matrix intact throughout preparation. Consolidant reversal and delicate mechanical means (pin vises, art brushes, etc.) were used to make the surfaces workable to clean and define the fossil fish.

A gentle, but time-consuming approach ensured that specimens were successfully prepared with little sustained damage. A team of skilled volunteer preparators were also key in making continuous progress towards completion of this difficult project.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

TESTING ADAPTIVE HYPOTHESES FOR ANTERIOR CERVICAL FUSION IN CERATOPSIA

VANBUREN, Collin S., University of Toronto, Toronto, ON, Canada, M5S 3B2; CAMPIONE, Nicolás E., University of Toronto, Toronto, ON, Canada; TANKE, Darren H., Royal Tyrrell Museum, Drumheller, AB, Canada; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

The neoceratopsian syncervical is a coalesced element composed of the first three cervical vertebrae. Although recent studies have ascertained the homologies of this structure, its function has been less intensely studied. This structure has been hypothesized to have evolved as an adaptation within Ceratopsia to 1) support the large skull, or 2) act as a buttress for the skull during intraspecific combat. Here we test these hypotheses within a phylogenetic context for the first time by assessing the predictions that enlarged head size and/or cranial weapons (brow/nasal horns) must have evolved in concert with, or before, cervical fusion.

To test the head-support hypothesis, we used a dataset of 47 extant tetrapods and 16 non-ceratopsian dinosaurs to first assess previously proposed thresholds for determining large relative skull size. Results indicate that the three previously proposed thresholds for large relative head size in Ceratopsia represent averages, rather than extremes in terrestrial vertebrates when basal skull length is considered. Importantly, the extant comparisons do not indicate that the majority of ceratopsians that have syncervicals have exceedingly large skulls relative to body size, except when the length of the thin frill is included in skull length. Recent models indicate that the frill makes up <2% of body mass suggesting that it would have minimal contribution on skull mass.

Despite the observation that most ceratopsians do not have large relative heads among terrestrial vertebrates, proper testing of the functional hypotheses requires that these characters be assessed within Ceratopsia. Maximum likelihood ancestral state reconstruction of head size proxies onto a complete ceratopsian phylogeny and discrete character optimizations of cranial weaponry, head size, and the syncervical indicate that neither the evolution of cranial weaponry nor head size correlates with the origin of the syncervical. We therefore reject both hypotheses as the selective pressure(s) for syncervical origin. We cannot reject the possibility that the syncervical was exapted in ceratopsids for combat and/or head support. Nevertheless, strong functional hypotheses for the syncervical should reflect its origin in small-bodied neoceratopsians. Cervical fusion has evolved independently in a number of extant terrestrial taxa, including armadillos, rodents, and hornbills; future research should focus on these taxa as models to predict ecologies and/or behaviors associated with cervical fusion early in neoceratopsian evolution.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE UNIQUE PREMAXILLARY DENTITION OF *YINLONG DOWNSI*, AND THE MORPHOLOGY, FUNCTION, AND EVOLUTION OF PREMAXILLARY TEETH IN CERATOPSIA

VARRIALE, Frank, King's College, Wilkes-Barre, PA, United States, 18711

Many ceratopsians possessed premaxillary teeth, but the function of these teeth is largely unstudied. Here, dental microwear and gross morphology are examined to better document and interpret these structures.

The most basal ceratopsian *Yinlong downsi* possesses three premaxillary teeth. The first shows a vertical wear facet and a basal horizontal shelf lingually, with apicobasally-oriented microwear and exposed dentine. These features support formation via occlusion with the lower beak. The second tooth also has a vertical lingual surface that is planar, and this surface has previously been interpreted as a wear facet. This surface lacks microwear, and no dentine is exposed. Denticles occur at the mesial and distal edges of the tooth, and the base of each denticle is unworn and continuous from the labial side to the lingual surface. Thus, the flat lingual surface of the second premaxillary tooth is primary morphology and not due to wear, imparting marked heterodonty and a more dagger-like appearance than previously thought. These features are seen in teeth of both sides.

Other ceratopsians do not approach this degree of premaxillary tooth heterodonty. The teeth of *Archaeoceratops* and *Liaoceratops* are slightly labiolingually compressed cones with bulbous bases, and the teeth of *Protoceratops* are simple conical pegs. Wear facets occur in all three taxa. Here, facets show exposed dentine, but facet shape varies intra- and interspecifically. Some facets are planar relative to the unworn shape, supporting formation via attrition with the beak. Others are slight losses of the enamel, leaving the primary shape little altered. This indicates that some teeth may not be in contact with the beak or that initial formation of a facet may be due to food-tooth abrasion followed by rhamphothecal attrition as eruption progresses.

Microwear on premaxillary facets indicates that these teeth were functional, perhaps for cropping vegetation. However, the caniniform daggers of *Yinlong* may have functioned as intraspecific agonistic display structures, like those of extant chevrotain and moschid deer, and as that hypothesized for heterodontosaurids. Premaxillary teeth were lost at least three times during ceratopsian evolution, suggesting functional changes associated with mastication or other behaviors.

Symposium 1 (Wednesday, October 30, 2013, 11:30 AM)

WOUNDING-TOOTH GROWS UP: ONTOGENY IN THE CRETACEOUS THEROPOD *TROODON FORMOSUS*

VARRICCHIO, David, Montana State Univ, Bozeman, MT, United States, 59717

An ontogenetic series for the theropod dinosaur *Troodon formosus* permits comparison of limb and element proportions, bone texture, prominence of bony features, apomorphies, degree of skeletal fusion, size and chronologic age. All specimens come from a 1.4 Ma span of the Upper Cretaceous Two Medicine Formation, Montana, USA and include embryonic remains (Museum of the Rockies [MOR] 246), a small juvenile (MOR 430), a large juvenile (MOR 563), a multi-individual assemblage (MOR 553), and an adult associated with eggs (MOR 748). Thus, the sample spans a 10-fold increase in linear dimensions (e.g. greatest femoral lengths from 32.7 to over 330 mm) and likely an over 100-fold increase in weight. Histologic sampling of femora and tibiae show these elements to represent pre-hatching (MOR 246), several-months (MOR 430), one-year (MOR 563), and 12-year (MOR 748) old individuals.

Within the hind limb, more distal elements become shorter relative to the femur through ontogeny. Although even the phalanges of a given pedal digit express this pattern, relative digital length remains constant with age. Both humerus and femur maintain their distinctive curvature as well as form and placement of the deltopectoral crest and proximal trochanters, respectively. Nevertheless, all hind limb elements including pedal phalanges become increasingly more robust late in ontogeny. In contrast, dorsal centra shift early in ontogeny from a long, low form (centrum length/height ratio of about 1.25) to a short, deep form (ratio of 0.80 to 0.85). Smooth bone surface replaces more porous texture and more prominent muscle scars and detailed articular surfaces occur late in the growth of limb bones. Nevertheless, some important apomorphies (e.g., larger, more broadly rounded maxillary fenestra; lateral groove on the dentary; pneumatic quadrate) appear in embryonic specimens. Individuals segregate into three age-fusion stages: stage I (by several months) - neurocentral sutures of caudal vertebrae fused; stage II (by one year) - all neurocentral sutures fused; stage III (perhaps 10 or more years old) - fusion of sacral vertebrae into sacrum, astragalus with calcaneum, and tarsometarsus. Mature bone surface texture, the definition of articular surfaces and attachments, element robustness and not neurocentral fusion appear to correlate with sexual maturity in *Troodon*. Observed ontogenetic changes are complicated and not readily predicted from other taxa. This highlights the taxon-specific nature of growth and the importance of histology in assessing ontogenetic maturity.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

THE LARGEST LOWER DEVONIAN ARTHRODIRE (PLACODERMI) *ANTINEOSTEUS RUFUS* SP. NOV., FROM THE EMSIAN OF THE BARRANDIAN AREA (CZECH REPUBLIC)

VASKANINOVA, Valeria, Charles University, Faculty of Science, Prague, Czech Republic

*Placoderms are subordinate faunal elements in the Devonian of the Barrandian area (central Bohemia). The most abundant placoderm remains occur in the basal Lochkov Formation (Lochkovian) whilst higher up in the section they are rare.

Two large dermal bony plates, described as *Antineosteus rufus* sp. nov., were discovered in the Emsian strata. The plates were prepared with electric needle and observed under optic and electronic microscope. The fragment of a right central plate of the head shield is some 13 cm long and wide, but its original size was substantially larger. The medial suture with the left central plate is poorly preserved but seems to be slightly curved. The shape of the posteromedial margin shows that the anterior margin of the nuchal plate was wide and concave. The second plate, right anterior dorsolateral, is slender in the anterior part and widens gradually posteriorly. The anterior part of the plate along with the articular condyle is exposed to the inner bone structure forming a spiny projection in the midline. The articular condyle points dorsally, the shape of the articular area being long, slender and concave. Both plates are covered with a strongly damaged dermal ornament. On a few spots the typical arthrodire ornament, oval tubercles with a shallow ridge separating the tip, is visible. Towards the outer margins of both plates, the tubercles tend to be arranged in lines.

Both plates show affinity to the family Homostiidae, with numerous characters in common with *A. lehmani*. According to the size of the incomplete plates, the total length of the animal had exceeded 250 centimetres, having been the largest Lower Devonian arthrodire known so far. It was much larger than the Australian *Dhanguura* and *Cathlesichthys*, considered to be comparable in size to *Tityosteus rieversae*.

Primitive brachythoracid arthrodires (a group comprising the homostiids) in the Lower Devonian are known from various regions of the world: Morocco, Aragón, Rhineland, Minusinsk Basin and south-eastern Australia – the northern and eastern continental margins of Gondwana - and from Spitsbergen; representing mostly shallow tropical to subtropical marine environments. The occurrence of *A. rufus* is in favor of the possible migration route of this group along the northern continental margin of Gondwana.

Symposium 4 (Saturday, November 2, 2013, 10:15 AM)

LATITUDINAL GRADIENTS AND PROVINCIALITY IN CHONDRICHTHYAN FAUNAS FROM THE LATE CRETACEOUS NORTH AMERICA

VAVREK, Matthew J., University of Alberta, Edmonton, AB, Canada, T6G 2E9; HARRISON, Luke, McGill University, Montreal, QC, Canada; CUMBAA, Stephen, Canadian Museum of Nature, Ottawa, ON, Canada; BECKER, Michael, McGill University, Montreal, QC, Canada; LARSSON, Hans, McGill University, Montreal, QC, Canada

The latitudinal diversity gradient (LDG) of extant biodiversity is a robust biogeographic pattern: marine and terrestrial diversity decreases towards high latitudes. A number of processes have been hypothesized to drive this LDG, with climate-related processes most commonly proposed. High latitude paleocommunities offer unparalleled insight to the history and formation of this pattern because they preserve communities assembled in unique combinations of temperature and photoperiod that have no modern analogue. Here we describe a new and diverse marine chondrichthyan assemblage from the Late Cretaceous of the Canadian Arctic. The assemblage is composed of isolated teeth and tooth plates of at least seven taxa from the Kanguk Formation (Santonian to Maastrichtian) of Bylot Island, Nunavut, Canada. This constitutes the northern-most sample of chondrichthyan diversity from this period. Although Late Cretaceous temperatures were globally elevated, polar regions were especially warmer, resulting in an equator-to-pole gradient that may have been half as steep as it is today. Annual average temperatures in the Arctic may have been 15°C higher than present, and the annual range of temperatures was likely reduced, creating a much more equable climate. We compare the Bylot Island assemblage to approximately contemporaneous and well-sampled chondrichthyan localities of North America to test for the presence of an LDG and hypotheses of provinciality along the Western Interior Seaway. We find no support for the presence of an LDG in chondrichthyans during the latest Cretaceous, and our results suggest that there was a reduced or absent latitudinal gradient in shark diversity at this time. These results suggest that the LDG may have been more associated with temperature gradients than with insolation. We find no strong signal of latitudinally delimited provinciality for the whole seaway, although there is a strong longitudinal signal that may be an artifact of proximity to the paleoshoreline.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

PARTIAL SKELETON OF A TOOTHED WHALE (ODONTOCETI, CETACEA) FROM THE MID TO LATE MIOCENE GATUN FORMATION, PANAMA

VELEZ-JUARBE, Jorge, Florida Museum of Natural History, Gainesville, FL, United States, 32601; WOOD, Aaron, Florida Museum of Natural History, Gainesville, FL, United States; RIDGWELL, Nicole, University of Colorado, Boulder, CO, United States; BLOCH, Jonathan, Univ of Florida, Gainesville, FL, United States; MACFADDEN, Bruce, Univ of Florida, Gainesville, FL, United States

Fossils of marine mammals from Central America are rare, with only a handful of relatively incomplete specimens described from Nicaragua, Costa Rica and Panama. This has thus far limited our understanding of cetacean diversity in the New World Tropics. Here we report a newly discovered partial axial skeleton of an odontocete whale from the late Miocene Gatun Formation, Panama Canal Basin. It is the most complete cetacean fossil yet known from the middle Miocene of Central America, with articulated cervical, thoracic, and lumbar vertebrae, and ribs, allowing for insights into its affinities as well as aspects of its feeding behavior. Characteristics of the vertebral column in the Gatun odontocete are unique among known Neogene odontocetes, these include cervical vertebrae with centra that are nearly as long as high, and long lumbar vertebrae with a centrum length/centrum height ratio greater than 1. The third through sixth cervical vertebrae (C3-6) have long, ventrolaterally oriented transverse processes, with those of C6 nearly twice as large as those of C3-5 and C7. These features of the vertebral column are otherwise known in the early Miocene platanistoid *Allodelphis pratti*, and the fossil from the Gatun is herein referred to that genus. In addition, the ribs of the Gatun platanistoid are partially osteosclerotic, a characteristic seen in mammals that feed on marine vegetation (i.e. sirenians), benthic invertebrates (i.e. sea otters), as well as in early whales (pakicetids). Taken together, these features indicate that the Gatun *Allodelphis* likely foraged at shallow depths, an interpretation that is consistent with the depositional environment of the Gatun Formation at about 25 meter of depth. *Allodelphis*, otherwise known from the early Miocene of the northern eastern Pacific region, is the first middle Miocene platanistoid known from the tropical Americas and hints at a much greater cetacean diversity in the region than at present.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ANALYSIS OF DESICCATION CRACK PATTERN FOR QUANTITATIVE INTERPRETATION OF DINOSAUR TRACKS

VIEFHAUS, Hanna, Ruhr University, Bochum, Germany; NGUYEN TUAN, Long, Ruhr University, Bochum, Germany; LINS, Yvonne, Ruhr University, Bochum, Germany; MARTY, Daniel, Office de la culture, Section d'archéologie et paléontologie, Paléontologie A16, Porrentruy 2, Switzerland; SCHANZ, Tom, Ruhr University, Bochum, Germany

This study addresses questions related to how much dinosaurs weighed and how they moved, with a new approach based on dinosaur tracks. Fossil tracks may be used to back-calculate the properties of the subsoil such as geometrical and constitutive parameters (layer thickness, strength and stiffness). The purpose of this work is to deduce the soil properties at the time of track formation in order to estimate the pressure applied on the soil and hence make conclusions about the weight of the dinosaur that left the tracks. This is done by simulating processes during and after track formation. At many tracksites, radial and axial cracks around the tracks are frequently observed. It is supposed that the origin of these cracks can be explained by desiccation right after track formation rather than by the mechanical load.

In order to confirm this assumption and to allow for a precise interpretation of dinosaur tracks, a series of laboratory tests and numerical simulation with Finite Element Analysis were carried out, designed to mimic hydro-mechanical processes during desiccation. Within the experiments, a range of environmental humidity and temperature was considered. The laboratory experiment showed that both the radial and axial cracks can be best explained due to desiccation processes.

The numerical simulation was performed to better understand and explain the cracking mechanism in and around dinosaur tracks caused by diverse physical processes. In this research, the coupled process has been numerically simulated in 3D by means of thermo-hydro-mechanical analyses available in CODE_BRIGHT software. The stress-strain behavior is considered by an appropriate thermo-elasto-plastic model which is a modification of the Barcelona Basic Model accounting for soil swelling and shrinking with the change of water content and temperature. Based on the analysis of the tensional stresses, it was found that the high tension stress around the track due to soil shrinkage phenomena may cause cracks in radial and axial directions.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

INSIGHTS INTO THE MICROBIAL DEGRADATION OF BONE IN MARINE ENVIRONMENTS: GENETIC SEQUENCING OF BIOFILMS FROM LAB-SIMULATED WHALE-FALLS

VIETTI, Laura, University of Minnesota, Minneapolis, MN, United States, 55413

Evidence of microbial activity is prevalent on marine vertebrate fossils. Since microbes are sensitive to environmental conditions, evidence of their activity may provide environmental, temporal, and diagenetic information pertinent for taphonomic reconstructions. However, little is known about which specific microbes target decaying bone, which limits the use of microbial activity in taphonomic analyses. To better understand which bacteria are responsible for bone decay, I simulated aspects of natural whale-falls by adding defleshed bones to mesocosms made of natural marine mud and water. Sequencing the V3 region of the 16S rRNA taxonomic identifier gene and fluorescence in situ hybridization (FISH) were used to study the composition of bone-associated microbial communities. I then correlated these bacterial communities with bone surface and histologic changes using microscopic, SEM, and FISH analyses. Sequencing results indicate that the dominant bacterial groups exploiting bone nutrients were taxa within the Alphaproteobacteria, Deltaproteobacteria, Gammaproteobacteria, and Epsilonproteobacteria, as well as Bacteroides and Firmicutes. Relative abundances of these bacterial groups changed throughout the experiment, reflecting three general community trends: 1) an early diverse community degrading large organic molecules into smaller end-products, 2) an intermediate community dominated by sulfide-oxidizing bacteria, and 3) a more diverse late stage community primarily involved in nitrogen and sulfur cycling. Histologic and bone surface damage was observed after two months of microbial activity and is characterized by localized degradation points near Haversian canals and bone trabeculae. After four months of microbial activity, a thin rim (0.5 mm) of brecciated bone and bone dissolution features were observed on bone surfaces. Bones from sterilized control mesocosms lacked comparable indication of bone alteration, suggesting that observed bone damage was microbially mediated. Histologic analyses of fossil bones recovered from marine sediments have similar bone destruction features, indicating that they may have experienced bacterial decomposition histories comparable

to the whale-fall mesocosms. My results provide the first glimpse into which bacteria are responsible for microbial degradation traces in fossil bone. Identifying indicators of specific microbial processes in fossil material may provide the starting point for using evidence of microbial activity in more detailed taphonomic analyses.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

LYSTROSAURUS BONEBED ORIGINS AND THEIR PALAEOENVIRONMENTAL IMPLICATIONS FOR THE EARLIEST TRIASSIC KAROO BASIN, SOUTH AFRICA

VIGLIETTI, Pia, University of Witwatersrand, Johannesburg, South Africa; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa; COMPTON, John, University of Cape Town, Cape Town, South Africa; BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa

Earth experienced the "mother of all mass extinctions" at the end of the Permian Period 252.3 million years ago (Ma). Despite an estimated 75 to 90% loss of species globally in both marine and terrestrial realms across the Permian-Triassic Boundary (PTB), many of the terrestrial tetrapods in southwestern Gondwana survived and simultaneously began to occupy vacant niches of the earliest Triassic. Preserved in the Karoo Basin of South Africa is an almost continuous stratigraphic record of terrestrial sedimentation through the PTB that hosts a fossil record of ecosystem collapse, survivorship and recovery. The adaptation of the therapsids from the Lower Triassic *Lystrosaurus* Assemblage Zone to a highly seasonal (monsoonal), semi-arid climate is associated with changes in modes of fossilisation. Isolated dicynodont skulls and postcranial elements are commonly found in latest Permian deposits. However, in the earliest Triassic deposits, dicynodont fossils occur as articulated "curled up" skeletons and multi-individual monotaxic bonebeds. Lack of epiphyses and relatively small skull lengths confirm that the bonebeds comprise several subadult *Lystrosaurus declivis* carcasses. Lack of evidence for significant hydraulic bone concentration as well as clusters of ribs in life position are evidence that complete carcasses were present at the site of death, and suggests that animals behaviourally congregated before perishing together. The bonebeds are hosted by floodplain mudrocks containing carbonate nodules and sand-filled mud cracks. These fine-grained deposits are capped by tabular sandstones and nodule conglomerates, which are indicative of rapid deposition during waning floods. These observations support a semi-arid, monsoonal climate at a higher latitude (~55ºS) compared to the modern Karoo Basin. The presence of vertebrate burrow casts on bonebed horizons and evidence of shelter sharing suggest that tetrapods were attempting to escape seasonal climatic extremes. This study concludes that the *L. declivis* bonebeds represent aggregating subadults that died en masse during earliest Triassic drought events in the Karoo Basin.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

REDESCRIPTION OF *CEARADACTYLUS ATROX* (PTEROSAURIA, PTERODACTYLOIDEA) FROM THE EARLY CRETACEOUS ROMUALDO FORMATION (SANTANA GROUP) OF THE ARARIPE BASIN, BRAZIL

VILA NOVA, Bruno, Universidade de Sao Paulo, Ribeirao Preto, Brazil; SAYÃO, Juliana, Universidade Federal de Pernambuco, Recife, Brazil; KELLNER, Alexander, , Rio de Janeiro,

Based on one of the first pterosaur skulls unearthed from the Romualdo Formation (Araripe Basin), *Cearadactylus atrox* has caused disagreement among paleontologists regarding its relationships. Ranging from an ornithocheirid to a ctenochasmatid pterodactyloid pterosaur, some authors even regarded this species as representing a distinct suprageneric clade ("Cearadactylidae"). Further preparation of the holotype, now housed at the Museu Nacional/UFRJ (MN 7019-V), revealed several new features allowing a redescription and re-evaluation of the phylogenetic position of this species. Detailed preparation showed that the rostral end of this specimen had been glued inverted to the skull, causing incorrect anatomical interpretations. There is no rostral gap and the expanded rostral end of the premaxilla is larger than the dentary. The remains of a premaxillary sagittal crest were identified and start at the third rostral tooth. *Cearadactylus atrox* is considered a valid taxon that can be diagnosed by a dentary groove which bifurcates at the rostral end, an orbit occupying a high position relative to the nasoantorbital fenestra, and comparatively small number of teeth (32–36 maxillary, 22–26 mandibular) decreasing in size towards the posterior end. The rostral teeth are elongated, thin, and slightly curved posteriorly, and directed somewhat forward and outward. Starting from the 6th tooth, the teeth become smaller, more vertical, and straighter, so that they are less curved toward the posterior region. Although the dentition is similar in size to that of anhanguerids and *Brasileodactylus*, *C. atrox* lacks the typical *Anhanguera* feature of the fifth and sixth teeth being smaller than the fourth and seventh. A phylogenetic analysis places this taxon as the sister group of the Anhangueridae, with the European taxon '*Ornithocheirus' compressirostris* as the next closest related taxon.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

DOES ECOLOGY OR TAPHONOMIC BIAS DESCRIBE THE DIFFERENCES IN MAMMALIAN COMMUNITIES IN THE PLIOCENE HADAR AND TURKANA BASINS, ETHIOPIA AND KENYA? A QUANTITATIVE APPROACH

VILLASEÑOR, Amelia, George Washington University, Washington, DC, United States, 20052

Across space and time, *Australopithecus afarensis* evinces wide variation in relative abundance at the sites in which it is found. Though known from Hadar, Maka, Dikika, and Woranso-Mille, Ethiopia; Turkana, Kenya; and Laetoli, Tanzania, approximately 90% of the known *A. afarensis* hypodigm comes from the site of Hadar. Paleoecological reconstructions have shown that *A. afarensis* inhabited a wide range of habitats: from woodlands adjacent to rivers and lakes at Hadar, to more open and arid habitats at Turkana, and wooded to closed habitats at Laetoli. Given that local environments affect population size and create distinctive selective pressures, the hypothesis that variation in *A. afarensis* abundance and distribution was due to ecological differences across space and time deserves attention. While the abundance and proportion of associated fauna differ between basins, it is not clear if these differences are due to ecological effects or random effects associated with different depositional environments and taphonomic histories. This project tests the hypothesis that taphonomic factors have driven the appearance of higher abundance and faunal richness at Hadar than in the Turkana basin. At Hadar, 32 mammalian species greater than 5kg are known, while at East Turkana, only 18 are known; however, the total fossil assemblage for Hadar is 710 individuals and for Turkana it is 77. To test the hypothesis that the difference in species richness (alpha diversity) is an artifact of the disproportionate sample sizes, the Hadar assemblage was rarefied using randomization to equal that observed for the Turkana basin. The 95% confidence interval for the rarefied Hadar distribution is 18.15 to 28.06 species; thus, the observed richness for Turkana lies outside the 95% confidence intervals ($p< 0.05$). The difference in taxonomic richness between the two sites is not simply an artifact of the disproportionate sample sizes. In regard to beta diversity, the observed Jaccard Similarity value (0.136) for the Hadar and Turkana basins indicates few shared species and when compared to a randomized distribution of Jaccard Indices, it lies outside the 90% confidence interval ($p= 0.036$). Thus the Hadar and Turkana basins share fewer species than expected if species are randomly distributed across space. This study suggests that the Hadar and Turkana basins may have been separate centers of endemism, lending credit to the idea that Hadar may be a core environment for hominins and other mammals, worthy of future study.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

FEMUR DIMENSIONS AND BODY SIZE ESTIMATION TO TRACK PREHISTORIC POPULATION CHANGES IN THE SOUTHERN SEA OTTER *ENHYDRA LUTRIS NEREIS*.

VILLAVICENCIO, Natalia , University of California, Berkeley, CA, United States, 94720-3140; TOMIYA, Susumu, University of California, Berkeley, CA, United States; HOFMEISTER, Jennifer, University of California, Berkeley, CA, United States; LINDBERG, David, University of California, Berkeley, CA, United States

Regression analyses of bone dimensions relative to body size measurements are commonly used to estimate body size from fossil samples. While cranial and dental measurements are frequently used, limb bone dimensions have been shown to be highly reliable in terrestrial mammals. Here, we analyzed the relationship between body size and femur dimensions in the sea otter, *Enhydra lutris nereis*. In contrast to other members of the family Mustelidae, *Enhydra* spends most of its life in water, which is reflected in its overall anatomy. Our goal was to estimate body size of ancient Holocene populations of *E. lutris nereis* from the abundant postcranial elements found at the archaeological site of the Emeryville shell-mound in San Francisco, California. These remains date to around 1800 -2400 years before present (yr BP), and they represent otters that were hunted by prehistoric humans.

Femur length and diameter were measured from skeletons of adult modern specimens (n=25) with known body masses and body lengths. We used simple linear regression models to relate limb size to body size. Correlation coefficients were fairly low ($r<0.45$) between body weight and femur dimensions among modern specimens; this might reflect the intra-annual variation in body mass known to occur in modern sea otters. The highest correlation coefficient was detected between femur length and standard body length ($r=0.58$) and we used this linear regression result to derive a preliminary equation to estimate body size. The prehistoric samples of femora from the Emeryville shell-mound were assigned to 7 different temporal groups. The preliminary estimation of body lengths in older samples generally showed values close to the mean body length of modern sea otters. None of the older group of samples showed shorter body length values than the modern specimens. The samples that dated from ~1860-2050 yr BP were, on average, significantly larger in body length ($p<0.05$). Given the low correlation coefficient attained for the predictive equation, it is still unclear whether this change in body size should be regarded as biologically significant. However, if it is, it would be consistent with changes in body size reported for other vertebrates that were also hunted by humans at the Emeryville shell-mound site.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

THE INTERNAL CRANIAL MORPHOLOGY OF THE EXTINCT BONE-CRACKING HYENA *PLIOCROCUTA PERRIERI* (CARNIVORA, HYAENIDAE)

VINUESA, Víctor, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; MADURELL-MALAPEIRA, Joan, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; FORTUNY, Josep, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain

Hyaenids currently display a decreased diversity and disparity compared to those displayed by this group in the Miocene, so that three out of the four extant hyaenids (*Crocuta crocuta*, *Hyaena hyaena* and *Parahyaena brunnea*) belong to the bone-cracking ecomorphotype—to which several extinct species, such as *Pachycrocuta brevirostris* and *Pliocrocuta perrieri*, have been attributed. The internal cranial morphology of such extinct taxa might provide significant data for our understanding of hyaenid evolution from both phylogenetic and paleobiological viewpoints. With the aid of computed tomography (CT) techniques, here we report the internal cranial morphology of *P. perrieri*, based on a well-preserved, unpublished cranium from the late Pliocene (MN16) of Villarroya (N Iberian Peninsula). Particular emphasis is put on the comparison of endocranial morphology and relative brain size with extant hyaenids, in order to make paleobiological inferences on cognition and social behavior in this taxon.

Our results show that the frontal sinuses of *P. perrieri* are caudally extended, as in extant and other extinct bone-cracking hyenas. Among extant bone-cracking hyenas, the brain morphology (with a poorly-developed anterior portion) and sulcal pattern (e.g., the shape and position of the cruciate, coronal and presylvian sulci) of *Pliocrocuta* are more similar to those of *Hyaena* and *Parahyaena* than to those of *Crocuta*. These features might suggest a closer phylogenetic link with the two former genera instead of *Crocuta*—thereby contradicting recent phylogenetic hypotheses for these taxa—although additional data on other extinct hyaenids would be required to determine the polarity of change. With regard to relative brain size, our results for *Pliocrocuta* indicate a lower degree of encephalization compared to *Crocuta*, which is the extant hyaenid displaying more developed social behaviors. Our results further show that *Pliocrocuta* displays a relatively small anterior region of the cerebrum compared to all extant bone-cracking hyenas, allowing us to infer the possession of a poorly developed frontal cortex. Overall, our results indicate that *P. perrieri* possessed less developed cognitive abilities than extant bone-cracking hyenas for processing the information associated with complex social behaviors, and suggest instead a poorly social or even solitary life style for the former.

Preparators' Session (Thursday, October 31, 2013, 10:30 AM)

ROCK, PAPER, ADHESIVE: DEVELOPING VARIOUS METHODS FOR THE USE OF PAPER IN ARCHIVAL FOSSIL REPAIR

VITAL, Demetrios, American Museum of Natural History, New York, NY, United States, 10024; DAVIDSON, Amy, American Museum of Natural History, New York, NY, United States; ZDINAK, Alan, American Museum of Natural History, New York, NY, United States; BROWN, Gregory, Univ of Nebraska State Museum, Lincoln, NE, United States

The previous use of fibrous and granulated cellulose as adhesive thickeners is well documented. These techniques were elaborated upon using pulped and intact sheets of archival paper impregnated with Paraloid B-72 ethyl methacrylate copolymer in 20 to 50% ethanol or acetone solutions. The first technique is the use of adhesive-impregnated pulped paper to fill and structurally support gaps ranging from small cracks to areas of major loss where there is limited or no contact between joins. A second technique is the use of adhesive-impregnated paper to build a structurally supportive armature to which a paste of adhesive mixed with pulped paper or pulverized matrix can then be applied. A third technique involves using such a paper armature to maintain association of elements of a fossil in a field jacket during preparation. As a thermoplastic resin, Paraloid B-72 can be manipulated after setting with the application of directed low heat, a characteristic which allows the impregnated paper armature to be adjusted and re-shaped after the fossil is removed from the jacket. A fourth technique is analogous to the external "bandages" of adhesive-impregnated fiberglass that have been presented previously for use in fossil preparation. Adhesive-impregnated archival paper has been used in the same way, providing similar benefits. These techniques are simple, archival, cost-effective, and are beneficial in diverse scenarios faced by fossil preparators.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW PATTERNS OF SPATIOTEMPORAL VARIATION IN THE EASTERN BOX TURTLE (*TERRAPENE CAROLINA*) AND THEIR INFLUENCE ON EVOLUTIONARY HYPOTHESES

VITEK, Natasha, The University of Texas at Austin, Austin, TX, United States, 78751

An understanding of variation within a given species can inform our understanding of patterns and drivers of evolution. However, variation often is poorly understood within a given species, especially in a temporal context, because of lack of research or lack of a suitable fossil record. The eastern box turtle, *Terrapene carolina*, presents an excellent opportunity to explore spatiotemporal patterns of variation because the species has high levels of morphological variation in skeletal characters that can be studied through time. Importantly, *T. carolina* also has a published fossil record that includes shells that are complete enough and abundant enough to be used in statistical analyses of shape. Variation within this species, both in the modern and fossil records, often is interpreted as subspecific variation in the literature.

To explore patterns of spatiotemporal variation, I used geometric morphometrics to quantify the shape of 200 modern and 44 fossilized shells of *T. carolina*. First I analyzed differences in the shapes of nominative subspecies in the modern record. Then I compared the results from the modern biota to those of the fossilized specimens.

Results of pairwise comparisons indicated significant differences between subspecies, but the results of assignments tests and canonical variates analyses indicated insignificant or unreliable differences. In sum, results indicate that differences between subspecies are more statistically significant than they are biologically significant, and may not be the best explanation for patterns of variation in the modern record. More importantly, statistical analyses are unreliable for the identification of individuals of a subspecies based on skeletal features. That means that extant subspecies cannot be identified in the fossil record.

Differences between fossilized and modern shells were greater than the differences between various extant subspecies, further indicating that applying subspecific identifications to fossils is inappropriate. Variation in fossilized specimens is best characterized by the presence of three morphotypes that do not correspond to the current taxonomic arrangement for *Terrapene*. Furthermore, two of the morphotypes co-occur in the same strata, and represent a unique situation not seen in the modern biota. My results reveal a remarkably more complex pattern than previously proposed. They support an evolutionary history different from previous hypotheses that masked evolutionary complexity by recognizing artificially circumscribed taxa.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

REDISCOVERING AMEGHINO'S FOSSIL LOCALITIES OF THE SANTA CRUZ FORMATION (EARLY MIOCENE) IN THE SANTA CRUZ RIVER VALLEY, SANTA CRUZ PROVINCE, ARGENTINA

VIZCAÍNO, Sergio, Museo de La Plata, La Plata, Argentina; KAY, Richard, Duke Univ Medical Ctr, Durham, NC, United States; FERNICOLA, Juan, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; BARGO, M.Susana, Museo de La Plata, La Plata, Argentina; CUITIÑO, José, Universidad de Buenos Aires, Buenos Aires, Argentina

The Santa Cruz Formation (SCF, Early Miocene), crops out in Santa Cruz Province, Argentina from the Atlantic coast westward to the Andes. The first vertebrate fossils of this formation were found in the vicinity of the Gallegos, Chico, and Santa Cruz rivers. In 1887, Carlos Ameghino collected over 2000 specimens along the Santa Cruz River. These were described by Florentino Ameghino in 1887 and 1889, and largely formed the basis for what we now call the Santacrucian Age. In subsequent years, Carlos Ameghino discovered further localities of SCF on the Atlantic coast, especially remarkable for their better state of fossil preservation, and also found fossils close to the Andes. Florentino Ameghino ascribed the Atlantic coastal specimens to the Santacrucian and proposed that the westerly localities near Lago Argentino were somewhat older than those in the east. For more than a century since, fossil recovery in the Santacrucian concentrated on the eastern localities (between Monte León and Gallegos River) and western ones (around Lake Argentino), with almost no prospecting of exposures along the Santa Cruz River. In recent fieldwork supported by notes and letters of the Ameghinos, we have relocated the collecting localities of Carlos Ameghino on the south bank of the Santa Cruz River, identified marine oysters levels (an important marker for the base of the formation) observed by him at the easternmost outcrop, and recovered more than 2000 fossils including Santacrucian mammals (primates, rodents, marsupials, ungulates, and xenarthrans), birds, reptiles, and frogs. The taxonomic composition of the fauna indicates stronger affinities with the faunas from the localities in the East: primates and frogs were previously recorded only in the East and there are not notohippid ungulates, previously recorded only in the west. Stratigraphic and sedimentologic analysis of the SCF along the Santa Cruz River revealed a gradational transition of this unit from the underlying early Miocene marine Monte León Formation. The SCF is composed of claystones, siltstones, and minor sandstones, with abundant pedogenetic features, deposited in a low-energy fluvial environment. Abundant pyroclastic intercalations allowed us to collect samples of more than 10 datable levels that will establish a chronostratigraphy between eastern and western outcrops and permit an evaluation of competing hypotheses about whether the east to west faunal differences are explained by temporal or geographical and paleoecological ones.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

PTEROSAUR SIZE CLASSES IN THE TRANSYLVANIAN LATE CRETACEOUS?

VREMIR, Matyas, Transylvanian Museum Society, Cluj-Napoca, Romania; NAISH, Darren, University of Southampton, Southampton, United Kingdom; DYKE, Gareth, University of Southampton, Southampton, United Kingdom

Diverse Campanian-Maastrichtian vertebrate assemblages are known from Romania, from both the Hateg and Transylvanian basins. We review the pterosaur fossil record of small, medium, large and gigantic forms.

At least two dozen specimens are known from the Romanian Cretaceous and comprise at least four taxa. Specimens come from similar environments, but occur in both Campanian and Maastrichtian units within the Hateg and Transylvanian basins. All known Romanian giant azhdarchids, most famously *Hatzegopteryx thambema*, come from late Campanian-late Maastrichtian estuarine-coastal environments and continental settings, while other pterosaurs, representing a range of sizes, come from the same continental environment. The following pterosaur-bearing sites are known in Transylvania: Pui, Sinpetru, Vadu, the Ciula-Densus Formation (all in the Hateg Basin), the Bozes Formation and the Sebes Formation (Transylvanian Basin).

Included among the small-sized specimens (wingspans estimated at less than one meter) are maxillary and mandibular fragments of an indeterminate pterosaur from Oarda (Sebes Formation). Additionally, a notarium, femur and humerus that might be referable to indeterminate pteranodontids are known from Sinpetru in Hateg.

Medium-sized specimens (wingspans estimated at ca. 3 meters) include a third wing phalanx from Boita (Ciula-Densus Formation), a pterodactyloid scapula, humerus and azhdarchid mid-cervical from Pui, and the holotype of *Eurazhdarcho langendorfensis* from Lancram-Glod (Sebes Formation).

Large-sized specimens (wingspans estimated at ca. 5-6 metres) include a femoral shaft from Tustea (Ciula-Densus Formation), an azhdarchid coracoid and vertebral corpus from Vadu (Sinpetru Formation), and the anterior part of a mandibular symphysis associated with poorly preserved wing bones, all from the Sebes-Glod site (Sebes Formation).

Pterosaurs of unusual size (wingspans estimated at ca. 10-11 meters) include the holotype of *Hatzegopteryx thambema* (palatal fragment, occipital skull, proximal humerus) from Valioara, a mandibular symphysis, also from Valioara, a dorsal rib from Pui (Sinpetru Formation), and a wing phalanx fragment from Petresti Arini (Bozes Formation). Additional specimens–all discovered in the Sebes Formation and belonging to indeterminate azhdarchids–are known, including a seventh cervical, the distal end of a humerus, a proximal syncarpal and an unfused coracoid.

Documented fossils inform hypotheses on niche partitioning and habitat choice in these pterosaurs.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW SKELETON OF *PRISTINAILURUS BRISTOLI* (AILURIDAE, AILURINAE) SUGGESTS STRONG SEXUAL DIMORPHISM IN THIS RARE CARNIVORAN

WALLACE, Steven, East Tennessee State University, Johnson City, TN, United States, 37614; FULWOOD, Ethan, University of Tennessee, Knoxville, TN, United States

In the spring of 2012, a second skeleton of *Pristinailurus bristoli* (Ailuridae: Ailurinae) was recovered from the Late Miocene, Gray Fossil Site of eastern Tennessee. The individual is fairly complete, but is lacking most of one hind limb, the pelvis, and the tail. Included with the specimen is a cranium and jaws with complete, unworn dentition. Mass estimates for the species based on a previously recovered skeleton ranged from 6.9–9.6 kg. However, values calculated from this new specimen range from 12.5–15.7 kg (approaching twice the size). Though younger (based on dental wear), the new skeleton is also significantly more robust than the previous individual. Statistics on limb measurements show <5% chance of randomly drawing such distant end members from a normally distributed population, suggesting two size morphs, which could represent sexual dimorphism. Unfortunately, no baculum was recovered to confirm that the larger skeleton is a male; however, because related portions of the skeleton are missing, its absence is merely inconclusive rather than indicative. The smaller, more gracile skeleton, is missing only a few tarsals and phalanges, so the lack of a baculum on that specimen seems real and supports the interpretation of it being a female. Sexual dimorphism has also been suggested for other members of the subfamily in Europe (including *Parailurus*). All of this is significant because the living *Ailurus fulgens* exhibits little to no sexual dimorphism suggesting that its condition is the exception within the subfamily.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A REINTERPRETATION OF THE BRAIN MORPHOLOGY OF *CEREBAVIS CENOMANICA* (AVES: INCERTAE SEDIS)

WALSH, Stig, National Museums Scotland, Edinburgh, United Kingdom; MILNER, Angela, The Natural History Museum, London, United Kingdom; BOURDON, Estelle, The Natural History Museum, London, United Kingdom

Avian brain evolution is of considerable importance for studying the transition from non-avian theropod dinosaurs to modern birds, yet scant information on brain morphological development during the Mesozoic exists. An isolated specimen (Paleontological Institute of the Russian Academy of Sciences [PIN] 5028/2) from Cenomanian deposits of Melovatka, Russia, was described originally as a 'fossilized brain', designated the holotype of *Cerebavis cenomanica* and tentatively referred to Enantiornithes. We have previously highlighted that this specimen is actually an incomplete skull, rendering the diagnostic characters invalid and *Cerebavis cenomanica* a nomen dubium. Here we provide a thorough description of the brain cavity morphology of this taxon based on µ-CT data kindly supplied by the late Evgeny Kurochkin. The brain of *C. cenomanica* closely fit the thin walled endocranium, and was characterized by strong brain axis flexion and caudolateral expansion of a comparatively short telencephalon, resulting in an equilateral triangular shape in dorsal view. Large non-bifurcated olfactory lobes suggest a strong reliance on olfaction, while the optic tectum was relatively large and overlapped dorsally by the telencephalon. As in *Archaeopteryx*, no eminentia sagittalis (wulst) was present. Wulst size and visual specialization are positively associated in living birds, and its absence, despite the size of the optic tectum, indicate that *Cerebavis* was less visually specialized than most living avian taxa. Inner ear morphology was similar to that of living birds, and long cochlear canals suggest wide hearing frequency sensitivities. The exceptionally thin walled skull bones and an expanded vestibular labyrinth support derivation from a volant animal, but obliteration of the cranial bone sutures makes referral to a pterosaur, non-avian dinosaur or even Enantiornithes unlikely. Overall brain morphology in *Cerebavis* is much closer to that of Neornithes than to *Archaeopteryx*, and the degree of skull bone fusion may indicate that the specimen is referable to an ornithurine. If so, the absence of a wulst (a synapomorphy of extant Neornithes) indicates that this feature must have appeared more recently than the Cenomanian in Ornithurae.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

DECIDUOUS TEETH SHOW CLOSE RELATIONSHIPS BETWEEN OREODONT GENERA (*EUCROTAPHUS, MERYCOCHOERUS* AND *PROMERYCOCHOERUS*)

WALTERS, Kendra, University of Oregon, Eugene, OR, United States, 97403; EMERY, Meaghan, University of Oregon, Eugene, OR, United States; DAVIS, Edward, University of Oregon, Eugene, OR, United States

*Oreodont taxonomy has historically been plagued by the repeated reassignment of specimens to different species and genera. Previous work has established deciduous dentition as a good taxonomic marker for oreodonts, capable of diagnosing clear differences at the genus level. *Eucrotaphus, Merycochoerus* and *Promerycochoerus* have previously been assigned to two or three different subfamilies, and species have been bumped between genera by different researchers. Currently, only some researchers consider *Promerycochoerus* a valid genus, rather than a synonym for *Merycochoerus*. Our examination of the deciduous dentition of four individuals from these three genera found great morphological similarity.

We measured two individuals of *Eucrotaphus trigonocephalus* (University of California Museum of Paleontology (UCMP) 76108 and 74944) from the Whitneyan of the John Day Formation, one individual of *Merycochoerus* sp. (UCMP 7750) from the Arikareean of the John Day Formation, and a *Promerycochoerus carrikeri* (UCMP 67574) from the Arikareean of the Harrison Formation. Members of all three genera display deciduous premolars indistinguishable from Wood's previous description of *Promerycochoerus carrikeri*, with the only variation present that of size. All four show nearly identical dP4 characters, including a cingulum that dams the median valley and a larger cingulum on the anterior side than the posterior. The dP3 also shows very little shape variation between genera, each with a crescentic paracone, and cingula on both the anterior and posterior sides of the hypocone. These characters contradict the current subfamily divisions, indicating a close relationship between all three genera. We propose a re-division of oreodont subfamilies that reflects the close deciduous morphology of these three genera. We also agree with the synonymy of *Promerycochoerus* and *Merycochoerus*, as our examination primarily found size differences between them that we do not accept as genus-level distinctions.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW OVIRAPTORID (THEROPODA, OVIRAPTOROSAURIA) EMBRYOS FROM THE UPPER CRETACEOUS OF SOUTHERN CHINA

WANG, Shuo, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; ZHANG, Shukang, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China

Three embryonic oviraptorid skeletons preserved within eggs were recovered from the Upper Cretaceous Nanxiong Formation of Nankang County, Jiangxi Province, China. The eggs can be referred to *Macroolithus yaotunensis* based on external ornamentation, eggshell thickness and eggshell microstructure. Pathological features are apparent in radial section of the eggshells, but they have not been found in the embryonic skeletons. The embryonic skeletons present the best-preserved examples of the craniofacial region, vertebral column, pelvic girdle and hind limbs that are known among oviraptorid embryos. We have identified many morphological features in these embryonic skeletons that differ from the condition in previously described adult oviraptorids, including: in the embryos, the ratio of the anteroposterior length of the premaxillary ventral margin to the total skull length is large; the premaxilla is dorsoventrally shallow; the nasal process of the premaxilla slopes posterodorsally at an angle of about 45º relative to the horizontal axis of the skull; the maxilla is anteroposteriorly longer than dorsoventrally high; the angle between the posterior and ventral borders of the antorbital fossa is less than 90º; the posterior end of the fused nasals overlaps the frontals; the triangular antorbital fossa is anteroposteriorly longer than dorsoventrally high; the anterior process of the lacrimal is proportionally long and situated more ventrally than in adults; the lacrimal recess is proportionally large; the hypocleidium of the furcula is absent; the femoral cranial trochanter is absent; and the femoral accessory trochanteric crest is present. Most of these distinctive features presumably reflect the early ontogenetic stage of these individuals, but it is possible that some represent taxonomic differences between the new specimens and previously described oviraptorids. However, it is clear that oviraptorid growth was characterized not only by changes in skeletal proportions, but also by changes in the structure of some elements.

Technical Session X (Friday, November 1, 2013, 12:00 PM)

MIO-PLIOCENE CARNIVORANS FROM WESTERN TIBET AND THE EARLIEST RECORD OF PANTHERINE FELIDS

WANG, Xiaoming, Natural History Museum of LA County, Los Angeles, CA, United States, 90007; TSENG, Z. Jack, American Museum of Natural History, New York, NY, United States; SLATER, Graham, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; TAKEUCHI, Gary, The Page Museum, Los Angeles, CA, United States; LI, Qiang, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

*The Zanda Basin in western Tibet Autonomous Region, at 4,200 m above sea level, produces fossil mammals of Mio-Pleistocene age. Recent discoveries of early woolly rhinos and cursorial *Hipparion* horses mark this region as an important new addition to understanding central Asian faunas during the uplift of the Tibetan Plateau, with implications for faunas of Pleistocene glacial-interglacial cycles. Top mammalian predators in the order Carnivora, informative for both biostratigraphic and zoogeographical interpretations of mammal faunas, have never been described from this region of the Himalayan Range. Here we present, for the first time, nine carnivoran species known from collections of five fieldwork seasons. Most of them represent new occurrences previously unknown to the southern Tibetan Plateau. Among them are genera typical of Pliocene northern Eurasian faunas such as the hyaenids *Pliocrocuta* and *Chasmaporthetes*, mustelids *Meles* and *Mustela*, and the canids *Vulpes, Xenocyon*, and *Nyctereutes*. In addition, the Zanda Basin records the earliest occurrence of *Panthera*, providing a record of pantherines in the late Miocene. Isotope analyses estimate that the Zanda Basin reached altitudes of >2,500 m above sea level no later than the mid-Pliocene. Within this context, endemic and widespread carnivorans coexisted, adding to the high-altitude faunal diversity in their Pliocene environment, and offering a comparison to the relatively depleted modern Tibetan Plateau fauna. Together with high diversity of Pliocene ungulates, several of which are candidates as predecessors to Ice Age megaherbivores, these carnivoran fossils indicate the Tibet region was a hotspot of both mammal dispersal and in situ evolution.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A NEW ORNITHUROMORPH BIRD FROM THE EARLY CRETACEOUS CHANGMA BASIN OF GANSU PROVINCE, NORTHWESTERN CHINA

WANG, Ya-Ming, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; O'CONNOR, Jingmai, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; LI, Da-Qing, Gansu Geological Museum, Lanzhou, China; YOU, Hai-Lu, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

In the last decade, numerous avian specimens have been recovered from the Lower Cretaceous Xiagou Formation in Changma Basin of Gansu Province, northwestern China, providing valuable information on the diversity and early evolution of basal birds. Until now, described specimens belong to two ornithuromorphs (*Gansus yumenensis* and an indeterminate taxon, Gansu Geological Museum specimen GSGM-05-CM-021) and four enantiornithines (*Qiliania graffini* and three indeterminate taxa), with the vast majority of specimens referred to *Gansus*. Here we report a new ornithuromorph specimen (GSGM-06-CM-013) from the same Xiagou Formation in Changma Basin, which had been previously loosely referred to *Gansus yumenensis*. GSGM-06-CM-013 consists of partial sternum, pectoral girdle and a completely articulated left pectoral limb. All three Changma ornithuromorphs preserve the sternum, which clearly distinguishes GSGM-06-CM-013 from previously identified taxa: the cranial margins of the sternum intersect at an angle of approximately 90º, contrasting with the greater angle of *Gansus*, the lateral process is larger and more rounded than those of *Gansus* and GSGM-05-CM-021, the sternal body is comparatively much longer than that in GSGM-05-CM-021, the lateral trabecula is short and extremely expanded caudally, contrasting to the long, reversed L-shaped lateral trabecula in GSGM-05-CM-021 or long strap-like trabecula in *Gansus*. The new taxon is also more robust: the ratio of the width of the midshaft to the total length of humerus is much larger in GSGM-06-CM-013 than in *Gansus*. A preliminary phylogenetic analysis resolves GSGM-06-CM-013 as a basal ornithuromorph, although relationships with *Gansus* and GSGM-05-CM-021 are unresolved. Body mass estimates of the Changma birds demonstrate that enantiornithines were much smaller than ornithuromorphs in this avifauna. Most Changma enantiornithines preserve long and recurved pedal unguals, suggesting an arboreal lifestyle; comparatively, Changma ornithuromorphs show aquatic adaptions. Similar ecological differences are also observed between Jehol ornithothoracines, suggesting niche partitioning between these clades in the Early Cretaceous.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

DINOSAUR EGGSHELL OOFAUNA FROM THE NEMEGT AND BARUNGOYOT FORMATIONS IN THE GOBI DESERT, MONGOLIA - TAXONOMY AND TAPHONOMY

WATABE, Mahito, Hayashibara Museum of Natural Sciences, Setouchi, Japan; FASTOVSKY, David, Univ of Rhode Island, Kingston, RI, United States; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia; CHINZORIG, Tsogtbaatar, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

A dinosaur fossil locality, Khermeen Tsav, western Mongolia, yields many osteological, ichnological, and oological specimens of dinosaurs from the Barungoyot Formation (Middle Red Beds [MRB]) and overlying Nemegt Formation (Upper White Beds [UWB]). Taphonomy of the dinosaur eggshells and nests in the MRB is especially interesting. In a transitional zone from the MRB (mainly eolian) to the UWB, many small elongated eggs are discovered in well-sorted red-colored fine-grained sandstone beds. The eggs have been assigned to *Gobipteryx* form. The eggs are all buried in the beds in a vertically standing position. These eggs are located in the beds separately, not forming an aggregation (a clutch). Some of the eggs cut the horizontal lamination of the bearing beds. Sedimentological interpretation on the occurrence of those eggs is very difficult. Hydrodynamic (in the case of fluvial) and aerodynamic (in the case of eolian) agents will not allow such vertical arrangement of the elongated eggs with yolk in the sandstone bed. The red beds yielding the vertical-standing small eggs have a small part of fluvial lithology within widely distributed eolian beds that change transitionally from fluvial beds of the UWB. Such a peculiar taphonomic condition of the small eggs requires activities of the parental animal. From the same part of the succession, many specimens of oofamily Dendroolithidae are also found. From the transitional zone, skeletal specimens of a large-sized ankylosaurian, *Bagaceratops*, alvarezsaurids, and *Gobipetryx* have been found. In the lower part of the MRB, a clutch of elongated eggs with smooth external surface was found in middle-grained red sandstone in which the eggs (nearly 10 individuals) were vertically arranged. The eggshell ultrastructure of the lower MRB egg shows *Protoceratopsidovum* form. On the other hand, the vertically standing small eggs shows ornithopod basic type. From the middle part of the MRB, elongatoolithid eggs are found with horizontally arranged clutch structure. The taxonomic attribution of the small egg is problematic. They are of a bird or a small-sized alvarezsaurid.

Technical Session XVII (Saturday, November 2, 2013, 3:00 PM)

TREE BUILDING FROM NOAH'S ARK: THE IMPACT OF POOR SAMPLING WITHIN SPECIES ON PHYLOGENETIC RECONSTRUCTION

WATANABE, Akinobu, American Museum of Natural History, New York, NY, United States, 10024; NORELL, Mark, American Museum of Natural History, New York, NY, United States

Intraspecific variation is a key ingredient for evolution and a ubiquitous phenomenon in the natural world. One major component of this variation is polymorphism, or the occurrence of two or more distinct forms within a species, exclusive of sexual dimorphism and ontogenetic changes. Polymorphisms can often be difficult to detect due to inadequate sampling. This complication is a particular problem for phylogenetics because poor sampling within polymorphic species may alter the character-based affinities among taxa depending on which set of polymorphic character states is sampled. Although sufficient sampling may be feasible for extant groups, poor sample size is a pervasive problem in paleontological studies, in which species are commonly represented by a single specimen or a few fragmentary fossils. Consequently, sampling only a single individual for polymorphic species could have a substantial impact on their phylogenetic placement. However, the magnitude of this effect remains largely unclear. Here we introduce the Polymorphic Entry Replacement Data Analysis (PERDA), a new script written and executed in the TNT phylogenetic program (Tree analysis using New Technologies). This tool simulates the sampling of a single individual for each species by iteratively replacing all polymorphic scorings (e.g., [01]) with single states (e.g., '0' or '1'). It then generates a distribution of topological differences (Robinson-Foulds distances) between a reference tree produced from original data and trees recovered from iterated data, allowing the user to assess the stability of phylogenetic reconstructions with respect to poor sampling. Applying PERDA to well-sampled morphological data of extant taxa demonstrates substantial variability in the topology of phylogenetic trees. On average, 30% of internal nodes in the iterative trees do not occur in the reference tree, leading to major disagreements in the relatedness of these groups. This result suggests that the phylogenetic placement of extinct taxa may be more dubious than implied by standard phylogenetic analyses and if available, multiple fossil specimens of the same species should be sampled for inferring the evolutionary history of organisms.

Technical Session XIV (Saturday, November 2, 2013, 11:45 AM)

SYSTEMATICS OF A FLIGHTLESS DUCK FROM THE PLEISTOCENE OF SHIRIYA, NORTHEAST JAPAN

WATANABE, Junya, Kyoto University, Kyoto, Japan; MATSUOKA, Hiroshige, Kyoto University, Kyoto, Japan

A new flightless fossil duck (Aves, Anatidae), which has previously been reported as *Chendytes*, is described as a member of the Shiriya local fauna, a well known Middle–Late Pleistocene marine and land vertebrate fauna occurring from the fissure-filling deposits in the limestone bodies of Shiriya area, northeast Japan. *Chendytes* is an extinct flightless member related to Recent *Somateria* (eiders) of the tribe Mergini (seaducks), which is solely known from the Pleistocene and Holocene of coastal California. The new species (hereafter, the Shiriya duck) is represented by isolated elements, including fragmentary skull elements, vertebrae, fragmentary elements of the pectoral and pelvic girdles, and most of major limb elements. Comparisons with Recent representatives of major anatid taxa and *Chendytes* showed that the Shiriya duck is characterized, and can be differentiated from *Chendytes*, by a number of unique osteological features, including: subtriangular fossa without a pit on the manubrial area of the sternum, stout shaft and distally extending, dorsocaudally concave crista deltopectoralis of the humerus, and well-developed crista cnemialis lateralis of the tibiotarsus with deep excavation lateral to it. Nevertheless, the Shiriya duck can be referred to Mergini based on a combination of osteological features, including distally overhanging tuberculum ventrale of the humerus and narrow tarsometatarsus with concave lateral margin. Furthermore, morphology of the quadrate indicates its affinity to *Somateria*. Although several osteological features of the pectoral girdle, along with the overall large size and proportions of the hind limb elements of the Shiriya duck show strong resemblance to *Chendytes*, comparisons of these taxa and other flightless members of the Anatidae showed that some of the apparently shared osteological features of the Shiriya duck and *Chendytes* are possibly homoplasious characters associated with flightlessness. Therefore, these characters may not necessarily reflect a close relationship between the two. There are two possible hypotheses on the evolutionary histories of these flightless ducks that once inhabited the opposite sides of the Pleistocene North Pacific contemporaneously: one is that they were descended from a single flightless common ancestor, and the other is that they were descended from distinct lineages and became flightless independently. The latter hypothesis appears more likely, given the impaired flight ability (or the occurrence of "temporary" flightless condition) in Recent *Somateria*.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

AN ASSESSMENT OF CLOVERLY FORMATION (LOWER CRETACEOUS) CROCODYLOMORPH DIVERSITY USING TOOTH MORPHOLOGY

WAYRYNEN, Kaisa, Wellesley College, Wellesley, MA, United States, 02481; CARRANO, Matthew, Smithsonian Institution National Museum of Natural History, Washington, DC, United States

Isolated crocodylomorph teeth are frequently among the most common elements found in Cretaceous vertebrate fossil-bearing deposits, but studying the diversity represented by such remains poses a challenge. Crocodylomorph teeth are known to vary both within and among taxa, but few attempts have been made to quantify this variation in a manner suited to the subsequent identification of isolated teeth. Here we present the results of a study on several thousand crocodylomorph teeth recovered from vertebrate microfossil bonebeds in the Lower Cretaceous Cloverly Formation of Wyoming and Montana. As the formation preserves abundant such teeth but few skeletal remains, this is an ideal case study for determining the utility of such fossils in assessing crocodylomorph diversity.

We used several morphometric techniques (primarily Principal Coordinate Analysis and Non-metric Multidimensional Scaling) on a reference set of known extant and fossil crocodylomorph taxa to create a morphospace within which different taxa could potentially be identified. Relevant morphometric data included several size parameters, striation pattern, thickness and density, and development of molariform morphology. Combinations of these features allowed us to successfully separate out the different reference taxa.

When applied to the Cloverly sample, four distinct clusters of teeth were recovered, which largely conformed to preliminary identifications made based on gross morphology. The best separation of taxa occurred on axes that were positively correlated with size (i.e. length, width, and height), molariformity + striation strength, and molariformity + striation convergence. Although we cannot assign these clusters to specific taxa, they bear strong resemblances to teeth previously assigned to bernissartids, atoposaurids, goniopholidids, and pholidosaurids. Regardless of their particular taxonomic identities, this supports the presence of at least four distinct crocodylomorph taxa in the Cloverly Formation, a diversity that is consistent with other coeval strata. It also demonstrates the utility of isolated teeth for such studies, provided appropriate taxonomic goals are set.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

NEW MATERIAL FROM THE RARE AMPHICYONID GENUS *PARADAPHOENUS* AND ITS IMPLICATIONS ON THE VALIDITY OF CANIFORM CARNIVORES IDENTIFIED WITHIN CHADRONIAN THROUGH ARIKAREEAN COLLECTIONS

WELSH, Ed, Badlands Ntl. Park, Interior, SD, United States, 57750

A recent study of fossil canid material in the Cedar Pass fauna, within the Badlands National Park collections reposited at the South Dakota School of Mines and Technology, has revealed a new stratigraphic occurrence of the miniature amphicyonid *Paradaphoenus*. This is the first recognized occurrence of *Paradaphoenus*within the Poleslide Member (Whitneyan) of the Brule Formation in South Dakota. Material from *Paradaphoenus* is incredibly rare, with only eight specimens known in vertebrate collections from the Orellan through early Arikareean in Nebraska, South Dakota, and Oregon. However, *Paradaphoenus* is infrequently known in South Dakota, with occurrences exclusively known from the Scenic Member (Orellan) of the Brule Formation and the Sharps Formation Wounded Knee Fauna (Arikareean). Four specimens represent the taxon in the Cedar Pass fauna, but the material is fragmentary and limited, containing three isolated molars and a dentary with partial dentition. Nonetheless, the material is representative enough to include *Paradaphoenus* and *P.* cf. *minimus* as faunal constituents in approximation to the Whitneyan-Arikareean transition, based on other representative mammalian taxa. The aforementioned Cedar Pass faunal specimens were previously misidentified as material from *Hesperocyon*. This is likely due to the overall scarcity of *Paradaphoenus* material, stemming from the lack of awareness on this carnivore's presence. Though *Paradaphoenus* is similar in size to co-occurring canidae, a close study of the dental morphology clarifies the distinctions of concurrent small caniform carnivores. These *Paradaphoenus* specimens clearly demonstrate the widening of the M1 through an exaggerated and distinct parastyle in addition to a strong medial expansion of the labial cingulum. The dentary attributed to *P. tooheyi* exhibits premolars lacking accessory cusps and an m2 with the talonid encompassing 80% of the tooth length. Comparable morphology is described in some Arikareean specimens of the early canine *Leptocyon*, calling into question the validity of collection identifications within Caniformia. Misidentifications such as these have been elucidated before, but seem to persist. This study ultimately calls for more attentiveness to evaluating caniform carnivore identification in similar collections of similarly sized caniforms representative of the Chadronian through Arikareean.

Technical Session XVII (Saturday, November 2, 2013, 4:00 PM)

MORPHOLOGICAL AND SPECIES DIVERSITY OF COELACANTHS FROM THE LOWER TRIASSIC SULPHUR MOUNTAIN FORMATION OF BRITISH COLUMBIA, CANADA

WENDRUFF, Andrew, Ohio State University, Columbus, OH, United States, 43202; WILSON, Mark, Univ of Alberta, Edmonton, AB, Canada

Coelacanths, which have a large temporal range (~407 million years), are traditionally considered to be a morphologically static group. However, early in their evolutionary history, the morphological diversity of this group peaked (Devonian–Mississippian), followed by a drop in diversity that led to evolutionary conservatism. We assess this interpretation of this decline in coelacanth morphological diversity by describing a number of new forms from a single locality in British Columbia, Canada. Coelacanths from the Lower Triassic Sulphur Mountain Formation (Wapiti Lake) have been known for nearly 100 years and are only now being described. Preliminary works attributed all of the coelacanth material from this locality to a single undescribed species of *Whiteia*; however, after extensive study, six distinct species have been identified. These include several new genera and a member of a newly described family of active predators, the Rebellatricidae. These new forms add to the growing number of coelacanths from the Early Triassic, which has the highest recorded species diversity. Two of the new coelacanths, *Rebellatrix* and another currently undescribed genus, had body forms that significantly departed from the typical coelacanth bauplan. Features such as a forked tail, denoting an active predatory nature, or an everted caudal fin, with a short supplementary lobe and elongate principal lobes, are non-typical features for coelacanths. These specimens represent the first major change in the coelacanth body form since their initial radiation in the Devonian and Mississippian. Fast-swimming, predatory forms such as *Rebellatrix* indicate that coelacanth morphological diversity was not as conservative as it had long been assumed.

Symposium 1 (Wednesday, October 30, 2013, 8:15 AM)

WHAT ARE WE ACTUALLY MEASURING? AN EVALUATION OF OSTEOHISTOLOGICAL INDICATORS OF DINOSAURIAN GROWTH RATE

WERNING, Sarah, Univ of California Berkeley, Berkeley, CA, United States, 94720-4780

Histological studies have established specific relationships between the microstructural features of bone and the growth rates of primary cortical bone. For animals of a given body size, the density and connectivity of vascular canals and the disorganization of collagen fibers increase with the rate of bone deposition, and osteocyte density is positively correlated with metabolic rate. Although these relationships are quantifiable, paleohistological studies generally use a tissue-level approach to compare bone growth among dinosaurs, except when reconstructing growth curves. I identified and refined several methods to improve the quantification of growth-related patterns in dinosaurian bone tissue, focusing on specific microstructural characters known to correlate with growth and metabolic rates in living tetrapods. The most critical histological indicator of growth, the rate of bone deposition, is rarely reported for dinosaurs. Occasionally, it has been estimated using values associated with specific vascular patterns in extant birds, a relationship that is not constant across tetrapods. Zonal area and average zonal width directly measure annual deposition, and can be used to bracket daily deposition rates. Estimating bone tissue growth based on vascularization pattern ("Amprino's Rule") actually confounds three separate vascular signals: density, connectivity, and patterning. As part of a larger study of archosaur growth, I measured canal density and the percentage of non-anastomosing canals in addition to describing vascular patterns, and reconstructed their ancestral states. Canal density shows an independent evolutionary trajectory from connectivity and patterning, and correlates more strongly with deposition rates. Collagen fiber orientation, which can signal seasonal shifts in deposition rate, is sometimes obscured in fossils by diagenetic alteration. Patterns of osteocyte organization and orientation, more than cell shape, are highly associated with fiber orientation and may be more appropriate proxies. Osteocyte and canal density, not typically reported for dinosaurs, are easily measured using digital boxplots along radial transects through the cortex. These measures suggest the possibility of more useful quantification of osteohistological indicators as proxies for growth and metabolic rates in extinct and extant vertebrates.

Technical Session IV (Wednesday, October 30, 2013, 2:15 PM)

A QUANTITATIVE MODEL FOR MORPHOLOGICAL EVOLUTION IN THE INTERATHERIIDAE (TYPOTHERIA, NOTOUNGULATA, MAMMALIA) AS A RESPONSE TO CLIMATIC AND TECTONIC CHANGES

WEST, Abagael, Columbia University, New York, NY, United States, 10025; FLYNN, John, American Museum of Natural History, New York, NY, United States; CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States; WYSS, Andre, University of California Santa Barbara, Santa Barbara, CA, United States

*An expanded phylogeny of the Interatheriidae (Typotheria, Notoungulata, Mammalia), including two new taxa represented by four newly described specimens from the Eocene-aged Los Queates Fauna of Chile, is presented. This phylogeny is used to quantify the relationship between climatic and tectonic events during the early Cenozoic and the rapid appearance of hypsodont dentitions, a morphological change observed in interatheriids as well as in many other families of South American ungulates at around this time. The rise of hypsodonty during the late Eocene in South America is likely related to cooling and aridification that occurred in South America at the Eocene-Oligocene Transition; it has also been attributed to the presence of volcanic ash on plant surfaces in varying amounts throughout the Cenozoic. Ancestral states for a continuously varying hypsodonty metric were reconstructed using both a likelihood model and phylogenetic independent contrasts, and show that hypsodonty appeared just once, in the common ancestor of Interatherium and Santiagorothia chiliensis, coinciding with the sudden radiation of the Interatheriinae. This implies that hypsodonty may have been important in the radiation of this subfamily. An oxygen isotope record of sea-surface temperature was used as a proxy for paleotemperature, and a model of rates of interplate convergence along the Chilean Andes was used as a proxy for volcanic activity. Rates of change in hypsodonty along the time-calibrated phylogeny were reconstructed, and the relationships between these rates of morphological evolution and the two proxies were quantified using a novel statistical method based on time series analysis. The results show no significant interaction between either of the two proxies and rates of change in hypsodonty, suggesting that neither of these aspects of paleoenvironment drove the evolution of hypsodonty, or that one or both were part of a more complex system that has not been captured here.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

QUANTITATIVE APPROACH TO RIB IDENTIFICATION AT AN ALASKAN PLEISTOCENE SITE

WHALEN, Christopher, University of Michigan, Ann Arbor, MI, United States, 48109-1079; Fisher, Daniel, Univ of Michigan, Ann Arbor, MI, United States; ROUNTREY, Adam, University of Western Australia, Perth, Australia; HOLMES, Charles, University of Alaska Fairbanks, Anchorage, AK, United States

Despite the occurrence of remains of *Mammuthus primigenius* (woolly mammoth) in Alaskan Pleistocene archaeological sites, it is difficult to specify the nature of human-mammoth interaction implied. Is it possible that molars, tusks, or bones recovered at such sites were transported for utilitarian purposes, unrelated to hunting or consumption of mammoths? Several small mammalian ribs were recovered from a central Alaskan, Pleistocene archaeological site known as Swan Point and were initially treated as taxonomically indeterminate. However, we noticed a resemblance between one of these ribs and the morphology emerging from an unrelated x-ray computed tomographic study of the internal anatomy of two well-preserved neonate mammoth carcasses from Siberia. This comparison suggested that the Swan Point rib was a juvenile mammoth's left second rib, an identification that was later supported by microCT analysis of the Alaskan specimen. Additional ribs found subsequently at Swan Point also resemble those of a neonate mammoth. To evaluate our identifications quantitatively, we experimented with ways of comparing these relatively landmark-poor elements of mammalian osteology. Ribs are often under-represented in specimen descriptions as they usually offer few useful morphological characters. The ribs of mammoths and some other mammals are flattened mediolaterally creating anterior and posterior edges that extend proximodistally; changes in the curvature of these edges may be one of their more informative features. The 3-dimensional configurations of these edges and the dearth of landmarks elsewhere on ribs discourage use of traditional 2-dimensional morphometric analyses. Instead, we plotted 3-dimensional coordinates of semi-landmarks along these edges and fit an equation to those points; this information was supplemented by elliptical Fourier analysis of regularly-spaced cross-sections. By comparing coefficients generated in this manner from the Swan Point ribs, known mammoth ribs, and ribs of other appropriately sized mammals, we provide a strong argument that the Swan Point ribs are derived from a juvenile mammoth. This identification is important because these ribs are too fragile to have served any utilitarian purpose; human procurement of a mammoth calf for

consumption offers the most probable explanation for their presence at the Swan Point site.

Technical Session XVI (Saturday, November 2, 2013, 1:45 PM)

FIRST PTEROSAUR DENTARY AND POSTCRANIA FROM THE UPPER TRIASSIC OWL ROCK MEMBER, CHINLE FORMATION, PETRIFIED FOREST NATIONAL PARK, ARIZONA

WHATLEY, Robin L., Columbia College Chicago, Chicago, IL, United States, 60605; BEHRENSMEYER, Anna K., Smithsonian Institution - NMNH, Washington, DC, United States; MCINTIRE, Suzanne B., Smithsonian Institution - NMNH, Washington, DC, United States; RAMEZANI, Jahan, Massachusetts Institute of Technology, Cambridge, MA, United States; PARKER, William G., Petrified Forest National Park, Petrified Forest National Park, AZ, United States

We report the first basal, non-pterydactyloid pterosaur with a multicuspid dentition from the Owl Rock Member of the Chinle Formation (Upper Triassic, late Norian), Arizona. A left dentary with 11 triangular teeth bearing three to seven cusps each as well as isolated teeth and limb elements have been recovered by laboratory micro-preparation of conglomeratic matrix from the "White Channel Complex" (WCC), a discontinuous fossiliferous sedimentary deposit up to 3 meters thick that occurs over an area of several square kilometers in the Petrified Forest National Park. This deposit consists of stratified sandstones and intraformational conglomerates that represent the partial filling of a channel system by an unusual influx of volcaniclastic sediments. U-Pb dates on detrital zircons from the same locality and lithological unit as the pterosaur fossils constrain the age of deposition. The late Norian date falls within the Sevatian European marine substage assigned to the Seefelder Schichten (Seefeld Beds), Tyrol, Austria, in which *Austriadactylus cristatus* occurs. Longitudinal enamel surface striations seen in posterior adult dentitions of *Eudimorphodon ranzii* and *Caviramus schesaplanensis* are absent from the teeth of the Owl Rock pterosaur. Extensive apical wear is present on most posterior teeth suggesting active food processing typical of other pterosaurs with heterodont dentitions from the Late Triassic. Additional material from the same locality includes abundant and well-preserved skeletal and dental elements of phytosaurs, fish, amphibians, theropod dinosaurs, and the archosaur *Revueltosaurus*. The teeth and small bones in the clastic sediments vary from pristine to highly abraded, suggesting variable degrees of time-averaging within the channel system. Ecological traits of the co-occurring taxa indicate that skeletal remains were derived from both terrestrial and aquatic habitats associated with the channel ecosystem. Pterosaur fossils, other than putative isolated teeth, are rare in Upper Triassic deposits of western Pangaea. The dentary from the Petrified Forest provides a reference for identifying isolated multicuspid teeth previously assigned to Pterosauria from the Church Rock Member, Bull Canyon Formation, and other Owl Rock equivalent strata. Our new date is the only direct radioisotopic date for any Upper Triassic pterosaur locality, and in combination with the long sequence of calibrated biostratigraphic range data from the Park will facilitate temporal correlations among other basal pterosaur occurrences.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

PHYLOGENETIC VERSUS SERIAL VARIATION IN THE ORNITHISCHIAN DINOSAUR AXIAL SKELETON: A GEOMETRIC MORPHOMETRIC STUDY

WHITE, Dominic, The George Washington University, Washington, DC, United States, 20052

The axial skeleton is under represented in character matrices of dinosaurs, partly due to a lack of consistent, invariant characters, and partly to a general lack of study of its anatomy. Where included, axial characters are often coded for a region of the axial skeleton whose morphology is treated as serially invariant. These approaches may omit or mask potential evolutionary signal in the data.

Serial and interspecific morphological variation in ornithischian dorsal vertebrae were quantitatively captured using 2-dimensional landmark morphometrics. Principal components analysis suggests that dorsal vertebral morphology is partially related to posture. Basal members of Thyreophora, Ceratopsia and Ornithopoda are morphologically similar but later taxa diversify to occupy a larger morphospace as they become larger and quadrupedal.

Phylogenetic permutations of the morphometric variables on a stratigraphically calibrated tree show that significant phylogenetic signal is also present in vertebral shape. The results suggest that significant phylogenetic information is being missed from the axial skeleton and morphometric characters may be able to capture this information where discrete qualitative states are undefinable.

However, comparisons of morphospace occupation by the dorsal series of different taxa show that the morphological variation within the dorsal series of a taxon is large compared to the variation between taxa. This suggests that coding a character for a region of the axial skeleton, such as the dorsal series, may introduce significant error into axial characters especially if an axial skeleton is incomplete and its full range of variation is unknown. Based on these results, more axial characters should be included in dinosaur phylogenies and they should be coded at a finer scale than in previous studies.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

LATE EOCENE FOSSIL ALLIGATORS FROM NEBRASKA AND THEIR IMPLICATIONS FOR THE BIOGEOGRAPHIC ORIGIN OF *ALLIGATOR*

WHITING, Evan, Florida Museum of Natural History, Gainesville, FL, United States, 32611; HASTINGS, Alexander, Georgia Southern University, Statesboro, GA, United States

The first fossil alligators from the White River Badlands of South Dakota were collected over a century ago. Subsequent research has shown that all identifiable fossils represent the most basal and oldest occurring *Alligator* species, *A. prenasalis*, which occupied this area of South Dakota during the late Eocene and early Oligocene. Late Eocene *Alligator* records outside this region are sparse, questionable, and provide little clarity regarding the true biogeographic extent of *A. prenasalis* and the origin of the genus. A new specimen collected from the late Eocene Chadron Formation of Sioux County, Nebraska offers a clearer picture of the historical biogeography of *A. prenasalis* during the late Eocene. Though incomplete, several morphological characters diagnosing this species are present, including splenial participation in a mandibular symphysis extending beyond the sixth dentary alveolus, a flat orbital region, and a lack of frontal or prefrontal ornamentation. The anteriormost premaxillae and supraoccipital are missing, which display the most important diagnostic characters for this species within *Alligator*. Due to the lack of these diagnostic features and a lingual foramen expressing the basal alligatoroid condition, a cladistic analysis of 28 alligatoroid taxa (with the new specimen entered as its own taxon), coded for 181 morphological characters, was run to test the phylogenetic affinity of the Nebraska specimen. This cladistic analysis resulted in 2,802 equally most parsimonious cladograms. The strict consensus of this analysis recovered the new specimen near the base of *Alligator* along with previously coded *A. prenasalis*, providing support for its assignment to this species. Three additional fragmentary specimens from Nebraska further support this region as having been inhabited by *A. prenasalis*, in addition to the South Dakota locality. These discoveries expand the known late Eocene geographic range of this species into the White River Badlands of Sioux County, Nebraska, suggesting that the biogeographic origin of *Alligator* was not as restricted as previously thought. This newly expanded late Eocene distribution contrasts with the poor early Oligocene record limited solely to South Dakota, which could constitute a geographic range contraction for this species across the Eocene-Oligocene transition. Fossil alligators from this major cooling interval provide insights into the history of temperature tolerance within *Alligator*, which is known to exist in cooler climates today than any other extant crocodylian genus.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

COMPLEX TOOTH HISTOLOGY IN A SAUROPOD DINOSAUR

WHITLOCK, John, Mount Aloysius College, Cresson, PA, United States, 16630; D'EMIC, Michael, Stony Brook University, Stony Brook, NY, United States; SMITH, Kathlyn, Georgia Southern University, Statesboro, GA, United States

Recent work on hadrosaurid dinosaurs has revealed that at least some dinosaurs had structurally complex teeth, with multiple tissue types present (e.g., primary dentin, secondary dentin, mantle dentin, enamel). These tissue types have been linked to tooth function in those animals, and such histological studies are a promising way to help resolve current questions about feeding behavior in other taxa such as sauropod dinosaurs. Here, we present preliminary results from a narrow-crowned sauropod, *Diplodocus*. Similar to hadrosaurids, *Diplodocus* had complex teeth at the histological level, with enamel, primary, secondary, and mantle dentin present, although some structures (e.g., giant tubules) are not present. Enamel thickness is asymmetrical on the labial versus the lingual tooth face, as in hadrosaurids. Mantle dentin in sauropods, as in mammals and hadrosaurids, makes up the outermost layers of dentin, whereas the majority of the tissue is orthodentin, with its regularly arranged tubule structure and daily depositional fronts. Secondary dentin is observable in the pulp cavity of mature but unerupted teeth of *Diplodocus*, distinguishable histologically from orthodentin by a change in color in ground section and a change in tubule orientation. Secondary dentin is not uniformly deposited, and in the examined teeth forms primarily on the roof of the pulp cavity, and not at the crown-root junction. Although secondary dentin forms throughout an animal's life following deposition of primary enamel, deposition of secondary dentin has also been tentatively linked to areas of high loading stress during tooth function in humans. Areas of highest deposition of secondary dentin are potentially informative as to tooth function, therefore, and may shed light on feeding behavior in these animals, a hypothesis that awaits testing with further histological sampling of extant and extinct animals.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

PALEOCENE-EOCENE RODENTS (ISCHYROMYIDAE, REITHROPARAMYINAE) FROM FRESHWATER LIMESTONE IN THE CLARKS FORK BASIN, WYOMING

WIDLANSKY, Sarah, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States, 32611; MANZ, Carly, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

The fossil record of early Paleogene rodents is mainly restricted to teeth and partial dentitions, limiting our understanding of their paleoecology and early evolution when they first appear in North America. Here we document cranial and postcranial fossils of primitive reithroparamyine ischyromyid rodents recovered from freshwater limestones of the Clarks Fork Basin, Wyoming. The fossils include a new partial skull of a small, early Eocene [Wasatchian North American Land Mammal Age (NALMA); faunal zone Wa-4] reithroparamyine referred to *Microparamys hunterae* that represents a temporal range extension for the species (previously Wa-1) and allows for a revised diagnosis of the genus that takes into account variability in the placement of the anterior root of the zygoma. Additionally, a partial skeleton of late Paleocene (Clarkforkian NALMA; faunal zone Cf-2) *Acritoparamys atavus* represents the oldest known dentally associated postcrania for crown-clade Rodentia. A series of 44 linear measurements of the forelimb including the manus, as well as the pes of *A. atavus* were analyzed within a comparative sample of extant rodents of known locomotor behaviors, including arboreal, terrestrial, saltatorial, and gliding. Results from principal-components analyses, elongation indices of the intermediate phalanges, and relative proportions of the digit elements using these data suggest that *A. atavus* can be categorized as generalized, with both arboreal and terrestrial osteological features. While results indicate some similarity to extant

saltatorialists, they are more generally consistent with previously documented interpretations of somewhat later Eocene taxa. Similar to those taxa, the first Paleocene rodents in North America lack a good modern analog, with the forelimb seemingly specialized towards a more arboreal lifestyle like arboreal sciurids, while the pes suggests behaviors similar to rodents with dominantly terrestrial locomotion.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW ANKYLOSAURID DINOSAUR (ORNITHISCHIA: THYREOPHORA) FROM THE UPPER CAMPANIAN KAIPAROWITS FORMATION OF GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, SOUTHERN UTAH

WIERSMA, Jelle, Natural History Museum of Utah and University of Utah, Salt Lake City, UT, United States, 84108; IRMIS, Randall, Natural History Museum of Utah and University of Utah , Salt Lake City, UT, United States

Ankylosaurids from Laramidia (western North America) are a poorly understood group of ornithischian dinosaurs that were previously limited to six Late Cretaceous taxa. The majority of these taxa are recovered from northern localities in Montana and Alberta and include *Ankylosaurus magniventris*, *Euoplocephalus tutus*, *Dyoplosaurus acutosqameus*, *Oohkotokia horneri*, and *Scolosaurus cutleri*. The lone exception is the southern taxon *Nodocephalosaurus kirtlandensis* from northern New Mexico. Here we present a new ankylosaurid taxon from the upper Campanian Kaiparowits Formation of southern Utah. Preserved elements include a complete cranium and two partial mandibles, much of the vertebral column, a complete tail club, most of the dorsal ribs, much of the forelimb minus the manus, a near complete synsacrum, and a tibia and fibula. The preserved armor comprises two near complete cervical neck rings, and a total of 17 dorsal and lateral osteoderms, all possessing deeply pitted surfaces, deep dorsal keels and short spines.

The skull possesses several characters suggesting a close taxonomic relationship with *Nodocephalosaurus*. These include a highly ornamented cranium containing ossified, sub-rounded to polygon-shaped and bilateral symmetrically arranged osteoderms that summit in a distinct apex that are situated along the dorsal and dorsolateral margins of the skull. Cranial osteoderms in northern taxa appear similar in morphology but lack the distinct apex and bilateral symmetry. As in *Nodocephalosaurus*, the supraorbital and quadratojugal protubera are well pronounced and exhibit a sub-triangular morphology in dorsal, lateral, and ventral views. Finally, the nares are situated rostrolaterally but are more enlarged compared to *Nodocephalosaurus*, and exhibit unusually large, laterally flaring margins. Character analysis suggests the new taxon has no close relationships with Late Cretaceous northern Laramidian ankylosaurids, but is closely related to the southern *Nodocephalosaurus* from the Kirtland Formation of New Mexico. These new data are consistent with evidence for distinct northern and southern biogeographic provinces in Laramidia during the upper Campanian.

Technical Sesssion XII (Friday, November 1, 2013, 2:30 PM)

A REDESCRIPTION OF *PEIPEHSUCHUS TELEORHINUS* (CROCODYLOMORPHA: THALATTOSUCHIA) AND ITS IMPLICATIONS FOR THE ORIGIN OF TELEOSAURIDAE AND THE EVOLUTION OF MARINE ADAPTATIONS IN THALATTOSUCHIA

WILBERG, Eric, University of Northern Iowa, Cedar Falls, IA, United States, 50614

Thalattosuchians are the most highly marine-adapted archosaurs, yet the pattern of acquisition of marine specializations remains poorly understood. This is, in part, due to a lack of well-preserved fossil material from the early history of the group. Here I redescribe the morphology of *Peipehsuchus teleorhinus* from the Early Jurassic of China, one of the earliest occurring teleosaurids and one of the few specimens from outside Europe. Reinterpretation of the morphology shows that *P. teleorhinus* already possesses the cranial specializations characteristic of teleosaurids. Contrary to previous reports, the postorbital does contribute to the orbital margin and broadly overlaps the jugal on the postorbital bar as in other thalattosuchians. The enlarged external carotid foramina are ventrally positioned, lying along the dorsolateral margins of the basioccipital tubera and not visible in occipital view. The premaxillae of *P. teleorhinus* are greatly expanded mediolaterally as in *Steneosaurus megarhinus*, but differ from those of all other teleosaurids. Despite being the oldest known teleosaurid, phylogenetic analysis recovers *P. teleorhinus* nested well within Teleosauridae, not in a basal position. The recovery of the only known Asian teleosaurid within a larger European clade suggests that the group originated in the western Tethys and the appearance of *P. teleorhinus* in Asia is the result of dispersal. Optimization of character state changes onto the tree demonstrates that while both teleosaurids and metriorhynchids show reduction in the size of the forelimb elements, this transformation occurred independently and followed a different morphological trajectory in each lineage. In teleosaurids, the humerus becomes reduced by shortening the proximal portion, moving the deltopectoral crest nearer to the proximal articulation surface. In metriorhynchids, the humerus becomes greatly reduced and dorsoventrally flattened. This, in combination with flattening of more distal elements into polygonal plates, forms a robust paddle. Given that the earliest appearing thalattosuchian, *P. teleorhinus*, already possesses the cranial specializations of Teleosauridae, it seems likely that we are missing some key transitional fossils from the early history of the group. In spite of this, the phylogeny presented here allows us to begin piecing together the morphological transformations that allowed these remarkable organisms to fully invade the marine realm.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

CHEWING THE FAT WITH *ARCTODUS*: COLLABORATIVE UNDERGRADUATE DEVELOPMENT OF A CALIBRATE APPARATUS FOR USE IN BITE FORCE RESEARCH

WILKINS, William, The Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States, 57747; PAGNAC, Darrin, South Dakota School of Mines & Technology, Rapid CIty, SD, United States; ELLINGSEN, Marius, South Dakota School of Mines & Technology, Rapid City, SD, United States

The Mammoth Site, a world-renowned paleontology site in Hot Springs, SD, contains *Mammuthus columbi*, *Mammuthus primigenius* and several other late Pleistocene fossils. A mammoth rib (93HS037) bears damage consistent with canine tooth puncture, likely from *Arctodus simus*. Mammoth Site research staff, in collaboration with faculty and students from the Mechanical Engineering (ME) and Geology and Geological Engineering (GGE) departments at South Dakota School of Mines and Technology, designed and built a machine that could replicate these puncture marks in Recent bone and measure the associated force.

Machine design was completed by two ME students as a senior capstone project, a year-long endeavor with formal review cycles. Students interviewed project sponsors for design needs that were translated into functional requirements and constraints and drafted competitive preliminary designs. This resulted in presentation of up to five viable designs for review by sponsors, faculty, and student judges. Students developed a sponsor-chosen design, with operating principles, parts layouts, strength and durability analyses, circuit diagrams, fully-toleranced manufacturing drawings, budgets, and detailed manufacturing plans. After final panel approval, manufacturing began. The completed machine was presented at the annual SDSMT Senior Design Fair to faculty and industry judges and exhibited to local visitors and tested by sponsors.

The principal benefit of this multidisciplinary project was student involvement at all levels, from conception to final product. ME students presented their final design product and a GGE student presented empirical bite force results as a senior thesis. All students contributed to the final display on exhibit at the Mammoth Site. The device is currently being utilized in outreach programs emphasizing the benefits of critical thinking skills involving trophic strategies, scientific data acquisition and analysis, and technical engineering applications. The apparatus is also being used in ongoing research at SDSMT and the Mammoth Site. Student involvement will continue via additional multiple-level student research projects.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

NEW SPECIMENS OF *WORTMANIA* (MAMMALIA, TAENIODONTA) FROM THE EARLY PALEOCENE (PUERCAN) OF NEW MEXICO

WILLIAMSON, Thomas, New Mexico Museum of Natural History and Science, Albuquerque, NM, United States, 87121; BRUSATTE, Stephen, University of Edinburgh, Edinburgh, United Kingdom

Taeniodonta is a clade of late Cretaceous - Paleogene mammals remarkable for their relatively extreme cranial, dental, and postcranial adaptations and notable for being among the first mammals to achieve relatively large size following the Cretaceous-Paleogene mass extinction. Previous workers have hypothesized that taeniodonts can be divided into two clades: Conoryctidae, a group of small-bodied taeniodonts with supposedly "generalized" postcranial skeletons, and Stylinodontidae, a group of large-bodied, robust animals with massive forelimbs and claws adapted for scratch-digging. However, many taeniodont taxa are poorly known and few are represented by postcranial material, leaving many details about their anatomy, biology, and evolution ambiguous. New specimens of the rare taxon *Wortmania otariidens* from the early Paleocene (Puercan) of New Mexico include a specimen with remarkably complete cranial and dental material, with associated upper and lower teeth, and another that consists of partial forelimbs. These specimens allow for an updated anatomical description of this unusual taxon, supply new data for phylogenetic analyses, and enable a more constrained discussion of taeniodont biology and functional morphology. The new specimen of *Wortmania* that includes associated upper and lower teeth indicates that previous interpretations of the upper dentition of this taxon were not accurate and the taxon *Robertschochia sullivani* is a junior synonym of *W. otariidens*. New specimens preserving postcrania affirm that *Wortmania* is very similar to later, large-bodied taeniodonts, with marked and distinctive adaptations for scratch-digging. A preliminary phylogenetic analysis incorporating new morphological data and taxonomic conclusions resulting from the new specimens of *Wortmania* supports *Schowalteria* and *Onychodectes* as basal taeniodonts, and indicates that Conoryctidae is not monophyletic.

Technical Session IX (Friday, November 1, 2013, 11:45 AM)

OSTEOLOGY OF *REBBACHISAURUS GARASBAE*, A DIPLODOCOID (DINOSAURIA: SAUROPODA) FROM THE EARLY LATE CRETACEOUS KEM KEM BEDS OF SOUTHEASTERN MOROCCO

WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, United States, 48109-1079; ALLAIN, Ronan, Museum National D'Histoire Naturelle, Paris, France

The sauropod *Rebbachisaurus garasbae* was discovered in infra-upper Cenomanian horizons of the Kem Kem region of southeastern Morocco in the 1950s. Original materials included part of a vertebral column, some of which was found in articulation, a scapula, humerus, and ischium. Of these remains, only the scapula and dorsal vertebra have been described, but in abbreviated form. Fortunately, these two elements were diagnostic and furnished characters that would later be shown to distinguish a lineage of late-surviving diplodocoid sauropods. Due to the large size of one of its dorsal vertebrae (ca. 1.45 m tall), *Rebbachisaurus* has been considered to be among the largest sauropods.

Following complete preparation of the partial skeleton, careful examination and fitting of scores of fragments collected with these materials, and Computed Tomography

imaging of the most complete vertebra, we present a complete description of the holotype of *Rebbachisaurus garasbae*. Our description identifies several autapomorphies of the dorsal and caudal vertebrae, both relating to the shape of the vertebrae and the architecture of their vertebral laminae. No autapomorphies were identified in the available appendicular bones, but they provide features that are diagnostic of higher-level relationships. Based on this reassessment of the anatomy of *Rebbachisaurus*, we evaluated its phylogenetic position among diplodocoids using character data from previous analyses. Preliminary results place *Rebbachisaurus* just outside Limaysaurinae + Nigersaurinae.

More complete preparation and fitting of pieces provides a clearer picture of the size and proportions of *Rebbachisaurus*. Although the height of its most complete dorsal vertebrae rivals those of the largest sauropod, *Argentinosaurus*, the size of the vertebral centra and the length and cross-sectional area of the humerus of *Rebbachisaurus* are considerably smaller. We estimate that this *Rebbachisaurus* individual was 7915–12 015 kg, which is slightly larger than *Amargasaurus* but comparable in size to some individuals of *Dicraeosaurus*. The dorsal vertebrae of *Rebbachisaurus* and other rebbachisaurids have been suggested to be highly mobile, owing to their elevated neural arch pedicles, confluent zygapophyses, lack of hyposphene-hypantrum articulations, and flat central articulations. Our results suggest that these features actually limited rotation, and these and other features suggest that rebbachisaurid vertebrae had increased resistance to dorsoventrally-directed forces applied to the transverse processes.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

UNIQUE TAPHONOMY OF THE DWARFED SAUROPOD *EUROPASAURUS* FROM LATE JURASSIC MARINE STRATA OF THE LANGENBERG QUARRY (LOWER SAXONY, NORTHERN GERMANY)

WINGS, Oliver, Niedersaechsisches Landesmuseum Hannover, Hannover, Germany; BERENSMEIER, Michaela, Universitaet Potsdam, Potsdam, Germany

Dinosaur tracks are very common in marginal marine environments and even skeletal remains of many dinosaur taxa - including sauropods - have been found in marginal or deeper basinal marine strata. However, most of these allochthonous finds are isolated bones or skeletons from carcasses that drifted out to the sea. The case of the dwarfed sauropod *Europasaurus* from the Kimmeridgian limestones of the Langenberg Quarry near Oker, Germany, is unique because its abundant and exquisite three-dimensionally preserved bones range from disarticulated elements to associated partial skeletons. The taphonomy of this site is still puzzling, because sedimentology and microfacies indicate clearly a shallow marine environment. Thin sections of limestones (wackestone/packstones) from the Langenberg show a diverse marine invertebrate fauna: bivalves and thin-walled gastropods, ostracodes, brachiopods, echinoderms, planktonic and benthic foraminifera appear in almost every layer. Charophytes show freshwater influx in the layer which yielded *Europasaurus*. Well rounded intraclasts and reworked material indicate a high-energy environment. Erosion, bottom reworking, bioturbation, and evaporation events did occur, but there is no evidence for subaerial emersion. Based on lower jaw bones, at least 14 *Europasaurus* individuals are present in the assemblage. Body size ranges from small juveniles 1 m in length to adults with a length of 6 to 8 m. From 770 prepared and measurable bones, 407 (52.9%) belong to the axial skeleton, 235 (30.5%) to the appendicular skeleton, and 128 (16.6%) are cranial bones, indicating a normal distribution of the skeletal elements. The high number of *Europasaurus* individuals renders hypotheses such as drifting carcasses, swimming or rafting animals implausible. Because sauropod and theropod tracks have been found higher up in the sequence, the most parsimonious interpretation is that a herd of *Europasaurus* migrated within the tidal zone and died during the crossing. Their carcasses were exposed long enough to be completely disarticulated. The bones seem to have accumulated in small channels or depressions. Preliminary measurements show no preferred bone orientation or indications for water currents. There is no evidence for terrestrial scavenging and the excellent preservation of even fragile bones (vertebral processes, skull bones) indicate parautochthonous and rather quick burial.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ENAMEL RIDGE ALIGNMENT IN UNGULATES: A CUT ABOVE

WINKLER, Daniela Eileen, Biocenter Grindel & Zoological Museum, Hamburg, Germany

Dentitions of herbivorous mammals are highly specialized food disintegration systems. Over a variety of taxa, analogous adaptations have occurred in tooth crown height (from brachydont to hypsodont) and enamel ridge configuration (from short and simple to long and complex). It has been shown that browsing animals have less complex enamel ridges with wider dentin crushing basins, while grazing species have complexly folded ridges. However, the alignment of enamel ridges in relation to chewing direction is also important for an efficient mastication of a herbivorous diet, as angles close to 90 degree should be most efficient in comparison to lower or higher angulated ridges. I investigate enamel ridge alignments and infer functional traits in extant equids and bovids. Further I assess ontogenetic shifts in functionality and gradients along the cheek tooth row. I utilized subadult individuals with the M3 in early wear in order to cover the longest period with all permanent molars in use. Based on CT-data, dental tissues were segmented and hypothetical occlusal surfaces were created based on enamel areas only. These represent successive ontogenetic stages. From enamel patterns of each plane a functional residual was computed to eliminate thin edges that do not emerge over softer tissues in life and thus do not contribute to shearing function. Angles towards the chewing direction were only computed for leading edges. Lower dentitions generally show a higher alignment towards 90 degree than upper dentitions. The distribution of angles is overall least dispersed in upper and lower third molars. *Equus quagga*, the only grazing perissodactyl in this study has more dispersed angles than grazing bovids, but fewer differences between individual tooth positions, with the exception of P2 and M3. This is due to the high degree of molarization in the premolars in equids. I hypothesize that less dispersion in enamel ridge alignment increases functional focussing on shearing in the M3. As this tooth erupts last, it compensates the loss of function in heavily worn anterior cheek teeth. A concentration of shearing function on the latter tooth position is further consistent with the higher masticatory forces at the posterior end of the dentition. Since the phenomenon seems to be universal to bovids and equids, it indicates a high degree of dental functional compensation independent of digestive physiology.

Technical Session XV (Saturday, November 2, 2013, 9:30 AM)

DIFFERENCES IN INFERRED FORAGING BEHAVIOR AMONG EARLY MIOCENE SPECIES OF *DIPLOTHERIUM*: EVIDENCE FROM A NEW FOSSIL DUGONG FROM THE PANAMA CANAL

WOOD, Aaron, University of Florida, Gainesville, FL, United States, 32611; VELEZ-JUARBE, Jorge, University of Florida, Gainesville, FL, United States; BOURQUE, Jason, University of Florida, Gainesville, FL, United States; BLOCH, Jonathan, University of Florida, Gainesville, FL, United States; JARAMILLO, Carlos, Smithsonian Tropical Research Institute, Panama, Panama

Species of the genus *Dioplotherium*, from the late Oligocene – late Miocene of the East Pacific, Caribbean, and West Atlantic are distinctive from other dugongids from these regions in possessing large, lozenge-shaped tusks interpreted as advantageous for foraging on thick seagrass rhizomes. A partial skeleton of a fossil dugongid attributable to *Dioplotherium* was recently discovered in the lower Culebra Formation (latest Aquitanian – earliest Burdigalian) exposed along the Panama Canal. This specimen, consisting of a skull and cervical – posterior thoracic vertebrae, exhibits characters distinguishing it from its two best-known congeners: *D. manigaulti* from eastern North America and a Brazilian *Dioplotherium* referred to *D. allisoni*. The Panama specimen possesses functional traits that indicate a different feeding strategy than the roughly contemporaneous Brazilian *Dioplotherium*. The traits include less rostral deflection, broad maxillary projections into the palatal keratinous pad attachment site, prominent temporal crests on the parietal, and a posteriorly-directed flange above the supracondylar fossa of the exoccipitals. The flange may have served as an enlarged attachment site for atlanto-occipital ligaments. Similarly, the attachment sites for the m. rectus capitis on the dorsal arch of the atlas vertebra are more robust and project dorsally to a greater degree. Greater rostral deflection is considered an adaptation for bottom foraging on rhizomes while maintaining a horizontal position in the water column, suggesting that the Brazilian *Dioplotherium* specimen may have been more specialized for this feeding strategy than the Panamanian specimen. However, the enlarged ligament and muscle attachment sites associated with atlanto-occipital joint in the Panama specimen indicates habitual downward motion of the head, permitting bottom feeding without compromising an overall horizontal posture. The Panamanian *Dioplotherium* likely had a different feeding strategy than its congeners; its functional traits are more consistent with pit-making behavior than a linear feeding-trail strategy expected in taxa with higher rostral deflection. Such remarkable differences in inferred feeding strategy among congeners support previous hypotheses that competition for seagrass resources is the major driver of morphological diversity in fossil sirenians.

Symposium 1 (Wednesday, October 30, 2013, 11:00 AM)

CHANGES IN VERTEBRAL MOPRHOLOGY ASSOCIATED WITH HISTOLOGIC DATA SUPPORT SIGNIFICANT CHANGE THROUGH ONTOGENY IN DIPLODOCID SAUROPODS

WOODRUFF, Cary, Museum of the Rockies & Montana State University, Bozeman, MT, United States, 59717; FOWLER, Denver, Museum of the Rockies & Montana State University, Bozeman, MT, United States; HORNER, John, Museum of the Rockies & Montana State University, Bozeman, MT, United States

It is difficult to determine maturity in sauropod dinosaurs because Lines of Arrested Growth (LAGs) are destroyed or obscured due to rapid secondary remodeling. Although a complimentary system has been devised utilizing relative amounts of remodeling (Histologic Ontogenetic Stage [HOS]; youngest HOS = 1, oldest =13) most assessments of sauropod maturity are based on osteological features such as skeletal fusion. To better assess indications of maturity, and to test recent assertions about ontogenetic change of gross skeletal features, we examined material from over twenty small individuals of Diplodocidae (up to two-thirds the size of *Diplodocus carnegii* [Carnegie Museum specimen CM 84] and *Apatosaurus louisae* [CM 3018]) from the Morrison Formation. Along with macroscopic examination of cranial, vertebral, and limb elements, in select specimens we also examined pneumatic structures via computed axial tomography and histology of cervical and thoracic ribs, neural spines, and limb bones. We found consistent combinations of vertebral morphology which, combined with histology, can be used to ascertain maturity. The fifteen small diplodocids (approximately one-third size) from the Mother's Day Quarry (MDQ) display non- to weakly bifurcated cervical and dorsal neural spines, acamerate to camerate centra, cervical rib microstructure identical to juvenile hadrosaur ossified tendons, and two to six preserved LAGs in thoracic ribs. Individuals larger than the MDQ specimens (approximately two-thirds size) have more developed internal pneumatic structures, greater neural spine bifurcation, preserve up to eight LAGs, and are HOS 9. This contrasts with the larger and presumably adult sauropods (CM 84 and CM 3018) that have complex pneumatic structures such as pervasive camerae in the centrum and neural arch, exaggerated neural spine bifurcation that now includes the anterior caudals, cervical rib microstructure identical to adult hadrosaur ossified tendons, and have reached HOS 12 or 13. Further, all of the small skulls examined (Academy of Natural Sciences [ANS] 21122, Sauriermuseum Aathal [SMA] 0004, SMA 0011, and Museum of the Rockies [MOR] 592) possess a post-parietal foramen, which has been suggested to be an apomorphy of Dicraeosauridae, but which is absent in large skulls (such as CM 84) suggesting that it may be an ontogenetic character seen only in young individuals. These findings suggest that significant morphological change occurred during the ontogeny of diplodocid sauropods, and that

erecting new taxa on the basis of small-bodied holotypes should be approached with caution.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

SUPERTREE PERSPECTIVES ON THE PHYLOGENY OF FOSSIL AND EXTANT MAMMALS

WOODRUFF, Emily, University of Florida, Gainesville, FL, United States, 32611; BURLEIGH, Gordon, University of Florida, Gainesville, FL, United States; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, United States

Large-scale phylogenetic studies have elucidated the relationships of extant mammals but the evolutionary placement of many fossil taxa within these trees is less clear. Combining extant and fossil taxa is particularly challenging given the difficulty of analyzing molecular and morphological data simultaneously. Additionally, phylogenetic studies that focus on fossil mammals are generally limited in taxonomic scope. Supertree methods provide one approach to combining disparate data from partially overlapping taxa into a single comprehensive phylogenetic hypothesis. Given the extensive number of previous studies of relationships among mammal taxa, it is now possible to infer the evolutionary relationships of all major clades of fossil and extant mammals using supertree methods. We investigate the evolutionary relationships of 580 representative taxa from all major mammalian clades including fossil and extant mammals using the matrix representation with parsimony (MRP) and the Robinson-Foulds (RF) supertree methods. MRP is the most widely used supertree method, but RF is a new method that directly seeks the supertree that includes the most clades found in the input trees. We compare the performance of MRP and RF methods and assess criteria for selecting source trees, re-analysis of source trees, and taxon overlap between different data sets. The supertrees presented here reveal a framework with which many other evolutionary questions may be addressed, in particular, documenting large-scale patterns of morphological change.

Symposium 1 (Wednesday, October 30, 2013, 8:45 AM)

PREDICTING PEAK PERFORMANCE AND SENESCENCE IN THE ORNITHOPOD DINOSAUR *MAIASAURA PEEBLESORUM*

WOODWARD, Holly, Montana State University, Museum of the Rockies, Bozeman, MT, United States, 59717; HORNER, John, Montana State University, Museum of the Rockies, Bozeman, MT, United States; FREEDMAN FOWLER, Elizabeth, Montana State University, Museum of the Rockies, Bozeman, MT, United States

Juvenile mortality rates of birds and mammals are generally high until individuals attain threshold body size and reproductive experience. They then enter a period of 'peak performance', when survival rates and reproductive success are greatest. Senescence follows, signaled by deterioration in reproductive fitness and increasing mortality rates. Ongoing population studies of red deer (*Cervus elaphus*) from the Isle of Rum, Scotland, reflect such survivorship patterns. Variation in post-peak performance conditions of red deer demonstrate that increased early investment in growth and reproduction is followed by earlier onset of senescence. Because osteohistology has demonstrated that large-bodied dinosaurs grew at rates similar to those of birds and extant mammalian megafauna, the extensive red deer population studies provide satisfactory analogues for large-bodied dinosaur life history studies, including inferences regarding peak performance. A laterally extensive bonebed of the hadrosaurid dinosaur *Maiasaura peeblesorum* provides an excellent comparative sample to the red deer studies. As with extant mammals and birds, juvenile mortality rates of *Maiasaura* were high; of 50 tibiae histologically examined, 31 represent individuals less than a year of age. Peak performance, signaled by a period of increased survivorship, began during the third year of growth and was therefore uncoupled from asymptotic body size. Instead, it coincided with sexual maturity, as body mass at 3 years was between the 1/3 and 1/2 adult mass predicted for the onset of sexual maturity in dinosaurs. However, growth curves demonstrate that of those individuals achieving sexual maturity, only the largest survived to senescence. This may indicate that an initial early investment in growth, and likely reproductive fitness, increased the chance of surviving to skeletal maturity. Senescent deterioration after the period of peak performance is evidenced by a second episode of elevated mortality that began between 8 and 9 years of age, coinciding with asymptotic size. If attainment of maximum body size is correlated with rapid senescent deterioration, this may explain why especially large, skeletally mature dinosaurs are rare in the fossil record. Additionally, if the highest survivorship rates occurred during peak performance, then the majority of dinosaur specimens collected likely represent juvenile individuals, as well as those just entering sexual maturity but unable to survive the added physiological stresses of reproduction.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

THE LOWER JURASSIC ACTINOPTERYGIAN *PACHYCORMUS BOLLENSIS*: IMPLICATIONS FOR PACHYCORMIFORM PHYLOGENY AND PALEOBIOGEOGRAPHY

WRETMAN, Lovisa, Uppsala University, Uppsala, Sweden; BLOM, Henning, Uppsala University, Uppsala, Sweden; KEAR, Benjamin, Uppsala University, Uppsala, Sweden

Pachycormiforms were a group of Mesozoic stem-teleost fishes that first diversified in the Early Jurassic (Sinemurian−Toarcian) and declined towards the end of the Cretaceous (Campanian−Maastrichtian). Their monophyly has been robustly established on the basis of unique derived traits, including peculiar scythe-like pectoral fins, reduced pelvic fins, and a fused rostrodermethmoid. Ecologically, however, pachycormiforms appear to have radically diverged into parallel hyper-specialized radiations: pursuit carnivores characterized by massive blade-like teeth and an elongate 'sword-fish like' snout; and colossal filter-feeders, which trend towards tooth loss and include some of the largest fishes of all time. The phylogenetic framework underlying this extreme evolutionary dichotomy was re-evaluated using parsimony and Bayesian methods, together with a comprehensive assessment of one of the most ancient (Toarcian, Early Jurassic) and best-preserved taxa, *Pachycormus bollensis*, from the famous Holzmaden deposits of Germany. The placement of *Pachycormus* is critical to pachycormiform tree topology because it has been variously nested as a basal sister to either the carnivorous or filter-feeding ecomorph clades. Confoundingly, our rescored analyses failed to resolve this uncertainty, and moreover, returned weak support for almost all ingroup nodes within Pachycormiformes. Nevertheless, a rationalization of *Pachycormus* species-level diversity can be proposed, and a preliminary quantitative palaeobiogeographical hypothesis infers origin of the pachycormiform lineage within the Boreal Tethys followed by endemic speciation of carnivorous forms in epicontinental seaways and trans-oceanic dispersal of gigantic pelagic filter-feeders.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

MORPHOLOGICAL DIVERSITY AND PHYLOGENY OF THE 'TURTLE-LOOKING' SAUROSPHARGIDAE

WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada, K1P 6P4; LI, Chun, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; JIANG, Da-yong, Peking University, Beijing, China; CHENG, Long, Wuhan Institute of Geology and Mineral Resources, Wuhan, China; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States

Saurosphargidae was a newly established group of the Triassic marine reptiles in 2011 although it was not defined then. The type species, *Saurosphargis volzi* from the Lower Muschelkalk (Anisian, Middle Triassic) of Poland, was based on a fragment of the trunk which was first mentioned by Huene in 1902. The nearly rounded body with an enclosed rib-basket under a fully developed dermal armor was not known for the group prior to the discovery of *Sinosaurosphargis yunguiensis* from the Middle Triassic of China in 2011. As for phylogenetic relationships, *Saurosphargis volzi* was originally thought to be closely related to placodonts and later to *Helveticosaurus*. With the discovery of *Sinosaurosphargis yunguiensis*, a thalattosaurian affinity of Saurosphargidae was proposed in 2011. Here we report a new saurosphargid with two species. It represents a new morphotype for the group, showing an elongate body with no completely developed dermal armor to cover the rib-basket. In addition, the new form retained a moderately developed supratemporal fenestra and reveals the presence of a suborbital fenestra and a large supratemporal bone. With additional information from the new form, Saurosphargidae can be well diagnosed by a set of characters, such as dorsal ribs forming a closed basket, presence of dorsal osteoderms, external naris retracted and much closer to orbit than rostral tip, presence of interpterygoid vacuity and open braincase-palatal articulation, lateral most elements of gastral ribs broadened to contact each other, supratemporal extensively meeting quadrate shaft, posterior margin of skull roof deeply emarginated, jugal contacting squamosal, leaf-shaped tooth crown with convex labial surface and concave lingual surface, dorsal vertebrae with elongate transverse processes and a very low neural spines, large interclavicle boomerang-like or atypically 'T'-shaped, nine carpals, and four tarsals. The discovery of the new form also added further data for phylogenetic analysis; our study suggests a sister-group relationship to Sauropterygia rather than to Thalattosauria.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

A MIDDLE OLIGOCENE (WHITNEYAN) RHINOCEROTID FROM NORTH-EASTERN CALIFORNIA

WYSS, Andre, University of California, Santa Barbara, Santa Barbara, CA, United States, 93106-9630; BRIGHT, Jen, University of Bristol, Bristol, United Kingdom; TIFFNEY, Bruce, University of California, Santa Barbara, Santa Barbara, CA, United States

Rhinoceroses were an important component of North American mammal faunas from the middle Eocene through the Miocene, occurring in abundance and in high diversity in several ecological niches and habitats. A significant hindrance to understanding North America rhinocerotid biogeography is the group's poor sampling outside the High Plains and eastern Rocky Mountain regions, from which the overwhelming majority of fossils come. Few specimens have been recovered elsewhere owing to sparse terrestrial sediments of appropriate age and lithology. This geographic restriction is particularly true of early – middle Oligocene time, with over 90% of localities in the Whitneyan North American Land Mammal 'Age' (NALMA) occurring in the White River Badlands of South Dakota. Thus, the recovery of a rhinocerotid from outside the High Plains is significant. We describe a new rhinocerotid specimen, a mandibular fragment bearing two molar teeth, from the Middle Oligocene Steamboat Formation (SF) of the north-eastern Warner Mountains in California. Although the SF is well known for preserving a rich assemblage of fossil plants, to our knowledge this new specimen is only the second mammalian fossil recovered from the area. The first, another rhinocerotid lower molar not previously fully described or illustrated, clearly pertains to the same taxon and horizon. The lack of distinctive morphological characters suggests both fossils be conservatively referred to Rhinocerotidae *incertae sedis*. On the basis of published tooth measurement data, *Trigonias osborni* represents the closest match, but this species is currently only known from the Chadronian NALMA, and upwards temporal extension of this taxon into the Whitneyan is required to encompass these fossils. Similarly, the Whitneyan taxon *Diceratherium tridactylum* is also approximately the right size, but is currently only known from the High Plains and its presence in California would expand its geographic range substantially. Of greatest importance here is the recognition that sediments of the eastern Warner Mountains are a potential and largely unexplored locale for early – middle Oligocene fossil vertebrates. The paucity of terrestrial vertebrate fossil localities not only for this region, but also for this time period, suggest that these strata may yield important finds that would fill in a gap in the rhinocerotid record of North America, and possibly other taxa as well.

Poster Session III (Friday, November 1, 2013, 4:15 - 6:15 PM)

HOMEOTIC TRANSFORMATION IN THE EVOLUTION OF THE THEROPOD SEMILUNATE CARPAL

XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; ZHAO, Qi, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; HAN, Fenglu, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China

The 'semilunate' carpal, historically interpreted as an important structure linking non-avian and avian dinosaurs, is traditionally regarded based on paleontological data as having been formed by fused distal carpals 2 and 3 in extinct maniraptorans including *Archaeopteryx* (we identify the three manual digits of tetenuran theropods as II-III-IV). However, this interpretation is inconsistent with embryological data from extant maniraptorans (birds), in which the 'semilunate' element is partly formed by distal carpal 4.

Here we describe the wrist morphologies of some exceptionally well preserved non-avian maniraptoran specimens representing different ontogenetic stages. These rarely preserved sources of ontogenetic data from non-avian maniraptorans support the primary homology hypothesis that distal carpal 4 was involved in formation of the 'semilunate' carpal. Furthermore, the 'semilunate' shape shifts its position laterally along the proximal end of the metacarpus in tetanuran evolution, probably as a result of selection for foldable wings in birds and their close theropod relatives. We propose that homeotic transformation was involved in the evolution of the 'semilunate' shape, as has been suggested for tetanuran manual digits.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

EXTANT HYPSODONT UNGULATES PROVIDE NEW INSIGHT ON MESOWEAR ANALYSIS FOR THE LATE MIOCENE UNGULATES FROM MARAGHEH, IRAN

YAMADA, Eisuke, Kagoshima University, Kagoshima, Japan; HASUMI, Eri, Kagoshima University, Kagoshima, Japan; MIYAZATO, Nao, Kagoshima University, Kagoshima, Japan; NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan; WATABE, Mahito, Hayashibara Museum of Natural Science, Okayama, Japan

We investigated the paleoecology of fossil hypsodont equids and bovids from the late Miocene Maragheh Formation, northwestern Iran. The excavation report of the animals from Maragheh used in this study suggests that they were excavated from a single quarry and bed, indicating that they were sympatric. In fact, several extant plant-eating mammalian taxa exist sympatrically, which indicates dietary segregation. However, few studies have been made to show how results of mesowear analysis might reflect these differences. This study involved an interspecific comparison of extant sympatric mammalian populations with known diets; Japanese sika deer (*Cervus nippon*; Cervidae) and Japanese serow (*Capricornis crisps*; Bovidae). In a deciduous broad-leafed forest of central Japan, the deer is a mixed-feeder whereas the serow is a browser. We scored upper second molars of the deer (n = 55) and the serow (n = 37) and compared these with a dataset of extant forms. The results clearly suggest that the mesowear analysis correctly extrapolates their food habits.

Next, the same mesowear analysis was applied to upper and lower fossil cheek teeth of 128 specimens of equids and 89 of bovids from Maragheh (*"Hipprion"* fauna). The results indicate that the equids have mainly grazing diets whereas sympatric bovids were more likely browsers. Based on the analysis of extant forms, the mesowear results of the Maragheh hypsodont animals suggest dietary niche segregation. This result supports a hypothesis that the paleoenvironment of the late Miocene Maragheh formation would have been a mosaic of woodland and herbaceous habitats that allowed for feeding segregation of the plant-eaters.

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

A NEW ANKYLOSAUR DINOSAUR FROM THE EARLY CRETACEOUS HEKOU GROUP OF LANZHOU-MINHE BASIN, NORTH-CENTRAL CHINA

YANG, Jing-Tao, China University of Geosciences (Beijing), Beijing, China; YOU, Hai-Lu, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; LI, Da-Qing, Gansu Geological Museum, Lanzhou, China; KONG, De-Lai, Administration of Liujiaxia Dinosaur National Geopark, Yongjing, China

New ankylosaurian dinosaur material was recovered from the Early Cretaceous Hekou Group in Lanzhou-Minhe Basin, north-central China. The material is housed at Gansu Dinosaur Museum (GSDM 00021) and represented by a proximal–mid caudal vertebra, three dorsal ribs, an almost complete left ilium, and several pieces of dermal armor including a partial sacral shield. GSDM 00021 possesses three autapomorphies: shape of neural canal of proximal–mid caudal vertebra an inverted trapezium, lateral edge of preacetabular process inverted 'S'-shape in dorsal view, and sacral shield composed of various-sized and irregularly-arranged osteoderms. Cladistic analysis shows that GSDM 00021 is a polacanthine nodosaurid ankylosaur, and is the sister taxon of *Polacanthus foxii* from the Early Cretaceous (Barremian) of England. Here Polacanthinae is defined as the most inclusive clade containing *Polacanthus foxii* but not *Ankylosaurus magniventris* or *Panoplosaurus mirus*. GSDM 00021 represents the first occurrence of a polacanthine ankylosaur in Asia, and indicates again the existence of a rich and unique dinosaur assemblage in the Lower Cretaceous Hekou Group of Lanzhou-Minhe Basin.

Technical Session X (Friday, November 1, 2013, 8:30 AM)

THE INFLUENCE OF FEEDING ECOLOGY ON THE DISTRIBUTION OF NORTH AMERICAN PLEISTOCENE CAMELIDS

YANN, Lindsey, Vanderbilt Univeristy, Nashville, TN, United States, 37235-1805; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, United States; KOCH, Paul, Univ of California Santa Cruz, Santa Cruz, CA, United States; LUNDELIUS, Ernest, Univ of Texas at Austin, Austin, TX, United States

The paleoecology and diet of Pleistocene camelids can be used to better understand how modern camelids are adapted to some of the harshest environments on Earth. Stable isotope analyses of herbivores from six mid-lower latitude sites in the United States (n=327) were used to assess if the opportunistic feeding behavior of dietary generalists allowed for the co-occurrence of genera from the same family. We aim to clarify the feeding behavior of camelids and how their diet and/or occurrence at Pleistocene fossil sites is potentially affected by the presence of other taxa including members of the same family. $\delta^{13}C$ values were used to infer diet and corresponding floral landscapes, while environmental heterogeneity was investigated using dietary specialists such as obligate grazers, *Equus* and/or *Bison*, and obligate browsers, *Mammut* and/or *Tapirus*, the latter typically found in dense forests. At the genus level, *Palaeolama* has a more restricted diet (composed of C_3 vegetation; mean=-12.2‰, range=3.9‰) than *Hemiauchenia* (-7.6‰, 11.1‰) or *Camelops* (-6.0‰, 13‰; all $p<0.0001$). Independent analysis of each site suggests that Ingleside had dense forests and open grasslands while the floral environment at McKittrick Brea was less variable since the isotopic composition of faunal diets are more similar to one another and intermediate in isotopic values. At Leisey 1A, *Hemiauchenia* has a greater mean $\delta^{13}C$ value (-6.4‰) than *Palaeolama* (-13‰, $p<0.0001$). At Ingleside, *Camelops* has a greater mean $\delta^{13}C$ value (-8.5‰) than *Palaeolama* (-11.5‰, $p=0.041$), and *Camelops* also has a greater range in $\delta^{13}C$ values (-12 to -1‰) than *Palaeolama* (-11.3 to -10.8‰). At Haile 8A and Inglis 1A *Hemiauchenia* is the only camelid present, and $\delta^{13}C$ values range from -12.1 to -2.4‰ and -11.3 to -10.8‰, respectively. These $\delta^{13}C$ values are consistent with a specialized forest browsing dietary niche occupied by *Palaeolama* and more generalized diets in *Hemiauchenia* and *Camelops*. Additionally, based on occurrence data from the Paleobiology Database, *Palaeolama* co-occurs with *Tapirus* at ~90% of Pleistocene sites. This suggests that *Palaeolama* may be restricted to forested environments, much like *Tapirus*, while *Camelops* and *Hemiauchenia* co-occur with a broader range of taxa including just obligate grazers or both grazing and browsing taxa. Collectively, these data clarify the dietary ecology of extinct camelids and potential biotic factors influencing their distributions during the Pleistocene.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

ESTIMATING BODY MASS OF FOSSIL PRIMATES: A COMPARISON OF DENTAL AND TARSAL VARIABLES

YAPUNCICH, Gabriel, Duke University, Durham, NC, United States, 27708; GLADMAN, Justin, The Graduate Center, CUNY, New York, NY, United States; BOYER, Doug, Duke University, Durham, NC, United States

Body mass is a fundamental descriptor of an animal's ecology. For fossil species, reliable body mass estimations provide avenues for understanding an extinct species' ecological and behavioral profile. Since the last comprehensive analysis using tarsal elements for estimating primate body mass, there have been substantial increases in fossil specimens, documentation of extant primate body masses, and digital measurement technology. All three factors expand the potential for accurate predictions. Here we present ordinary least squares regression equations for inferring fossil primate body mass from astragalar and calcaneal facets, two bones with good representation and secure taxonomic attribution throughout the primate fossil record. Unlike teeth, articular surfaces of weight-bearing joints transmit forces proportionally to body mass, and therefore offer great promise for predicting body mass.

Using surfaces generated from microCT data, the articular surface areas of five astragalar facets and two calcaneal facets were digitally measured in samples of 216 and 99 euarchontans for each element respectively. Body masses of non-captive primate populations were taken from published sources, log-transformed and regressed against log-transformed facet areas. Separate regressions are presented for all primates, strepsirrhines, and anthropoids. For all predicted body masses, bias introduced by log-transformation was corrected using a quasi-maximum likelihood estimator. For mean body mass estimates, we calculate geometric mean mass estimates (using correlation coefficient of each regression to weight respective estimates), while the maximum value of lower confidence intervals and minimum value of upper confidence intervals for all estimates provide a bounded range for each specimen. Estimates for species from sixteen fossil primate families, spanning Paromomyidae to Proconsulidae, are compared to previously published body masses derived from both dental and postcranial measures. Our results reveal consistent agreement between area-based predictions, while linear measures often generate non-overlapping ranges when comparing estimates derived from the same skeletal element. Additionally, values for the standard error of the estimation are lower than previous results, even within the 'all-primates' sample. Compared to published dental estimates, these regressions generate smaller body masses for most fossil primates examined, indicating the importance of considering postcrania in body mass estimations.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

INNER-EAR MORPHOLOGY SUGGESTS BURROWING BEHAVIOUR IN EARLY SNAKES

YI, Hong-yu, American Museum of Natural History, New York, NY, United States, 10024-5192

More than 3000 living species of snakes share a limbless body plan, and are adapted to varying media including air (flying snakes), soil (burrowing snakes) and water (sea snakes). It is hotly debated whether snakes developed their specialized locomotion in a terrestrial or aquatic environment. This study uses endocranial structures (ossified inner ear) of recent and fossil snakes to test the hypotheses: 1) inner-ear morphology is indicative of snake locomotion styles including fossorial, surface active or aquatic; 2) the inner ear of *Dinilysia patagonica*, one of the oldest fossil snakes, suggests it to be a burrower. To test the hypotheses, 10 snake species and 9 lizard species are CT-scanned for inner-ear morphology. The sampling covers all major clades of snakes, and includes both limbed and limbless lizard species for outgroup comparisons. The ossified inner ear is segmented and reconstructed three-dimensionally, including three semicircular canals (anterior, posterior, and lateral) and the vestibule that form the vestibular (balance) apparatus of all vertebrates. The results show that distance between the lateral semicircular canal (SCC) and vestibule is indicative of locomotion in snakes. Among the three locomotion categories sampled, fossorial species show a highly reduced lateral SCC that is partly fused with the vestibule. In contrast, aquatic species, represented by several species of sea snakes, show an expanded distance between lateral SCC and the vestibule. Non-burrowing terrestrial snakes show an intermediate state where the lateral SCC does not fuse with the vestibule, but is not as expanded as in sea snakes. Results in extant species provides a context for comparison for the fossil snake *Dinilysia patagonica*. Recently published CT images of *Dinilysia patagonica* shows that its lateral SCC is slender and nearly fused to the vestibule, resembling the fossorial Asian sunbeam snakes (*Xenopeltis unicolor*). Our observations in extant snakes suggest that this resemblance is actually indicative of a burrowing behavior. Since *Dinilysia patagonica* is a terrestrial snake recovered phylogenetically near the root of all snakes, its inner ear provides evidence for burrowing behavior for early snakes.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

NEW SAUROPOD FROM THE CEDAR MOUNTAIN FORMATION OF UTAH, USA

YOSHIDA, Junki, Hokkaido University, sapporo, Japan; CARPENTER, Kenneth, Utah State University Eastern, Price, UT, United States; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, sapporo, Japan

The Early Cretaceous Cedar Mountain Formation is known as one of the richest dinosaur bearing formations of the time in North America, and produces the greatest diversity of Early Cretaceous sauropods in North America. Postcranial skeletons of a possibly new sauropod dinosaur were discovered from the base of the early Albian Mussentuchit Member, the uppermost member of the Cedar Mountain Formation, at the Price River II (PR2) Quarry near Price, Utah. The PR2 quarry is a multitaxic bonebed including disarticulated sauropod, ankylosaur (*Peloroplites* and *Cedarpelta*), iguanodontian, pterosaur, and turtle materials. The PR2 sauropod specimens include vertebrae (middle cervicals, dorsals, and caudals), forelimbs, and hind limbs, represented by at least three individuals based on the number of metacarpals. Phylogenetic analysis demonstrates that five synapomorphies of Titanosauriformes are present in the PR2 sauropod: camellate internal structure of the presacral vertebrae, anterior position of the neural arch on the centrum of anterior and middle caudal vertebrae, metacarpal I with undivided distal condyles, ratio of the haemal canal height and total chevron height approximately 0.5 in anterior caudal vertabrae, and pubic peduncle of ilium 1.5 times wider than long anteroposteriorly. The PR2 sauropod forms an unresolved polytomy with the Early Cretaceous derived brachiosaurids from the Ceder Mountain Formation (*Abydosaurus* from the Albian Mussentuchit Member, *Cedarosaurus* from the Barremian Yellow Cat Member, and *Venenosaurus* from the Aptian-Albian Poison Strip Member), sharing a synapomorphy (reduced fourth trochanter of the femur). This sauropod is probably a new taxon because it shows unique combination of characters (high iliac peduncle of ischium, vertically to posterodorsally projecting neural spines of middle caudal vertebrae, and gracile humerus, absence of transverse process with deep fossa into ventral face), differing from the other derived brachiosaurids. The occurrence of four derived brachiosaurids in the Cedar Mountain Formation indicates a great diversity of brachiosaurids in Utah during the Early Cretaceous, and suggests an actual time range for the existence of the derived brachiosaurids in this region between the Barremian and Albian.

Technical Session IX (Friday, November 1, 2013, 8:30 AM)

A NEW COELOPHYSOID THEROPOD DINOSAUR FROM THE EARLY JURASSIC LUFENG FORMATION OF YUNNAN PROVINCE, CHINA

YOU, Hai-Lu, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; AZUMA, Yoichi, Fukui Prefectural University, Fukui, Japan; WANG, Tao, Bureau of Land and Resources of Lufeng County, Lufeng, China; DONG, Zhi-Ming, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Coelophysoid dinosaurs are small- to medium-sized agile bipedal meat-eaters that lived throughout much of Pangaea during Late Triassic–Early Jurassic time. They are among the earliest well-documented dinosaurs and represent the first major radiation of neotheropods. A recent study indicated that late Norian–Rhaetian theropod assemblages were dominated by basal coelophysoids, whereas Early Jurassic ones were composed of derived coelophysoids (i.e., the '*Syntarsus*' + *Coelophysis* clade), dilophosaurids and basal averostrans. However, despite the well-documented discoveries of derived coelophysoids in North America and Africa, the coelophysoid material that has previously been reported from Asia is limited to two specimens comprising only limb fragments and perhaps belonging to one individual. Here we report a new coelophysoid based on a well-preserved skeleton from the same rock unit, the Lower Jurassic Lufeng Formation of Yunnan Province, China, that yielded both previously reported specimens. The new specimen, Bureau of Land and Resources of Lufeng County (LFGZ) ZLJ0103, is represented by an articulated partial skeleton that includes the cranium, the presacral vertebral column, part of the rib cage, the right scapula and partial right forelimb, part of the pelvic girdle and parts of both hind limbs, the right hind limb being almost complete. It is distinguished from other coelophysoid theropods by the unique combination of the following six character states: 1) large internal antorbital fenestra, 2) diagonal (rostrodorsal-caudoventral) ridge on lateral surface of maxilla, within antorbital fossa, 3) elliptical, laterally facing fenestra caudodorsal to aforementioned diagonal ridge, 4) presence of promaxillary fenestra, 5) long maxillary body, and 6) hooked craniomedial corner of distal tarsal IV. Cladistic analysis recovers (LFGZ) ZLJ0103 as a member of a clade that also includes '*Syntarsus*' and *Coelophysis*, and indicates that (LFGZ) ZLJ0103 is more closely related to *Coelophysis* than to '*Syntarsus*'. (LFGZ) ZLJ0103 represents the first well-preserved coelophysoid theropod dinosaur from Asia, and provides fresh evidence supporting the hypothesis that terrestrial tetrapods tended to be distributed pan-continentally during the Early Jurassic.

Poster Session IV (Saturday, November 2, 2013, 4:15 - 6:15 PM)

NEW UPPER JURASSIC MARINE VERTEBRATES FROM A BONEBED IN THE ATACAMA DESERT, NORTHERN CHILE

YURY-YÁÑEZ, Roberto, Red Paleontológica Universidad de Chile, Santiago de Chile, Chile; SOTO-ACUÑA, Sergio, Red Paleontológica Universidad de Chile, Santiago de Chile, Chile; OTERO, Rodrigo, Red Paleontológica Universidad de Chile, Santiago de Chile, Chile; ROJAS, Osvaldo, Museo de Historia Natural y Cultural del Desierto de Atacama, Calama, Chile; VARGAS, Alexander, Red Paleontológica Universidad de Chile, Santiago de Chile, Chile

The Upper Jurassic record of marine vertebrates from the Southeastern Pacific is restricted to the Callovian-Tithonian of the Neuquén Basin in northwestern Patagonia of Argentina and the Oxfordian of Northern Chile. Here we provide new information about the fossil vertebrate fauna from the Jurassic of Chile. The materials come from a bonebed belonging to the Cerritos Bayos Formation exposed near Calama, Northern Chile, and were recovered from levels of Oxfordian age. The assemblage is mainly comprised of abundant bony fishes and reptiles, which are fragmentary but show 3D preservation. Reptiles are represented by postcranial material referable to indeterminate cryptocleidian plesiosaurs. Also, there is abundant material of thalattosuchian crocodyliforms including cranial and postcranial remains. Among the firsts is a natural snout endocast of a Metriorhynchidae preserving a portion of the rostrum, the nasopharyngeal ducts, the salt glands and the left orbit. In addition, a large portion of the rostrum as well as part of the skull referable to a novel form of ichthyosaur was recovered from the same beds. Finally, we report remains of a new non-pterodactyloid pterosaur represented by a rostral portion of a skull with remarkable heterodonty and a high skull with convex profile. The latter comprises the first record of Upper Jurassic pterosaurs in Chile and one of the few findings of the group in South America during this period. The current study of this Oxfordian herpetofauna and its comparison with the Jurassic Caribbean and Tethyan reptiles is fundamental to understanding the paleobiogeographic distribution of these reptilian lineages. The faunas previously described in the Jurassic of the Neuquén Basin shows close relationships with the Western Tethyan faunas in Europe, supporting the Caribbean Seaway as a migration route used by marine reptiles.

Technical Session VI (Thursday, October 31, 2013, 10:45 AM)

A REASSESSMENT OF THE MONOPHYLY OF CARNIVORAMORPHA (MAMMALIA)

ZACK, Shawn, University of Arizona College of Medicine-Phoenix, Phoenix, AZ, United States, 85004

Carnivoramorpha, including crown group Carnivora and the Paleocene-Eocene families Miacidae and Viverravidae, is widely acknowledged to be monophyletic and has historically been characterized by a suite of dental synapomorphies. Most notably, restriction of carnassial shear to the P4/m1 pair is widely recognized as a distinctive feature that distinguishes carnivoramorphans from other carnivorous eutherians, including the likely non-monophyletic order Creodonta. Previous tests of carnivoramorphan monophyly have been limited and carnivoramorphan monophyly has never been tested relative to Oxyaenidae. To remedy this, oxyaenids and additional hyaenodontids, as well as several early members of Miacidae and Viverravidae, were added to a modified version of an existing phylogenetic analysis of carnivoramorphan phylogeny. Neither Creodonta nor Carnivoramorpha was found to be monophyletic. Oxyaenidae was identified as the sister taxon to Carnivoraformes (Miacidae plus Carnivora), followed by members of Hyaenodontidae. Viverravidae was basal to all other members of the ingroup.

Three lines of evidence are consistent with non-monophyly of Carnivoramorpha. First, some features thought to be synapomorphic for Carnivoramorpha are more broadly distributed among early carnivorous eutherians. These include a mesial P4 protocone, which also occurs in some hyaenodontids and oxyaenids, and distal reduction in molar size, which also occurs in palaeonictine and probably tytthaenine oxyaenids. Second, restriction of carnassial shear to the P4/m1 pair appears to be convergent between viverravids and miacids, as basal members of both families retain a functional M1/m2 carnassial pair (e.g., *Simpsonictis*, *Gracilocyon*). Finally, postcranial anatomy supports monophyly of Oxyaenidae plus Carnivoraformes. Early members of Oxyaenidae and Miacidae show adaptations to relatively mobile limbs, consistent with arboreality or scansoriality. Numerous features of the humerus and tarsus link oxyaenids to miacids to the exclusion of the more terrestrially adapted hyaenodontids and viverravids.

Poster Session II (Thursday, October 31, 2013, 4:15 - 6:15 PM)

SIGMODONTINE RODENTS FROM THE LATE PLEISTOCENE OF THE TALARA TAR SEEPS (NORTHWESTERN PERU) - SYSTEMATICS, PALEOENVIRONMENTAL INFERENCES, AND PRELIMINARY TAPHONOMIC STUDY

ZAPATA, John Percy, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru; MARTINEZ, Jean-Noël, Instituto de Paleontología, Universidad Nacional de Piura, Piura, Peru; RINCON, Ascanio, Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas, Venezuela

Since the excavations made at the late Pleistocene Talara Tar Seeps (Piura Region, northwestern Peru) in 1958 by Gordon Edmund of the Royal Ontario Museum, only three genera of rodents have been mentioned for the fauna, but without identification to species: a hydrochoerid (*Neochoerus*) and two sigmodontines (*Phyllotis* and *Sigmodon*). Between 2003 and 2011, occasional excavations at this site by the Paleontological Institute at the National University of Piura, allowed us to collect 62 samples of sigmodontine rodents, representing a minimum number of 12 individuals. They are assigned to two species: *Thomasomys* sp. (seven individuals) and *Phyllotis* cf. *P. amicus* (five individuals). While the occurrence of *Phyllotis amicus* does not indicate a marked difference between the present environmental conditions and those of the late Pleistocene in the region of Talara, the presence of *Thomasomys* is more surprising as all extant species of this genus are known from higher and wetter habitats and the closest modern record of the genus is located more than 200 kilometers east of Talara. However, the Talara Tar Seeps are not the only Pleistocene lowland locality where *Thomasomys* is known, as we have also identified it from Pampa de los Fósiles (La Libertad Region, northern Peruvian coast, about 450 kilometers southeast of Talara) and it has also been reported from Inciarte (Maracaibo Region, Venezuela), another lowland site. The presence of *Thomasomys* in the Talara Tar Seeps supports the hypothesis based on previous studies for the presence of a wooded savanna environment with a climate more humid than today, possibly with annual rainy seasons during the late Pleistocene. A preliminary taphonomic study of this tooth and bone material, applying the systematic-descriptive method proposed by Peter Andrews in 1990, indicates two types of digestive marks: weak on molars and moderate on incisors and post-cranial elements. The observed digestive marks are indicative of different types of predators: birds of prey such as the short-eared owl (*Asio flammeus*), the burrowing owl (*Athene cunicularia*), and the peregrine falcon (*Falco peregrinus*), as well as small carnivores like the skunks (*Conepatus* sp.), the Sechuran fox (*Lycalopex sechurae*), or even opossums (Didelphidae).

Poster Session I (Wednesday, October 30, 2013, 4:15 - 6:15 PM)

INTRASKELETAL HISTOVARIABILITY DURING *PSITTACOSAURUS MONGOLIENSIS* ONTOGENY

ZORIGT, Badamkhatan, Museum of the Rockies, Montana State University, Bozeman, MT, United States, 59717; HORNER, John, Museum of the Rockies, Montana State University, Bozeman, MT, United States

Bone histology is an important analytical tool for calculating age and growth rate of dinosaurs. Previous studies have evaluated age by histologically sampling elements such as ribs, ulnae, radii, humeri, scapulae, metatarsals, tibiae, femora, and fibulae. The tibia, femur, and fibula are typically preferred for histologic analysis as they are believed to have the highest potential to preserve most of the lines of arrested growth (LAGs) due to their low degree of remodeling. However, it is unknown how much histological variation may exist among the femur, tibia, and fibula due to differences in function and growth. Here we assess the variability and usefulness of the femur, tibia, and fibula for histologic analysis. We examined eleven individuals of *Psittacosaurus mongoliensis* (Ornithischia: Ceratopsia; Lower Cretaceous Khulsangol Formation, Mongolia) representing variable ontogenetic states (7 juvenile; 4 sub-adult). From each specimen we histologically sampled a femur, tibia, and fibula, comparing changes in tissue type (reticular, plexiform, laminar, and radial), vascularization, and LAGs. Within the cortical bone, the transition from one tissue type to another is similarly gradual in both the femur and tibia, but abrupt in the fibula. In young individuals (typically 4 or fewer LAGs), LAG counts for fibulae are similar to those of the femora and tibiae. However in older individuals, the femora and tibiae present the same age (4-6 LAGs), whereas the fibulae exhibit extreme variability (1-8 LAGs). This demonstrates that the tibiae and femora shared a similar growth pattern that was different from that of the fibula. These microstructural variations could be the result of differences in weight bearing function or genetic causes. Consequently, use of fibulae for histologic analysis could lead to possible misinterpretation of *P. mongoliensis* growth. A similar issue has been encountered in the hadrosaurid *Hypacrosaurus*, implying that this problem may exist across Dinosauria. Therefore we suggest that fibulae should not be used for age assessment, and also suggest caution in interpreting histological evidence based on elements other than the femur and tibia.

INDEX

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

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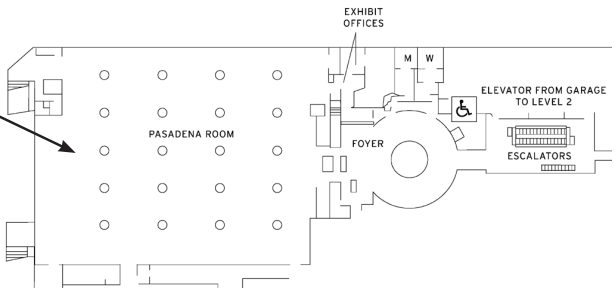
SOCIETY OF VERTEBRATE PALEONTOLOGY

Westin Bonaventure Hotel & Suites

Meeting Facilities Map

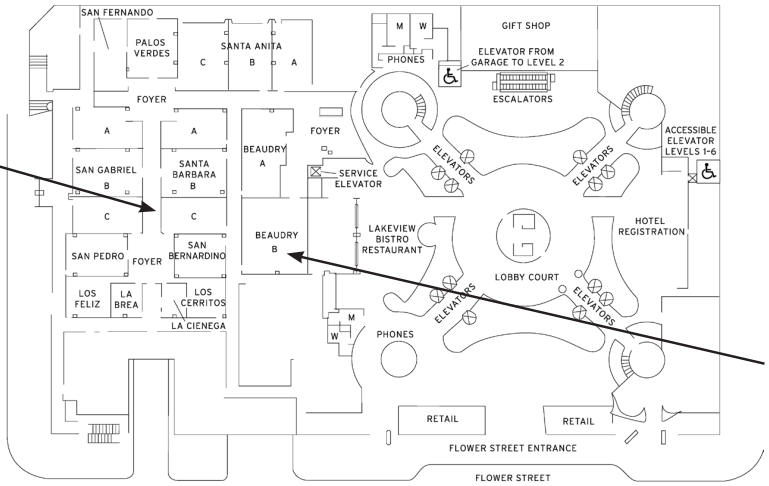
one level below lobby — pasadena room exhibition hall

- Auction Event
- After Hours Party



lobby level — function rooms

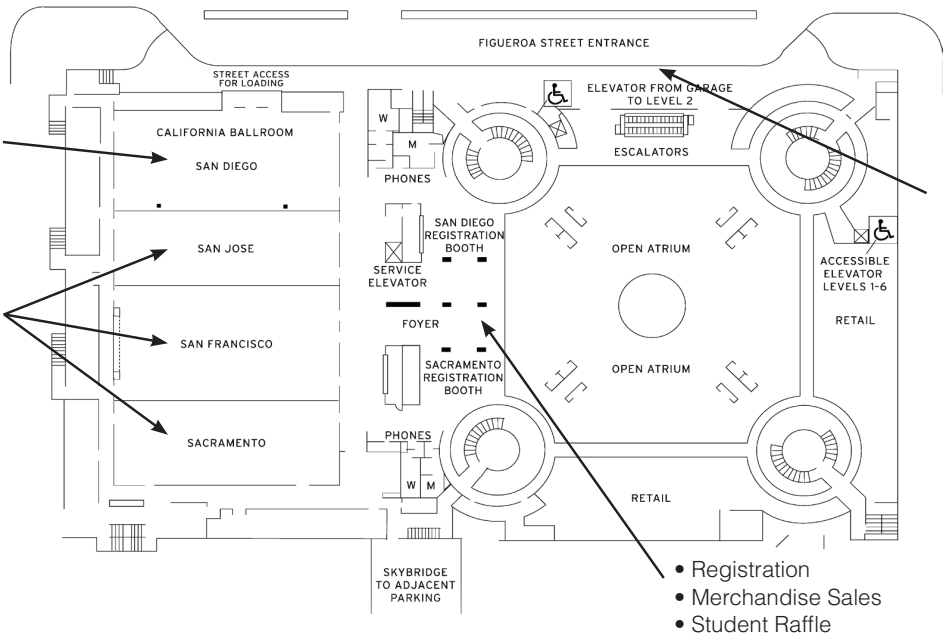
- Committee/Other Meetings
- Workshops



Speaker Ready Room

level 2 — california ballroom

- Poster Sessions
- Exhibits
- Concurrent Sessions
- Awards Banquet
- Student Roundtable Forum & Reprint Exchange



- Shuttle bus pick up for Welcome Reception at the Natural History Museum of Los Angels County
- Field Trip pick up

- Registration
- Merchandise Sales
- Student Raffle
- Poster Sessions
- Exhibits