SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

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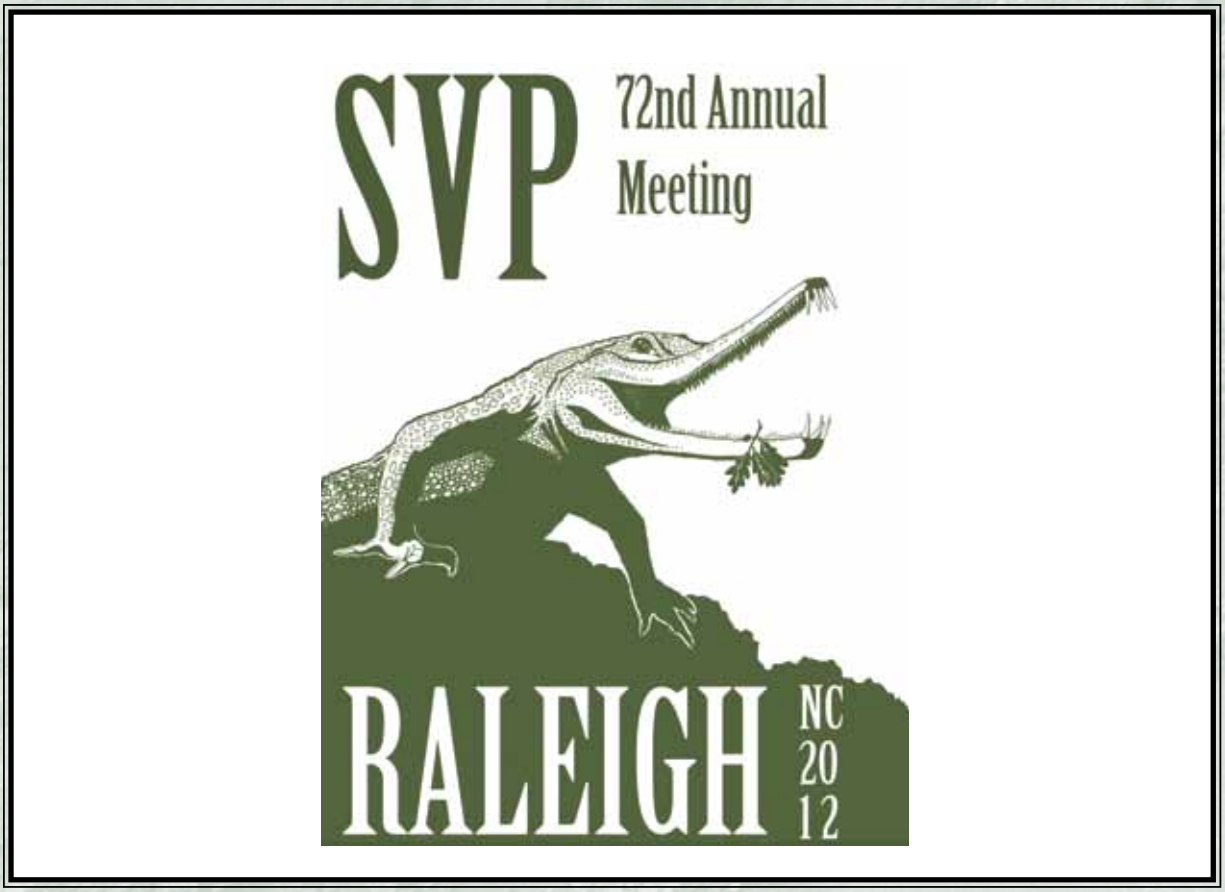
October 2012

Program and Abstracts



72nd Annual Meeting
Society of Vertebrate Paleontology

Raleigh Convention Center
Raleigh, NC, USA
October 17 – 20, 2012

Society of Vertebrate Paleontology

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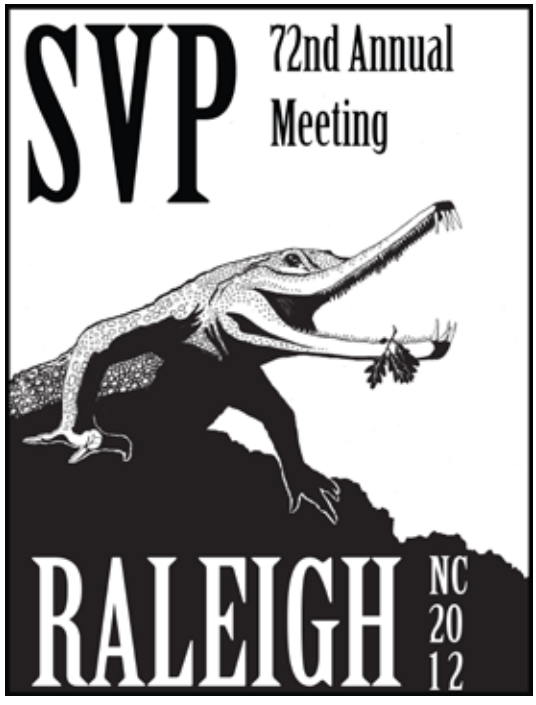
SOCIETY OF VERTEBRATE PALEONTOLOGY
OCTOBER, 2012
ABSTRACTS OF PAPERS
SEVENTY-SECOND ANNUAL MEETING

Raleigh Convention Center
Raleigh, NC, USA
October 17-20, 2012



SAVE THE DATE

SVP 73rd Annual Meeting

October 30 – November 2, 2013

Westin Bonaventure Hotel & Suites, Los Angeles, CA, USA

SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

Logo by Mark Hallett

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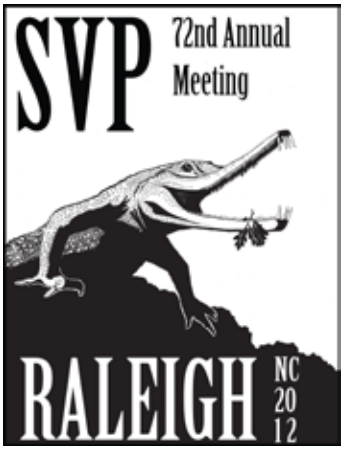
SOCIETY OF VERTEBRATE PALEONTOLOGY



Esteemed Friends and Colleagues of the Society of Vertebrate Paleontology,

The Host Committee of the 72nd Annual Meeting welcomes members and student members of the Society of Vertebrate Paleontology to Raleigh, North Carolina, where you can experience first-hand a bit of southern hospitality. Your Host Committee consists of individuals representing a number of institutions and whose research interests encompass many facets of the discipline of vertebrate paleontology.

The principal institutions hosting this year's meeting are the North Carolina Museum of Natural Sciences and North Carolina State University. The theme for this year's meeting emphasizes the Triassic roots of North Carolina paleontology, and we hope that you take advantage of the chance to learn about some of our spectacular specimens. Our rich Cenozoic deposits have yielded marine faunas including large cetaceans and sharks, and our scheduled field trips focus on these fantastic deposits. For those whose interests lie towards more human-oriented questions, another field excursion offers a rare opportunity to visit the Duke Lemur Center, the world's largest sanctuary for rare and endangered prosimian (strepsirhine) primates, and includes a visit to collections at the Division of Fossil Primates.

Raleigh is a small city, by most standards, but is very cosmopolitan, and easily accessible from any airport on the East coast, usually with direct flights. Raleigh is a premier travel destination, and presents visitors with a surprising diversity of ethnic cuisines and cultural opportunities, as well as more traditional southern cooking and hospitality. Our beautiful downtown area, within walking distance from the museum, offers many restaurants with a wide selection of food and drink, and many featuring outdoor seating, a real treat for socializing with colleagues on warm October evenings.

We warmly welcome you with a reception at the North Carolina Museum of Natural Sciences, where we will highlight our new Nature Research Center. While most traditional museums present a public face to the question "What do we know?," our new research facility is committed to bringing to the public a deeper awareness of the process of science, by emphasizing in all exhibits "HOW do we know what we know." To this end we have developed many 'citizen science' activities, and encourage public participation in research through more accessible, continually updated exhibits. We hope that you enjoy all the highlights of our museum, our city and our state as you take part in the 72nd Annual Meeting of the Society of Vertebrate Paleontology. Welcome to the City of Oaks!

72nd 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 audio/videotape professionals to archive sections of the meeting for the Society's use.)

Editorial policies of Science and Nature magazines: 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 2012 SVP PROGRAM AND ABSTRACTS BOOK

This Program and Abstract 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, 2012, < insert page number here >.

2012 SVP SCHEDULE OF EVENTS (subject to change)

All events are held at the Raleigh Convention Center unless otherwise noted with an **

Event/Function	Tuesday, October 16	Wednesday, October 17	Thursday, October 18	Friday, October 19	Saturday, October 20
Registration Desk	1 pm – 6 pm **Exhibit Hall A, Level 1**	7 am – 5 pm **Exhibit Hall A, Level 1**	7 am – 5 pm **Exhibit Hall A, Level 1**	7:30 am – 5 pm **Exhibit Hall A, Level 1**	8:00 am – 5 pm **Exhibit Hall A, Level 1**
Plenary Session/Welcome		7:45 am – 8 am Out on a Limb – Using Research Discoveries to Inspire Science Literacy by Meg Lowman **BALLROOM B, LEVEL 4**			
Symposium		8 am – 12:15 pm Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time **BALLROOM A, LEVEL 4**	8 am – 12:15 pm Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Dr. Donald Baird **BALLROOM A, LEVEL 4**	8 am – 12:15 pm Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution **BALLROOM A, LEVEL 4**	
Technical Session Romer Prize Session		8 am – 12:15 pm Technical Session I **BALLROOM B, LEVEL 4**	8 am – 12:15 pm Romer Prize Session **BALLROOM B, LEVEL 4**	8 am – 12:15 pm Technical Session IX **BALLROOM B, LEVEL 4**	8 am – 12:15 pm Technical Session XIV **BALLROOM A, LEVEL 4**
Technical Session Preparators' Session		8 am – 12:15 pm Technical Session II **BALLROOM C, LEVEL 4**	8 am – 12:15 pm Preparators' Session **BALLROOM C, LEVEL 4**	8 am – 12:15 pm Technical Session X **BALLROOM C, LEVEL 4**	8 am – 12:15 pm Technical Session XV **BALLROOM B, LEVEL 4**
Technical Session					8 am– 12:15 pm Technical Session XVI **BALLROOM C, LEVEL 4**
Technical Session		1:45 pm – 4:15 pm Technical Session III **BALLROOM A, LEVEL 4**	1:45 pm – 4:15 pm Technical Session VI **BALLROOM A, LEVEL 4**	1:45 pm – 4:15 pm Technical Session XI **BALLROOM A, LEVEL 4**	1:45 pm – 4:14 pm Technical Session XVII **BALLROOM A, LEVEL 4**
Technical Session		1:45 pm – 4:15 pm Technical Session IV **BALLROOM B, LEVEL 4**	1:45 pm – 4:15 pm Technical Session VII **BALLROOM B, LEVEL 4**	1:45 pm – 4:15 pm Technical Session XII **BALLROOM C, LEVEL 4**	1:45 pm – 4:15 pm Technical Session XVIII **BALLROOM B, LEVEL 4**
Technical Session		1:45 pm – 4:15 pm Technical Session V **BALLROOM C, LEVEL 4**	1:45 pm – 4:15 pm Technical Session VIII **BALLROOM C, LEVEL 4**	1:45 pm – 4:15 pm Technical Session XIII **ROOM 306 A-C, LEVEL 3**	1:45 am – 4:15 pm Technical Session XIX **BALLROOM C, LEVEL 4**
Workshops/Educational Events	9 am – Noon Archival Materials Workshop *For Pre-Registered Attendees* ****NORTH CAROLINA MUSEUM OF NATURAL SCIENCES – NATURE RESEARCH CENTER**	National Fossil Day Lectures ****NORTH CAROLINA MUSEUM OF NATURAL SCIENCES**			
	9 am – 4 pm Phylogenetic Comparative Methods Workshop *For Pre-Registered Attendees* **ROOM 306 A, LEVEL 3**	12:30 pm – 1:30 pm Paleontology and the Media – Communicating Your Research to the Popular Press Workshop *For Pre-Registered Attendees* **ROOM 306 A, LEVEL 3**			
	2:00 pm – 5:00 pm Archival Materials Workshop *For Pre-Registered Attendees* ****NORTH CAROLINA MUSEUM OF NATURAL HISTORY – NATURE RESEARCH CENTER**	12:30 pm – 1:30 pm Effective Poster Design Workshop *For Pre-Registered Attendees* **ROOM 306B, LEVEL 3**			
Special Event	7:00 pm Fleshing Out the Past…in 3D! Integrating Science, Technology and Outreach with the Visible Dinosaur Project – A Special Public Presentation by Lawrence Witmer ****NORTH CAROLINA MUSEUM OF NATURAL SCIENCES**				

2012 SVP SCHEDULE OF EVENTS (subject to change)

All events are held at the Raleigh Convention Center unless otherwise noted with an **

Event/Function	Tuesday, October 16	Wednesday, October 17	Thursday, October 18	Friday, October 19	Saturday, October 20
Poster Sessions **Set-up: 7:30 am – 9:30 am**		Poster Session I: 9:30 am – 6:15 pm Reception: 4:15 pm – 6:15 pm **EXHIBIT HALL A, LEVEL 1**	Poster Session II: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **EXHIBIT HALL A, LEVEL 1**	Poster Session III: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **EXHIBIT HALL A, LEVEL 1**	Poster Session IV: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **EXHIBIT HALL A, LEVEL 1**
Exhibit Viewing		9:30 am – 6:15 pm **EXHIBIT HALL A, LEVEL 1**	9:30 am – 6:15 pm **EXHIBIT HALL A, LEVEL 1**	9:30 am – 6:15 pm **EXHIBIT HALL A, LEVEL 1**	9:30 am – 6:15 pm **EXHIBIT HALL A, LEVEL 1**
SVP Business Meeting and Open Forum			12:30 pm – 1:30 pm SVP Business Meeting and Open Forum **BALLROOM B, LEVEL 4**		
Press Event			4:15 pm – 5:45 pm **ROOM 306A, LEVEL 3**		
Social Events		7 pm – 10 pm Welcome Reception ****NORTH CAROLINA MUSEUM OF NATURAL SCIENCES**	7 pm – 10 pm Student Roundtable Forum & Reprint Exchange ****MARRIOTT – STATE BALLROOM C/D**	6:30 pm – 10:30 pm Auction **BALLROOM B, LEVEL 4**	7 pm – 8:30 pm Awards Banquet Dinner (Open to all Meeting Attendees) 8:30 pm – 10 pm Awards Ceremony **BALLROOM B, LEVEL 4** 10 pm – 2 am After-Hours Party ****MARRIOTT – STATE, UNIVERSITY AND CHANCELLOR BALLROOMS**
Beverage Service		7 am – 8 am **BALLROOM FOYER, LEVEL 4** 10 am – 10:15 am **EXHIBIT HALL A, LEVEL 1**	7 am – 8 am **BALLROOM FOYER, LEVEL 4** 10 am – 10:15 am **EXHIBIT HALL A, LEVEL 1**	7 am – 8 am **BALLROOM FOYER, LEVEL 4** 10 am – 10:15 am **EXHIBIT HALL A, LEVEL 1**	7 am – 8 am **BALLROOM FOYER, LEVEL 4** 10 am – 10:15 am **EXHIBIT HALL A, LEVEL 1**
Speaker Ready Room	1 pm – 6 pm **ROOM 305A, LEVEL 3**	7 am – 5 pm **ROOM 305A, LEVEL 3**	7 am – 5 pm **ROOM 305A, LEVEL 3**	7 am – 5 pm **ROOM 305A, LEVEL 3**	7 am – 4 pm **ROOM 305A, LEVEL 3**
Meeting Rooms ****All Committee Meeting Rooms are Located at the Marriott Raleigh City Center 500 Fayetteville Street Raleigh, NC, USA**	8 am – 7 pm – ****at the MARRIOTT** **UNIVERSITY BALLROOM A** **UNIVERSITY BALLROOM B** **CHANCELLOR ROOM** **CONGRESSIONAL ROOM A** **CONGRESSIONAL ROOM B** **STATE BALLROOM A** **STATE BALLROOM B**	7 am – 7 pm - ****at the MARRIOTT** **UNIVERSITY BALLROOM A** **UNIVERSITY BALLROOM B** **CHANCELLOR ROOM** **CONGRESSIONAL ROOM A** **CONGRESSIONAL ROOM B** **STATE BALLROOM A** **STATE BALLROOM B**	7 am – 7 pm - ****at the MARRIOTT** **UNIVERSITY BALLROOM A** **UNIVERSITY BALLROOM B** **CHANCELLOR ROOM** **CONGRESSIONAL ROOM A** **CONGRESSIONAL ROOM B** **STATE BALLROOM A** **STATE BALLROOM B**	7 am – 7 pm - ****at the MARRIOTT** **UNIVERSITY BALLROOM A** **UNIVERSITY BALLROOM B** **CHANCELLOR ROOM** **CONGRESSIONAL ROOM A** **CONGRESSIONAL ROOM B** **STATE BALLROOM A** **STATE BALLROOM B**	7 am – 7 pm - ****at the MARRIOTT** **UNIVERSITY BALLROOM A** **UNIVERSITY BALLROOM B** **CHANCELLOR ROOM** **CONGRESSIONAL ROOM A** **CONGRESSIONAL ROOM B** **STATE BALLROOM A** **STATE BALLROOM B**

PROGRAM AT A GLANCE

	Ballroom A	Ballroom B	Ballroom C	Ballroom A	Ballroom B	Ballroom C
	Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time	Technical Session I	Technical Session II	Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Dr. Donald Baird	Romer Prize Session	Preparators' Session
	WED	WED	WED	**THURS**	**THURS**	**THURS**
8:00 am	Barrett	Zanno	Gai	Grandstaff	Bamforth	Keillor
8:15 am	Larsson	Snively	Criswell	Ciampaglio	Boehmer	Starck
8:30 am	Cadena	Stiegler	Giles	Garcia	Campione	Hlusko
8:45 am	Bloch	Gold	Mickle	Schwimmer	Christensen	Sagebiel
9:00 am	Head	Loewen	Standen	Brochu	Cleland	Storch
9:15 am	Antoine	Carr	Long	Parris	Dececchi	May
9:30 am	MacPhee	Burch	Daeschler	Weishampel	Gould	Marsh
9:45 am	Velez-Juarbe	Sullivan	Janis	Fix	Hammond	Colbert
10:00 am	COFFEE					
10:15 am	K. Hunt	Cullen	Presentation Withdrawn	Brusatte	Hastings	Supplee
10:30 am	MacFadden	Kobayashi	Presentation Withdrawn	Vavrek	Heers	Sadowska
10:45 am	Rincon	Lautenschlager	Pardo	Lamb, Jr.	Lyson	G. Brown
11:00 am	Scheyer	Wang	Liston	Crane	McHugh	Kline
11:15 am	Moreno-Bernal	He	Gottfried	Main	Montanari	Weiler
11:30 am	Madden	Goswami	Stearley	Hippensteel	Tseng	McCullough
11:45 am	Croft	Parsons	Friedman	Gallagher	Uno	Breithaupt
12:00 pm	Jaramillo	Presentation Withdrawn	Case	Denton	Wilberg	M. Brown
12:15 pm	LUNCH					
1:30 pm						
	Ballroom A	**Ballroom B**	**Ballroom C**	**Ballroom A**	**Ballroom B**	**Ballroom C**
	Technical Session III	Technical Session IV	Technical Session V	Technical Session VI	Technical Session VII	Technical Session VIII
1:45 pm	Theodor	Holliday	A. Boyd	Bourke	Sereno	Tomiya
2:00 pm	Noret	Tsai	Rivin	Schmitt	Lamm	Hopkins
2:15 pm	Sanders	Kellner	Berta	Bonnan	Ferrer	Badgley
2:30 pm	Plavcan	Padian	Fahlke	Holtz, Jr.	Burroughs	McLaughlin
2:45 pm	Zijlstra	Button	Clementz	N.D. Smith	Alroy	Campbell
3:00 pm	Granatosky	Morhardt	Bebej	Upchurch	Werning	Kay
3:15 pm	C. Miller	Porter	Fordyce	Mannion	Koyabu	Domingo
3:30 pm	Grass	Schweitzer	Lambert	Sander	Halliday	Casanovas-Vilar
3:45 pm	Wood	Barta	Ekdale	Stein	Asher	D. Fraser
4:00 pm	Samuels	C. Brown	Pyenson	D'Emic	Sánchez-Villagra	Moore
4:15 pm	*Poster Session I* *EXHIBIT HALL A, LEVEL 1*			*Poster Session II* *EXHIBIT HALL A, LEVEL 1*		
6:00 pm						

PROGRAM AT A GLANCE

	Ballroom A	Ballroom B	Ballroom C	Ballroom A	Ballroom B	Ballroom C
	Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution	Technical Session IX	Technical Session X	Technical Session XIV	Technical Session XV	Technical Session XVI
	FRI	FRI	FRI	**SAT**	**SAT**	**SAT**
8:00 am	Clarke	Bever	Angielczyk	LeBlanc	Pei	Famoso
8:15 am	J. Brown	Rabi	Castanhinha	J. Chen	Prieto-Marquez	Beatty
8:30 am	Mounce	Vitek	Beck	Marjanović	Mallon	Semprebon
8:45 am	Bapst	Lively	Abdala	Anderson	C. Boyd	DeSantis
9:00 am	Lloyd	Gignac	Blob	Tsuji	Osi	Meachen
9:15 am	Simpson	Butler	Huttenlocker	Reisz	Druckenmiller	Wroe
9:30 am	Slater	Nesbitt	Kammerer	Müller	Erickson	Rizk
9:45 am	Marcot	Irmis	Sidor	Schoch	Woodward	Figueirido
10:00 am	COFFEE					
10:15 am	G. Hunt	Molnar	O'Meara	Pritchard	Forster	Friscia
10:30 am	Organ	Young	Schultz	N. Fraser	Dalla Vecchia	Werdelin
10:45 am	Schmitz	Stocker	Krause	Peecook	Morschhauser	Bibi
11:00 am	Price	Conrad	T. Smith	Sookias	Levitt	Cherney
11:15 am	Hieronymus	Watanabe	M. Chen	Morris	Maiorino	Wicks
11:30 am	O'Connor	Schachner	Grossnickle	Kelley	Makovicky	Kimura
11:45 am	Claeson	Hutchinson	G. Wilson	Motani	Bykowski	Flynn
12:00 pm	Wainwright	Nestler	R. Beck	Maxwell	Arbour	Smiley
12:15 pm	LUNCH					
1:30 pm						
	Ballroom A	**Ballroom C**	**Room 306 A-C**	**Ballroom A**	**Ballroom B**	**Ballroom C**
	Technical Session XI	Technical Session XII	Technical Session XIII	Technical Session XVII	Technical Session XVIII	Technical Session XIX
1:45 pm	Persons	Jiang	De Bast	Hall	Secord	Shoemaker
2:00 pm	Leary	O'Keefe	Clemens	Habib	Yapuncich	Marcy
2:15 pm	Noto	Strganac	Chester	Kambic	Habersetzer	Polly
2:30 pm	Ezcurra	Konishi	Williamson	Balanoff	Manz	Davis
2:45 pm	Rauhut	Lindgren	Atwater	L. Wilson	Ruf	Yann
3:00 pm	Arajo	Gauthier	Ramdarshan	Mitchell	Ahrens	Du
3:15 pm	Mateus	Simoes	Gingerich	Ksepka	Hooker	J. Miller
3:30 pm	Simon	DeMar, Jr.	Koenigswald	N.A. Smith	Spaulding	Behrensmeyer
3:45 pm	Lamanna	McCartney	Kirk	Ando	Sole	Boessenecker
4:00 pm	J. Wilson	Larson	Beard	Meijer	Stucky	Barnosky
4:15 pm	*Poster Session III* *EXHIBIT HALL A, LEVEL 1*			*Poster Session IV* *EXHIBIT HALL A, LEVEL 1*		
6:00 pm						

WEDNESDAY MORNING, OCTOBER 17, 2012

SYMPOSIUM 1: VERTEBRATE PALEONTOLOGY IN THE NORTHERN NEOTROPICS: CRADLE AND MUSEUM OF EVOLUTION ACROSS GEOLOGICAL TIME

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4

MODERATORS: Jason Head and Marcelo Sánchez-Villagra

8:00 **Barrett, P., Butler, R., Irmis, R., Scheyer, T., Sánchez-Villagra, M.** A NEW ORNITHISCHIAN DINOSAUR FROM THE VENEZUELAN ANDES

8:15 **Larsson, H.** THE CRETACEOUS NEOTROPICS: COLOMBIAN VERTEBRATES AT THE BOUNDARY OF SHIFTING ENVIRONMENTS AND THE MESOZOIC MARINE INTERCHANGE

8:30 **Cadena, E., Ksepka, D., Bloch, J.** FOUR NEW PELOMEDUSOIDES TURTLES FROM THE MIDDLE-LATE PALEOCENE OF COLOMBIA: THE FIRST CENOZOIC GIANT FRESHWATER TURTLE AND AN UNUSUALLY CIRCULAR TURTLE SHELL

8:45 **Bloch, J., Rincon, A., Head, J., Herrera, F., Jaramillo, C.** EARLY EOCENE MAMMALS FROM THE HOT TROPICS OF NORTHERN SOUTH AMERICA

9:00 **Head, J., Bloch, J., Rincon, A., Moreno-Bernal, J., Jaramillo, C.** PALEOGENE SQUAMATES FROM THE NORTHERN NEOTROPICS: ECOLOGICAL IMPLICATIONS AND BIOGEOGRAPHIC HISTORIES

9:15 **Antoine, P.** CENOZOIC MAMMALS FROM AMAZONIA: DIVERSITY, ENVIRONMENT AND BIOGEOGRAPHY

9:30 **MacPhee, R., Iturralde-Vinent, M.** WHEN AND HOW DID LAND VERTEBRATES REACH THE GREATER ANTILLES?

9:45 **Velez-Juarbe, J., Domning, D.** PALEOGENE VERTEBRATE FAUNAS FROM THE GREATER ANTILLES

10:00 BREAK

10:15 **Hunt, K., Kay, R.** ORIGIN OF THE GREATER ANTILLEAN PRIMATE FAUNA

10:30 **MacFadden, B., Foster, D., Rincon, A., Morgan, G., Jaramillo, C.** THE NEW WORLD TROPICS AS A CRADLE OF BIODIVERSITY DURING THE EARLY MIOCENE: CALIBRATION OF THE CENTENARIO FAUNA FROM PANAMA

10:45 **Rincon, A., Bloch, J., MacFadden, B., Foster, D., Jaramillo, C.** THE EARLY MIOCENE LAS CASCADAS FOSSIL ASSEMBLAGE: BIOSTRATIGRAPHIC AND PALEOBIOGEOGRAPHIC SIGNIFICANCE OF THE OLDEST MAMMALS FROM THE PANAMA CANAL AREA, CENTRAL AMERICA

11:00 **Scheyer, T., Aguilera, O., Fortier, D., Sánchez, R., Sánchez-Villagra, M.** NEOGENE CROCODYLIAN MEGADIVERSITY PEAK AND FAUNAL SUCCESSION IN VENEZUELA

11:15 **Moreno-Bernal, J., Federico, M., Carrillo, J., Vallejo-Pareja, M., Jimenez-Campos, L.** NEOTROPICAL LATE MIOCENE-EARLY PLIOCENE VERTEBRATES FROM THE CASTILLETES FORMATION, NORTHERN COLOMBIA

11:30 **Madden, R., Dunn, R., Strömberg, C., Kohn, M.** THE MIOCENE OF EQUATORIAL SOUTH AMERICA AND THE BIOTIC CONSEQUENCES OF ANDEAN UPLIFT

11:45 **Croft, D.** A SYNTHESIS OF CENOZOIC NEOTROPICAL MAMMAL EVOLUTION IN SOUTH AMERICA: BIOGEOGRAPHY AND INFLUENCES FROM HIGHER LATITUDES

12:00 **Jaramillo, C.** FOSSIL VERTEBRATES FROM NEOTROPICAL LATITUTES: A VAST RECORD WAITING TO BE DISCOVERED

WEDNESDAY MORNING, OCTOBER 17, 2012
TECHNICAL SESSION I

RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATORS: Lindsay Zanno and Mark Loewen

8:00 **Zanno, L., Makovicky, P., Gates, T.** A NEW GIANT CARCHARODONTOSAURIAN ALLOSAUROID FROM THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION OF CENTRAL UTAH

8:15 **Snively, E., Cotton, J., Ridgely, R., Witmer, L.** FEEDING MOTIONS IN *ALLOSAURUS* (DINOSAURIA: THEROPODA): MULTIBODY DYNAMICS OF THE CERVICOCEPHALIC APPARATUS SUGGESTS RAPID LATERAL STRIKES BUT SAGITTAL PREY DISMEMBERMENT

8:30 **Stiegler, J., Choiniere, J., Xu, X., Clark, J.** A MULTI-ELEMENT HISTOLOGICAL ANALYSIS OF THE JURASSIC TYRANNOSAUROID *GUANLONG WUCAII*

8:45 **Gold, E., Brusatte, S., Norell, M.** PNEUMATICITY PATTERNS IN THE SKULL OF *ALIORAMUS ALTAI*, A LONG-SNOUTED TYRANNOSAURID (DINOSAURIA: THEROPODA), FROM THE LATE CRETACEOUS OF MONGOLIA

9:00 **Loewen, M., Sertich, J., Irmis, R.** THE EARLY EVOLUTION OF TYRANNOSAUROID DINOSAURS: NEW ANATOMICAL, PHYLOGENETIC AND BIOGEOGRAPHIC EVIDENCE

9:15 **Carr, T.** ONTOGENY AND PHYLOGENY OF CEPHALIC ORNAMENTATION IN TYRANNOSAUROIDEA (DINOSAURIA, COELUROSAURIA)

9:30 **Burch, S.** EVOLUTION OF THE FORELIMB MUSCULATURE IN TYRANNOSAUROIDEA (DINOSAURIA: THEROPODA)

9:45 **Sullivan, C., Hone, D., Rothschild, B., Wang, K., Xu, X.** TYRANNOSAURID DINOSAURS FROM THE UPPER CRETACEOUS WANGSHI GROUP OF ZHUCHENG, SHANDONG PROVINCE, CHINA: COEXISTING GIANT CARNIVORES AND A TYRANT WITH A TOOTHACHE

10:00 BREAK

10:15 **Cullen, T., Ryan, M., Evans, D., Currie, P., Kobayashi, Y.** MULTI-ELEMENT HISTOLOGICAL ANALYSIS OF AN ORNITHOMIMID (DINOSAURIA) BONE BED FROM THE HORSESHOE CANYON FORMATION, ALBERTA

10:30 **Kobayashi, Y., Lü, J., Pu, H., Xu, L., Wu, Y.** ORNITHISCHIAN-LIKE DENTAL ARRANGEMENT IN A BASAL THERIZINOSAUR DINOSAUR FROM NORTHEASTERN CHINA

10:45 **Lautenschlager, S., Rayfield, E., Witmer, L., Altangerel, P.** A BIOMECHANICAL MODEL OF *ERLIKOSAURUS ANDREWSI* (DINOSAURIA: THERIZINOSAURIA) WITH IMPLICATIONS FOR CRANIAL FUNCTION AND DIETARY PREFERENCES

11:00 **Wang, S., Xu, X.** A NEW OVIRAPTORID SPECIMEN FROM THE UPPER CRETACEOUS OF SOUTHERN CHINA

11:15 **He, T., Varricchio, D., Jackson, F., Jin, X., Poust, A.** AN OVIRAPTORID ADULT-EGG ASSOCIATION AND THE ORIGIN OF AVIALAN REPRODUCTIVE STRATEGIES

11:30 **Goswami, A., Prasad, G., Benson, R., Verma, O., Flynn, J.** NEW VERTEBRATES FROM THE LATE CRETACEOUS KALLAMEDU FORMATION, CAUVERY BASIN, SOUTH INDIA, INCLUDING A TROODONTID DINOSAUR, A GONDWANATHERIAN MAMMAL, AND A *SIMOSUCHUS*-LIKE NOTOSUCHIAN CROCODYLIFORM

11:45 **Parsons, W., Parsons, K.** THE FIRST INTACT SCAPULAR GLENOID REGION OF *DEINONYCHUS ANTIRRHOPUS* AND THE CONSEQUENT RE-INTERPRETATION OF DROMAEOSAURID FEATURES THAT ENHANCED THE EVOLUTION OF AVIAN FLIGHT

12:00 ***Presentation Withdrawn***

WEDNESDAY MORNING, OCTOBER 17, 2012
TECHNICAL SESSION II
RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: John Long and Matt Friedman

8:00 **Gai, Z., Zhu, M.** THE ORIGIN OF THE VERTEBRATE JAW: INTERSECTION BETWEEN DEVELOPMENTAL BIOLOGY-BASED MODEL AND FOSSIL EVIDENCE

8:15 **Criswell, K., Finarelli, J., Friedman, M., Garwood, R., Coates, M.** *DELTOPTYCHIUS:* CRANIAL CHARACTERS AND RETHINKING EARLY HOLOCEPHALAN PHYLOGENY

8:30 **Giles, S., Brazeau, M., Atwood, R., Friedman, M.** ENDOSKELETAL ANATOMY OF THE STEM ACTINOPTERYGIAN *CHEIROLEPIS* REVEALED BY HIGH-RESOLUTION COMPUTED TOMOGRAPHY

8:45 **Mickle, K.** IDENTIFICATION OF THE BONES OF THE SNOUT IN LOWER ACTINOPTERYGIANS – A NEW NOMENCLATURE SCHEME BASED ON CHARACTERS

9:00 **Standen, E., Larsson, H.** A LIVING ANALOGUE TO THE FIN-LIMB TRANSITION: LOCOMOTION AND FIN USE OF AN AIR BREATHING FISH ON LAND

9:15 **Long, J., Holland, T., Young, G.** A PECULIAR TETRAPODOMORPH FISH FROM THE MIDDLE DEVONIAN OF AUSTRALIA SUPPORTS GONDWANA ENDEMISM IN THE STEM TETRAPOD RADIATION

9:30 **Daeschler, E., Shubin, N., Jenkins, Jr., F.** TRANSFORMATION OF THE PECTORAL GIRDLE DURING THE FIN-TO-LIMB TRANSITION

9:45 **Janis, C., Devlin, K., Warren, D., Witzmann, F.** DERMAL BONE IN EARLY TETRAPODS: A PALEOPHYSIOLOGICAL HYPOTHESIS OF ADAPTATION FOR TERRESTRIAL ACIDOSIS

10:00 BREAK

10:15 ***Presentation Withdrawn***

10:30 ***Presentation Withdrawn***

10:45 **Pardo, J., Anderson, J.** A MICRO-CT INVESTIGATION OF MODES OF TOOTH IMPLANTATION AND REPLACEMENT IN EARLY TETRAPODS

11:00 **Liston, J.** GROWTH, AGE AND SIZE OF *LEEDSICHTHYS*, THE LARGEST BONY FISH

11:15 **Gottfried, M., Fordyce, R., Lee, D., Koehler, R.** EXCEPTIONAL PRESERVATION AND UNUSUAL FEATURES IN A DISTINCTIVE NEW TARPON-LIKE FISH [ELOPOMORPHA] FROM THE CRETACEOUS OF THE CHATHAM ISLANDS, NEW ZEALAND

11:30 **Stearley, R., Cavender, T.** A NEW FOSSIL CHAR (*SALVELINUS*) FROM MIOCENE LAKE SEDIMENTS IN STEWART VALLEY, NEVADA

11:45 **Friedman, M.** THE GEOLOGICAL AGE AND BIOGEOGRAPHY OF CICHLID FISHES: SETTING THE (FOSSIL) RECORD STRAIGHT

12:00 **Case, J.** DIVERSITY, ABUNDANCE AND TURNOVER IN THE ANTARCTIC MARINE FAUNA DURING THE EOCENE IN RESPONSE TO CLIMATE CHANGE

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
TECHNICAL SESSION III

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Aaron Wood and William Sanders

1:45 **Theodor, J., Dreger, S., Wigg, J., Ruf, I.** EAR MORPHOLOGY OF*CAENOMERYX* AND RELATIONSHIPS OF CAINOTHERIIDS

2:00 **Noret, J., Tabor, N., Jacobs, B., Sanders, W., Kappelman, J.** STABLE ISOTOPE DATA FROM THE CHILGA BASIN, ETHIOPIA, AND THEIR IMPLICATIONS FOR RESOURCE PARTITIONING AMONG LATE PALEOGENE AFRICAN ENDEMIC MAMMALS

2:15 **Sanders, W., Gunnell, G.** ONTOGENETIC, BEHAVIORAL AND EVOLUTIONARY CONSIDERATIONS OF CRANIAL POLYMORPHISM IN EARLY OLIGOCENE *AEGYPTOPITHECUS ZEUXIS* (CATARRHINI, PRIMATES)

2:30 **Plavcan, J., Ward, C., Manthi, F.** NEW DIMINUTIVE CERCOPITHECINE TEETH FROM KANAPOI, KENYA, AND IMPLICATIONS FOR THE EVOLUTION OF DIVERSITY IN GUENONS

2:45 **Zijlstra, J., Flynn, L., Wessels, W.** THE WESTERNMOST TARSIER: A NEW GENUS AND SPECIES FROM THE MIOCENE OF PAKISTAN

3:00 **Granatosky, M., Miller, C., Lemelin, P., Schmitt, D.** PHALANGEAL MORPHOLOGY OF SUSPENSORY MAMMALS: IMPLICATIONS FOR THE LOCOMOTION OF MALAGASY SUBFOSSIL SLOTH LEMURS (PRIMATES: PALAEOPROPITHECIDAE)

3:15 **Miller, C., Granatosky, M., Chester, S., Boyer, D., Schmitt, D.** LUMBAR MORPHOLOGY OF SUSPENSORY, GLIDING AND FLYING MAMMALS: IMPLICATIONS FOR THE LOCOMOTOR BEHAVIOR OF SELECT FOSSIL PRIMATES

3:30 **Grass, A.** INFERRING LEVELS OF ARBOREALITY OF EXTINCT SLOTHS THROUGH A GEOMETRIC MORPHOMETRIC ASSESSMENT OF SCAPULA MORPHOLOGY

3:45 **Wood, A., Rincon, A., Moreno Rodriguez, F., Bloch, J., Jaramillo, C.** HABITAT STRUCTURE AND HINDLIMB FUNCTIONAL MORPHOLOGY IN AN EARLY MIOCENE EQUID FROM PANAMA

4:00 **Samuels, J.** SKULL SHAPE REFLECTS LOCOMOTOR ECOLOGY IN RODENTS AND CARNIVORANS

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
TECHNICAL SESSION IV

RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATORS: Ashley Morhardt and Alexander Kellner

1:45 **Holliday, C., Nesbitt, S.** MORPHOLOGY AND DIVERSITY OF THE MANDIBULAR SYMPHYSIS OF ARCHOSAUROMORPHS

2:00 **Tsai, H., Holliday, C.** ANATOMY OF ARCHOSAUR PELVIC SOFT TISSUES AND ITS SIGNIFICANCE FOR INTERPRETING HINDLIMB FUNCTION

2:15 **Kellner, A., Costa, F., Rodrigues, T.** NEW EVIDENCE ON THE PTEROID ARTICULATION AND ORIENTATION IN PTEROSAURS

2:30 **Padian, K., Fallon, B.** META-ANALYSIS OF REPORTED PTEROSAUR TRACKWAYS: TESTING THE CORRESPONDENCE BETWEEN SKELETAL AND FOOTPRINT RECORDS

2:45 **Button, D., Unwin, D., Purnell, M.** CONTINUOUS CHARACTER STATES AND THEIR IMPACT ON THE PHYLOGENY OF THE PTEROSAURIA

3:00 **Morhardt, A., Ridgely, R., Witmer, L.** FROM ENDOCAST TO BRAIN: ASSESSING BRAIN SIZE AND STRUCTURE IN EXTINCT ARCHOSAURS USING GROSS ANATOMICAL BRAIN REGION APPROXIMATION (GABRA)

3:15 **Porter, W., Witmer, L.** DINOSAUR CEPHALIC VASCULAR ANATOMY AND ITS PHYSIOLOGICAL IMPLICATIONS: EVIDENCE FROM THE FOSSILS

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
TECHNICAL SESSION IV (CONTINUED)

3:30 **Schweitzer, M., Cleland, T., Zheng, W., Bern, M.** MOLECULAR EVIDENCE FOR ENDOGENEITY OF DINOSAUR OSTEOCYTES

3:45 **Barta, D., Varricchio, D., Jackson, F.** A CLADISTIC APPROACH TO UNDERSTANDING DINOSAUR EGG DIVERSITY AND THE EVOLUTION OF REPRODUCTIVE TRAITS WITHIN DINOSAURIA: PRELIMINARY RESULTS

4:00 **Brown, C., Evans, D., Campione, N., O'Brien, L., Eberth, D.** EVIDENCE FOR TAPHONOMIC SIZE BIAS IN A MODEL MESOZOIC TERRESTRIAL ALLUVIAL-PARALIC SYSTEM

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
TECHNICAL SESSION V

RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Mark Clementz and Nicholas Pyenson

1:45 **Boyd, A.** A RELATIONSHIP BETWEEN CERVICAL VERTEBRAL MORPHOLOGY AND TERRESTRIAL AND AQUATIC HABITATION

2:00 **Rivin, M., Velez-Juarbe, J., Rhue, V.** A NEW HALITHERIINE DUGONGID FROM THE EARLY MIOCENE OF ORANGE COUNTY, CALIFORNIA

2:15 **Berta, A., Kienle, S., Sorbi, S., Biannuci, G.** A RE-EVALUATION OF *PLIOPHOCA ETRUSCA* (PINNIPEDIA: PHOCIDAE) FROM THE PLIOCENE OF ITALY: PHYLOGENETIC AND BIOGEOGRAPHIC IMPLICATIONS

2:30 **Fahlke, J., Voss, M., Gingerich, P., Antar, M., Zalmout, I.** PREDATION OF *BASILOSAURUS ISIS* ON *DORUDON ATROX* (CETACEA, BASILOSAURIDAE): A CASE STUDY FROM THE EOCENE OF EGYPT

2:45 **Clementz, M., Uhen, M.** ONTOGENETIC VARIATION IN DENTAL STABLE ISOTOPE VALUES OF TWO SPECIES OF BASILOSAURIDS (ZYGORHIZA KOCHII AND DURUDON ATROX)

3:00 **Bebej, R., Zalmout, I., Abed El-Aziz, A., Antar, M., Gingerich, P.** FIRST EVIDENCE OF REMINGTONOCETIDAE (MAMMALIA, CETACEA) OUTSIDE INDO-PAKISTAN: NEW GENUS FROM THE EARLY MIDDLE EOCENE OF EGYPT

3:15 **Fordyce, R., Fitzgerald, E., González Barba, G.** LONG-TUSKED ARCHAIC OLIGOCENE ODONTOCETES FROM OREGON AND BAJA CALIFORNIA SUR, EASTERN PACIFIC MARGIN

3:30 **Lambert, O., Biannuci, G., De Muizon, C.** THE ARCHAIC BEAKED WHALE *NINOZIPHIUS PLATYROSTRIS*: CLUES ON THE EVOLUTIONARY HISTORY OF THE FAMILY ZIPHIIDAE (CETACEA, ODONTOCETI)

3:45 **Ekdale, E.** PHYSIOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE COCHLEAR MORPHOLOGY OF MIOCENE MYSTICETI (CETACEA)

4:00 **Pyenson, N., Gutstein, C., Parham, J., Rubilar-Rogers, D., Suárez, M.** ROADSIDE WHALES IN THE ATACAMA: A MASS DEATH ASSEMBLAGE OF MARINE MAMMALS FROM CERRO BALLENA, A NEW LOCALITY OF THE BAHIA INGLESA FORMATION, ATACAMA REGION, CHILE

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
POSTER SESSION I
RALEIGH CONVENTION CENTER, EXHIBIT HALL A, LEVEL 1
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Miyata, K., Demere, T.** NEW INFORMATION ON BASICRANIA OF *TROGOSUS* (TILLODONTIA, MAMMALIA) WITH AN EXQUISITELY PRESERVED PETROSAL

2 **Bastl, K., Nagel, D.** SCAPHOLUNATUM, OR SCAPHOID AND LUNATUM, THAT IS THE QUESTION. THE CASE OF *HYAENODON*

3 **Morse, P., Bloch, J., Secord, R., Chester, S., Boyer, D.** ARCTOCYONID DIVERSITY DURING THE PALEOCENE-EOCENE THERMAL MAXIMUM OF NORTH AMERICA

4 **Rankin, B., Ludtke, J., Barrón-Ortiz, C., Yang, X., Fox, J.** USING THE EXTENDED PRICE EQUATION TO ANALYZE PATTERNS OF BODY SIZE CHANGE IN MAMMALS ACROSS THE PALEOCENE-EOCENE THERMAL MAXIMUM IN NORTH AMERICA

5 **Missiaen, P., Quesnel, F., Dupuis, C., Storme, J., Smith, T.** SMALL IS BEAUTIFUL: THE ERQUELINNES MAMMAL FAUNA FROM THE EARLIEST EOCENE OF THE SOUTHERN MONS BASIN, BELGIUM

6 **Tsubamoto, T.** ESTIMATING BODY MASS OF FOSSIL LAND MAMMALS USING THE ASTRAGALUS

7 **Tabrum, A.** ADDITIONAL MATERIAL OF THE TYPE SPECIMEN OF THE TAPIROID *COLODON KAYI* (HOUGH) FROM THE SAGE CREEK BASIN, MONTANA

8 **Schwermann, L., Von Koenigswald, W.** DENTAL MORPHOLOGY AND FUNCTION OF *DIACODEXIS* IN COMPARISON WITH PRIMITIVE ARTIODACTYLA

9 **Rook, D.** THE IMPORTANCE OF SEDIMENT IN THE GRAZER/GRASSLAND STORY OF NORTH AMERICA

10 **Boardman, G., Secord, R.** A MULTI-PROXY REAPPRAISAL OF DIET AND MICROHABITAT IN CHADRONIAN AND ORELLAN UNGULATES FROM NEBRASKA BASED ON STABLE ISOTOPES, MESOWEAR AND HYPSODONTY INDEX

11 **Wilson, P., Moore, J.** QUANTITATIVE ANALYSIS OF THE TAPHONOMIC PATTERNS OF VERTEBRATE ASSEMBLAGES FROM THE OLIGOCENE POLESLIDE MEMBER OF THE BRULE FORMATION, BADLANDS NATIONAL PARK, SOUTH DAKOTA

12 **Lubar, C., Prothero, D.** FOSSIL CAMELS FROM THE LATE OLIGOCENE EASTLAKE LOCAL FAUNA, OTAY FORMATION, SAN DIEGO COUNTY, CALIFORNIA

13 **MacKenzie, K., Whistler, D., Hopkins, S.** THE GEOLOGY AND PALEONTOLOGY OF COGLAN BUTTES, OREGON: THE FIRST DISCOVERED ARIKAREEAN VERTEBRATE FOSSIL LOCALITY IN THE NORTHWESTERN GREAT BASIN

14 **Prothero, D., Beatty, B., Stucky, R.** *SIMOJOVELHYUS*, THE OLDEST MAMMAL FOSSIL FROM CENTRAL AMERICA, IS A PECCARY, NOT A HELOHYID

15 **Barrón-Ortiz, C., Rankin, B., Theodor, J.** CHARACTERIZATION OF UNGULATE BUCCAL CUSP SHAPE USING OUTLINE-BASED GEOMETRIC MORPHOMETRICS AND ITS IMPLICATION FOR MESOWEAR ANALYSES

16 **Gelnaw, W.** MORPHOMETRY.ORG, A NEW WEBSITE FOR SHARING MORPHOMETRIC DATA

17 **Burk, D.** USING GIS SLOPE AND ASPECT DATA AS PREDICTORS OF SURFACE FOSSIL ABUNDANCE IN THE UINTA BASIN, UTAH

18 **Moran, S.** INTRA-INDIVIDUAL VARIATION OF CARBON AND OXYGEN ISOTOPES WITHIN THE MIOCENE HORSE *PARAHIPPUS LEONENSIS* AND IMPLICATIONS FOR DIET

19 **Feranec, R., Pagnac, D.** EARLY EVIDENCE FOR THE ABUNDANCE OF C4 GRASSES FROM THE MIDDLE MIOCENE BARSTOW FORMATION, SAN BERNARDINO COUNTY, CALIFORNIA

20 **Maguire, K.** USING PALEOSOLS TO IDENTIFY NICHE PARTITIONING IN MIOCENE EQUIDS OF CENTRAL OREGON

21 ***WITHDRAWN***

22 **Martinez-Maza, C., Alberdi, M., Prado, J.** PALEOHISTOLOGICAL ANALYSIS OF METAPODIAL BONES OF MIOCENE *HIPPARION CONCUDENSE* FROM SPAIN

23 **Scott, E., Springer, K., Manker, C.** LATE PLEISTOCENE *EQUUS* AND *BISON* FROM THE TULE SPRINGS LOCAL FAUNA, UPPER LAS VEGAS WASH, CLARK COUNTY, NEVADA

24 **Hulbert Jr., R.** *EQUUS* SPECIES RICHNESS IN THE RANCHOLABREAN OF THE SOUTHEASTERN U.S. COASTAL PLAIN: A QUANTITATIVE ANALYSIS OF ISOLATED CHEEK TEETH

25 **Loffredo, L., DeSantis, L.** HIGH OBSERVER VARIABILITY IN DENTAL MESOWEAR ANALYSIS OF AN EXTREME GENERALIST *CORMOHIPPARION EMSLIEI* FROM FLORIDA: CAUTIONARY LESSONS LEARNED FROM INTEGRATING GEOCHEMICAL AND DENTAL MESOWEAR DATA

26 **McHorse, B., Davis, E., Hopkins, S.** FUNCTIONAL MORPHOLOGY IN MODERN HORSES: NATURAL VS. ARTIFICIAL SELECTION

27 **Gilmore, L., Bredehoeft, K.** PALEOPATHOLOGICAL ANALYSIS OF *TAPIRUS* SPP. FROM FLORIDA AND TENNESSEE

28 **Ayoub, M., Mihlbachler, M.** DENTAL WEAR AND FEEDING ECOLOGY IN NORTH AMERICAN LATE MIOCENE RHINOCEROTIDAE, *APHELOPS* AND *TELEOCERAS*

29 **Handa, N., Nakaya, H., Nakatsukasa, M., Kunimatsu, Y.** NEW SPECIMENS OF ELASMOTHERIINI (RHINOCEROTIDAE, PERISSODACTYLA) FROM THE NAMURUNGULE AND NAKALI FORMATIONS (EARLY LATE MIOCENE) OF NORTHERN KENYA

30 **Stilson, K., Hopkins, S., Davis, E.** THE EVOLUTION OF RHINO ARTHRITIS IN THE CENOZOIC

31 **Mihlbachler, M., Beatty, B., Ayoub, M.** EXTRACTION AND ANALYSIS OF INGESTA IMPACTED IN THE DENTITIONS OF MODERN UNGULATES: NEW EVIDENCE FOR LINKING DENTAL WEAR AND FEEDING ECOLOGY

32 **Karme, A., Kallonen, A., Galambosi, S., Engström, P., Fortelius, M.** ARTIFICIAL CHEWING WITH REAL TEETH

33 **Prado, J., Alberdi, M., Domingo, L.** MEGAFAUNA EXTINCTION AND CLIMATIC CHANGE IN THE PAMPEAN REGION, ARGENTINA

34 **Davis, M.** WHAT IS THE APPROPRIATE SPATIAL AND TEMPORAL SCALE OF FAUNMAP DATA?

35 **Damuth, J., Janis, C., Travouillon, K., Archer, M., Hand, S.** MOLAR WEAR GRADIENT ANALYSIS IN EXTANT AND FOSSIL KANGAROOS (MARSUPIALIA, MACROPODOIDEA)

36 **Vietti, L.** QUANTIFYING BONE WEATHERING STAGES USING RA, A SURFACE ROUGHNESS PARAMETER MEASURED FROM 3D DATA

37 **Louys, J.** A DIVERSE WOMBAT FAUNA FROM THE PLIOCENE CHINCHILLA SAND FORMATION, SOUTHEASTERN QUEENSLAND, AUSTRALIA

38 **Gunnell, G., Simmons, N., Rosenberger, A., O'Neill, H., Rimoli, R.** FIRST RECORDS OF FOSSIL BATS FROM THE DOMINICAN REPUBLIC

39 **Salles, L., Carlos, M., Lanzelotti, W., Perini, F., Simmons, N.** QUATERNARY BATS FROM SERRA DA MESA (BRAZIL): HUMERAL REMAINS AND TAXONOMIC ASSESSMENTS

40 **Schwermann, A.** NEW INFORMATION OF THE EVOLUTION OF THE SHOULDER GIRDLE AND FORELIMBS OF FOSSORIAL MOLES

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
POSTER SESSION I (CONTINUED)

41 **Pujos, F., Antoine, P., Mamani Quispe, B., Abello, A., Andrade Flores, R.** THE MIOCENE VERTEBRATE FAUNAS OF ACHIRI, BOLIVIA

42 **Gaudin, T.** PREMAXILLAE OF EXTINCT ANTILLEAN MEGALONYCHID SLOTHS *ACRATOCNUS* AND *NEOCNUS* AND A POTENTIAL NEW SYNAPOMORPHY FOR MEGALONYCHIDAE (XENARTHRA, MAMMMALIA)

43 **Resar, N., Green, J.** USING SCANNING ELECTRON MICROSCOPY TO RECONSTRUCT FEEDING ECOLOGY IN GROUND SLOTHS

44 **Green, J., Resar, N.** ANALYSIS OF DENTAL MICROWEAR IN THE XENARTHRA: DOES SCANNING ELECTRON MICROSCOPY REVEAL A LINK BETWEEN FEEDING ECOLOGY AND TOOTH SCARRING?

45 **Jasinski, S., Wallace, S.** AN ARMADILLO AND A LEG: INFERRING BEHAVIORAL DIFFERENCES OF *DASYPUS BELLUS* AND *DASYPUS NOVEMCINCTUS* FROM MORPHOLOGY OF THE CALCANEUS

46 **Gillette, D., Carranza-Castañeda, O., White, R., McCord, R., Thrasher, L.** EVOLUTIONARY STASIS OF NORTH AMERICAN GLYPTODONTS DURING THE GREAT AMERICAN BIOTIC INTERCHANGE

47 **Reizner, J.** AN ONTOGENETIC STUDY AND POPULATION HISTOLOGY OF THE CERATOPSID DINOSAUR *EINIOSAURUS PROCURVICORNIS*

48 **Brandau, D., Irmis, R.** COMPARATIVE TAPHONOMY OF CERATOPSID BONEBEDS: IMPLICATIONS OF NEW DATA FROM SOUTHERN LARAMIDIA

49 **Varriale, F.** THE NEOCERATOPSIAN HORIZONTAL SHELF IS NOT HORIZONTAL, AND OTHER NEW INFORMATION ABOUT THIS STRUCTURE

50 **Campbell, J., Ryan, M., Currie, P., Langston, W.** NEW RECONSTRUCTION OF THE PARIETALMORPHOLOGY OF PACHYRHINOSAURUS CANADENSIS, A CENTROSAURINE CERATOPSID FROM THE CAMPANIAN OF ALBERTA

51 **Scannella, J., Fowler, D., Goodwin, M., Horner, J.** TRANSITIONAL *TRICERATOPS*: DETAILS OF AN ONTOGENETIC SEQUENCE FROM THE UPPER MIDDLE UNIT OF THE HELL CREEK FORMATION, MONTANA

52 **Tokaryk, T., Ryan, M., Evans, D.** NO ENVIRONMENTAL PARTITIONING OF CERATOPSIDAE WITHIN THE LOWER DINOSAUR PARK FORMATION (CAMPANIAN) FAUNAL ZONE OF WESTERN CANADA

53 **Lund, E., O'Connor, P., Loewen, M., Jinnah, Z.** NEW CENTROSAURINE CERATOPSID MATERIAL FROM THE MIDDLE CAMPANIAN WAHWEAP FORMATION OF SOUTHERN UTAH

54 **Frederickson, J.** CRANIAL DEVEOPMENT OF *CENTROSAURUS APERTUS*: UNDERSTANDING HORN VARIATION AND EVOLUTION THROUGH AN ONTOGENETIC APPROACH

55 **Wiersma, J., Loewen, M., Irmis, R.** A RE-EVALUATION OF TOROSAURUS UTAHENSIS: IMPLICATIONS FOR MAASTRICHTIAN CERATOPSIAN DIVERSITY IN WESTERN NORTH AMERICA

56 **Hedrick, B., Dodson, P.** MYOLOGICAL RECONSTRUCTION OF THE BASAL CERATOPSIANS, *PSITTACOSAURUS* AND *PROTOCERATOPS*: UNDERSTANDING MUSCLE RELOCATION RELEVANT TO POSTURE

57 **Peterson, J., Dischler, C.** DISTRIBUTIONS OF INJURIES IN PACHYCEPHALOSAURIDS USING FRONTOPARIETAL LANDMARKS

58 **Gunn, J., Nazikian, T., Farke, A.** DENTAL MICROWEAR IN HADROSAURID DINOSAURS FROM THE KAIPAROWITS FORMATION, UTAH

59 **Lauters, P., Taquet, P., Vercauteren, M., Godefroit, P.** THE BRAINCASE AND ENDOCRANIAL SPACE OF THE IGUANODONTIAN *LURDUSAURUS ARENATUS*

60 **Mori, H., Druckenmiller, P., Prieto-Marquez, A., Joshi, S.** RECONSTRUCTION AND MORPHOMETRIC ANALYSIS OF JUVENILE *EDMONTOSAURUS* SP. FROM THE LOWER MAASTRICHTIAN (CRETACEOUS) PRINCE CREEK FORMATION OF NORTHERN ALASKA

61 **Freedman, E., Tanke, D., Wolff, E.** OSTEOPATHY IN HADROSAURINES (DINOSAURIA: ORNITHISCHIA) OF THE JUDITH RIVER FORMATION (CAMPANIAN) OF NORTHCENTRAL MONTANA

62 **Guenther, M., Wosik, M., McCarthy, S.** REFINING HADROSAURID DIVERSITY IN THE SAN JUAN BASIN THROUGH THE REEXAMINATION OF HISTORIC SPECIMENS

63 **Farke, A., Chok, D., Herrero, A., Scolieri, B.** ONTOGENY IN THE HADROSAURID DINOSAUR *PARASAUROLOPHUS* REVEALED BY AN ARTICULATED SKELETON FROM THE KAIPAROWITS FORMATION OF SOUTHERN UTAH

64 **MacDougall, M., Reisz, R.** RECONSTRUCTION OF INACCESIBLE ANATOMY FROM AN EARLY PERMIAN LANTHANOSUCHOID (AMNIOTA: PARAREPTILIA), AND A NEW PHYLOGENTIC ANALYSIS OF THE PARAREPTILIA

65 **Jones, M., Zikmund, T.** A FUNCTIONAL INTERPRETATION OF THE CRANIAL SUTURE MORPHOLOGY IN *CAPTORHINUS AGUTI* (REPTILIA)

66 **Drymala, S., Bader, K.** ASSESSING PREDATOR-PREY INTERACTIONS THROUGH THE IDENTIFICATION OF BITE MARKS ON AN AETOSAUR (PSEUDOSUCHIA) OSTEODERM FROM THE UPPER TRIASSIC (NORIAN) CHINLE FORMATION IN PETRIFIED FOREST NATIONAL PARK (ARIZONA, USA)

67 **Suzuki, D., Chiba, K.** MECHANISM OF THE CRUROTASAL JOINT

68 **Ji, C., Shang, W., Diao, G., Motani, R., Tintori, A.** BIODIVERSITY AND STRATIGRAPHIC DISTRIBUTION OF THE FIRST LATE LADINIAN (MIDDLE TRIASSIC) MARINE VERTEBRATE FAUNA – XINGYI FAUNA FROM SOUTH CHINA

69 **Beardmore, S., Orr, P., Manzocchi, T., Furrer, H.** CAN THE PALAEOECOLOGY OF REPTILE FOSSILS BE INFERRED FROM TAPHONOMY?

70 **Mueller, B., Chatterjee, S.** NEW DREPANOSAURID (ARCHOSAUROMORPHA: DREPANOSAURIDAE) MATERIAL FROM THE LATE TRIASSIC DOCKUM GROUP OF WEST TEXAS

71 **Spielmann, J., Lucas, S., Heckert, A.** A NEW ARMORED ARCHOSAUROMORPH FROM THE LATE TRIASSIC (OTISCHALKIAN) COLORADO CITY FORMATION OF THE CHINLE GROUP, WEST TEXAS

72 **Sobral, G., Müller, J.** X-RAY MICRO-COMPUTED TOMOGRAPHY REANALYSIS OF THE UPPER TRIASSIC DIAPSID *ELACHISTOSUCHUS HUENEI*

73 **Lucas, S., Heckert, A., Spielmann, J.** NEW SPECIES OF THE ENIGMATIC ARCHOSAUROMORPH DOSWELLIA FROM THE UPPER TRIASSIC BLUEWATER CREEK FORMATION, NEW MEXICO, USA

74 **Domingo, L., Barroso-Barcenilla, F., Cambra-Moo, Ó.** FIRST STABLE ISOTOPE ANALYSES ON CROCODILES AND DINOSAURS FROM THE LATE CRETACEOUS "LO HUECO" FOSSIL SITE (CUENCA, SPAIN)

75 **Dufeau, D., Morhardt, A., Witmer, L.** ONTOGENETIC CHANGE IN THE CRANIAL ENDOCAST AND ENDOSSEOUS LABYRINTH OF AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*): IMPLICATIONS FOR THE INTERPRETATION OF EXTINCT ARCHOSAURS

76 **Imai, T., Evans, T., Cahoon, J., Varricchio, D.** EGGSHELLS AS SEDIMENT: A FLUME STUDY TO DETERMINE THE APPLICABILITY OF SEDIMENT-TRANSPORT EQUATIONS TO EGGSHELLS

77 **Kruk, B., Susorney, H., Jackson, F., Shaw, C., Varricchio, D.** APPLICATIONS OF ELECTRON BACKSCATTER DIFFRACTION ON FOSSILIZED AND MODERN EGGSHELL

WEDNESDAY AFTERNOON, OCTOBER 17, 2012
POSTER SESSION I (CONTINUED)

78 ***WITHDRAWN***

79 **Lomax, D., Massare, J.** A NEW SPECIES OF *ICHTHYOSAURUS* FROM THE LOWER JURASSIC (PLIENSBACHIAN) OF WEST DORSET, ENGLAND

80 **Yang, P., Ji, C., Jiang, D., Motani, R., Sun, Z.** A NEW SPECIES OF *QIANICHTHYOSAURUS* (REPTILIA: ICHTHYOSAURIA) FROM XINGYI FAUNA (LADINIAN, MIDDLE TRASSIC) OF GUIZHOU, SOUTHWESTERN CHINA

81 **Burnham, D., Martin, L., Rothschild, B.** PLESIOSAURS HAD A TASTE FOR BIRDS

82 **Schumacher, B., Carpenter, K., Everhart, M.** A NEW PLIOSAUR (PLESIOSAURIA, PLIOSAURIDAE) FROM THE CARLILE SHALE (CRETACEOUS: MIDDLE TURONIAN) OF RUSSELL COUNTY, KANSAS

83 **Wilhelm, B., Tokaryk, T.** FURTHER CONSIDERATIONS OF THE OSTEOLOGY OF *TERMINONATATOR PONTEIXENSIS*

84 **Byrd, C.** ONTOGENETIC STATE OF A JUVENILE POLYCOTYLID PLESIOSAUR (SAUROPTERYGIA: PLESIOSAURIA) AND ITS IMPLICATIONS FOR PLESIOSAUR GROWTH AND REPRODUCTION

85 **Smith, A., Araújo, R.** A NEW RHOMALEOSAURID PLIOSAUR FROM THE SINEMURIAN (LOWER JURASSIC) OF LYME REGIS, ENGLAND

86 **Xue, Y., Jiang, D., Sun, Z., Yang, P., Ji, C.** NEW INFORMATION ON SEXUAL DIMORPHISM AND ALLOMETRIC GROWTH IN THE PACHYPLEUROSAUR *KEICHOUSAURUS HUI* FROM THE MIDDLE TRIASSIC OF GUIZHOU, SOUTH CHINA

THURSDAY MORNING, OCTOBER 18, 2012
SYMPOSIUM: CRETACEOUS FAUNAS OF APPALACHIA: SYSTEMATICS, PALEOECOLOGY AND TAPHONOMY: A SYMPOSIUM DEDICATED TO THE MEMORY OF DR. DONALD BAIRD

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Robert Denton, Jr. and Robert O'Neill

8:00 **Grandstaff, B., Parris, D.** SKELETONS IN THE CRETACEOUS CLOSET - AN OVERVIEW OF THE HISTORY OF PALEONTOLOGY IN APPALACHIA

8:15 **Ciampaglio, C., Cicimurri, D.** ELASMOBRANCH AND OSTEICHTHYAN DIVERSITY FROM TWO LATE CRETACEOUS (LATE CAMPANIAN) TRANSGRESSIVE LAG DEPOSITS ALONG THE NEUSE RIVER, LENOIR COUNTY, NORTH CAROLINA

8:30 **Garcia, W., Hippensteel, S.** CHONDRICHTHYAN AND OSTEICHTHYAN MATERIAL FROM ELIZABETHTOWN, NC, AND BOWIE, MD, AND THE FISH FAUNA OF THE CAMPANIAN-MAASTRICHTIAN OF EASTERN NORTH AMERICA

8:45 **Schwimmer, D.** LATE CRETACEOUS (MID-CAMPANIAN) VERTEBRATES OF THE HANNAHATCHEE CREEK SITE, WESTERN GEORGIA, A NEARSHORE MARINE BONE BED AT THE ATLANTIC/GULF TRANSITION

9:00 **Brochu, C., Denton, R., Grandstaff, B., Parris, D., Schein, J.** SOUTHERN NORTHERN CROCODILES: *BOREALOSUCHUS* FROM THE CAMPANIAN OF ALABAMA AND THE EARLY BIOGEOGRAPHIC HISTORY OF CROCODYLIANS IN NORTH AMERICA

9:15 **Parris, D., Clements, D., Lauginiger, E., Hope, S.** A FIELD GUIDE TO THE BIRDS (VOLANT VERTEBRATES) OF THE CRETACEOUS OF APPALACHIA

9:30 **Weishampel, D., Sartin, C., Nabavizadeh, A.** HADROSAURIDS FROM THE 'LOST CONTINENT' OF APPALACHIA

THURSDAY MORNING, OCTOBER 18, 2012
SYMPOSIUM: CRETACEOUS FAUNAS OF APPALACHIA: SYSTEMATICS, PALEOECOLOGY AND TAPHONOMY: A SYMPOSIUM DEDICATED TO THE MEMORY OF DR. DONALD BAIRD (CONTINUED)

9:45 **Fix, M., Darrough, G., Parris, D., Grandstaff, B.** WESTERN APPALACHIA DINOSAURIA AND ASSOCIATED VERTEBRATES OF THE LATE CRETACEOUS OF SOUTHEAST MISSOURI

10:00 BREAK

10:15 **Brusatte, S., Choiniere, J., Benson, R., Carr, T., Norell, M.** THEROPOD DINOSAURS FROM THE LATE CRETACEOUS OF EASTERN NORTH AMERICA: ANATOMY, SYSTEMATICS, BIOGEOGRAPHY, AND NEW INFORMATION FROM HISTORIC SPECIMENS

10:30 **Vavrek, M., Larsson, H.** LATE CRETACEOUS (SANTONIAN-MAASTRICHTIAN) VERTEBRATE FAUNAS FROM THE ARCTIC OF APPALACHIA

10:45 **Lamb, Jr., J.** VEGETATION AND CLIMATE RECONSTRUCTION OF DINOSAUR-BEARING LATE SANTONIAN, EARLY CAMPANIAN UNITS IN ALABAMA AND MISSISSIPPI

11:00 **Crane, C.** BRIDGING THE GAP: NORTH CAROLINA'S ROLE IN LATE CRETACEOUS (CAMPANIAN) RESEARCH AND ITS IMPLICATIONS FOR REGIONAL PALEOBIOGEOGRAPHY AND FAUNAL CORRELATIONS

11:15 **Main, D., Noto, C., Scotese, C., Weishampel, D.** WILDFIRE PALEOECOLOGY FROM THE CRETACEOUS COAST OF SOUTHWEST APPACLACHIA AT THE ARLINGTON ARCHOSAUR SITE, TEXAS

11:30 **Hippensteel, S., Garcia, W.** DEPOSITIONAL ENVIRONMENT AND REWORKING HISTORY OF THE SEVERN (BOWIE, MD) AND BLADEN (ELIZABETHTOWN, NC) FORMATIONS: TAPHONOMIC AND SEDIMENTOLOGICAL CHARACTERISTICS OF TWO LATE CRETACEOUS LAG DEPOSITS

11:45 **Gallagher, W.** COMPARATIVE TAPHONOMY OF LATE CRETACEOUS VERTEBRATE FOSSIL OCCURRENCES IN THE ATLANTIC COASTAL PLAIN DEPOSITS OF APPALACHIA: TESTING THE HYPOTHESIS OF MASS MORTALITY AT THE K/PG BOUNDARY

12:00 **Denton, R., O'Neill, R.** EXPLORING THE "LOST CONTINENT" OF APPALACHIA - THE ELLISDALEAN LAND FAUNA AND ITS IMPLICATIONS FOR LATE CRETACEOUS BIOGEOGRAPHY

THURSDAY MORNING, OCTOBER 18, 2012
ROMER PRIZE SESSION

RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATOR: David Fox

8:00 **Bamforth, E.** LOCAL ENVIRONMENTAL CONDITIONS DROVE VERTEBRATE DIVERSITY IMMEDIATELY PRIOR TO THE K/PG EXTINCTION: EVIDENCE FROM CENTRAL CANADA

8:15 **Boehmer, C.** FOSSILS, GENES AND THE EVOLUTION OF THE VERTEBRAL COLUMN IN ARCHOSAURS

8:30 **Campione, N.** A UNIVERSAL LIMB SCALING RELATIONSHIP FOR ESTIMATING BODY MASS IN EXTINCT TERRESTRIAL TETRAPODS

8:45 **Christensen, H.** CHANGING DIETARY NICHES IN MAMMALIAN COMMUNITIES ACROSS THE CRETACEOUS/PALEOGENE BOUNDARY

9:00 **Cleland, T.** CHEMICAL AND MOLECULAR CHARACTERIZATION OF ENDOGENOUS PROTEINS FROM THE BLOOD VESSELS OF *BRACHYLOPHOSAURUS CANADENSIS* AND *TYRANNOSAURUS REX* CORTICAL BONE

9:15 **Dececchi, T.** PATTERNS AND PROCESSES AT ORIGIN OF BIRDS: MACROEVOLUTIONARY TEMPO AND MODE

THURSDAY MORNING, OCTOBER 18, 2012
ROMER PRIZE SESSION (CONTINUED)

9:30 **Gould, F.** ARTICULAR SURFACE MORPHOLOGY AND THE EVOLUTION OF CURSORIALITY IN PALEOGENE UNGULATES: THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSIS OF COMPLEX TOPOLOGIES

9:45 **Hammond, A.** EVIDENCE FOR SUSPENSORY LOCOMOTOR ADAPTATIONS IN A LATE MIOCENE FOSSIL APE BASED ON *IN VIVO*-VALIDATED MODELS OF HIP JOINT ABDUCTION

10:00 BREAK

10:15 **Hastings, A.** DYROSAURID CROCODYLIFORMS ATTAIN PEAK TAXONOMIC DIVERSITY AND CRANIAL MORPHOSPACE DISPARITY IN FRESHWATER FOLLOWING LATE CRETACEOUS LARGE MARINE TETRAPOD EXTINCTION

10:30 **Heers, A.** FROM EXTANT TO EXTINCT: LOCOMOTOR ONTOGENY AND THE EVOLUTION OF AVIAN FLIGHT

10:45 **Lyson, T.** EVOLUTIONARY DEVELOPMENTAL MODEL FOR THE ORIGIN OF THE TURTLE SHELL AND A NOVEL FUNCTIONAL HYPOTHESIS FOR THE ORIGIN OF THE CHELONIAN LUNG VENTILATION MECHANISM

11:00 **McHugh, J.** ONTOGENY AND PHYLOGENY OF TEMNOSPONDYL AMPHIBIANS, A WINDOW INTO TERRESTRIAL ECOSYSTEMS DURING THE PERMO-TRIASSIC MASS EXTINCTION

11:15 **Montanari, S.** STABLE ISOTOPE ECOLOGY OF VERTEBRATES IN ARID ENVIRONMENTS: ARCHIVES OF ENVIRONMENT AND CLIMATE IN THE FOSSIL RECORD

11:30 **Tseng, Z.** CONVERGENT EVOLUTION AND ITS FUNCTIONAL MECHANISMS: A CASE STUDY OF BONE-CRACKERS

11:45 **Uno, K.** ENAMEL MATURATION AND INTRATOOTH STABLE ISOTOPE PROFILES IN ELEPHANT (*LOXODONTA AFRICANA*) MOLARS: A NEW TOOL FOR EVALUATING SEASONALITY IN TERRESTRIAL PALEOENVIRONMENTS FROM PROBOSCIDEAN TEETH

12:00 **Wilberg, E.** A SOLUTION TO THE "LONGIROSTRINE PROBLEM"? A PHYLOGENETIC REAPPRAISAL OF THALATTOSUCHIAN RELATIONSHIPS AND ISSUES SURROUNDING THEIR LABILITY

THURSDAY MORNING, OCTOBER 18, 2012
PREPARATORS' SESSION

RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Kyle Davies and William Simpson

8:00 **Keillor, T.** FEATHERING DINOSAURS

8:15 **Starck, E., Benton, R., Householder, M., Boyd, C., Pagnac, D.** FROM DISCOVERY TO PUBLIC OUTREACH: A NEW VISITOR ORIENTATED FOSSIL QUARRY AND FOSSIL PREPARATION LAB OPENS AT THE BEN REIFEL VISITOR CENTER AT BADLANDS NATIONAL PARK

8:30 **Hlusko, L., Njau, J.** INTRODUCING C.O.D.I. (THE COMPREHENSIVE OLDUVAI DATABASE INITIATIVE): AN ELECTRONIC REPOSITORY OF TERRESTRIAL VERTEBRATE FOSSILS FROM THE PLIO-PLEISTOCENE OF OLDUVAI GORGE, TANZANIA

8:45 **Sagebiel, J., Brown, M.** IMPROVING CURATION AND CONSERVATION STANDARDS AT THE VERTEBRATE PALEONTOLOGY LABORATORY THROUGH INTERDISCIPLINARY COLLABORATIONS

9:00 **Storch, P., Wilkins, W., Potapova, O., Agenbroad, L.** METHODOLOGY AND RESULTS OF A COMPREHENSIVE SPECIMEN CONSERVATION CONDITION SURVEY OF AN ACTIVE BONE BED AND STORAGE COLLECTION AT THE MAMMOTH SITE OF HOT SPRINGS, SD, INC.

9:15 **May, P., Fair, M., Crawford, B., May, A., MacLeod, M.** DIGITAL DEVELOPMENT AND MOUNTING OF AN *ALAMOSAURUS* SKELETON FOR THE PEROT MUSEUM OF NATURE AND SCIENCE

THURSDAY MORNING, OCTOBER 18, 2012
PREPARATORS' SESSION (CONTINUED)

9:30 **Marsh, A., Brown, M., Colbert, M., Rowe, T.** COMBINING MECHANICAL PREPARATION AND X-RAY COMPUTED TOMOGRAPHY TECHNIQUES TO VISUALIZE OBSCURED MORPHOLOGY IN A BASAL SAUROPODOMORPH DINOSAUR

9:45 **Colbert, M., Brown, M.** THE USE OF HIGH-RESOLUTION XRAY CT TO INTERPRET MATRIX VARIABILITY AND GUIDE FOSSIL PREPARATION

10:00 BREAK

10:15 **Supplee, J., Compton, B.** USING A GLYCEROL-WATER SOLUTION TO CONTROL RELATIVE HUMIDITY IN A CLOSED ENVIRONMENT

10:30 **Sadowska, V., Morrison, I., Silcox, M.** COMPARING IMPRESSION MATERIALS FOR DENTAL MICROWEAR ANALYSIS IN A SMALL FOSSIL MAMMAL

10:45 **Brown, G.** TECHNIQUES AND MATERIALS FOR MICROFOSSIL PREPARATION: MAXIMIZING SUCCESS AND MINIMIZING STRESS

11:00 **Kline, P., Kline, M., Main, D.** MAPPING AND LAB PREPARATION OF A CRETACEOUS (CENOMANIAN) TURTLE FROM THE WOODBINE FORMATION OF NORTH TEXAS: THE UNUSUAL CHALLENGES OF THE FLYING TURTLE PROJECT

11:15 **Weiler, M., Schumaker, K., Hartman, J.** LOST AND FOUND: THE CHALLENGES, OPPORTUNITIES AND SIGNIFICANCE OF A FOSSIL RHINOCEROS SPECIMEN FOUND DURING A STORAGE CLEANING EVENT

11:30 **McCullough, G., Walters, T., Gillette, D., White, R., Thrasher, L.** THE COLLABORATION OF INSTITUTIONS, AGENCIES, AND VOLUNTEERS FOR A "PAINLESS" EXCAVATION OF A LARGE *GLYPTOTHERIUM* FROM THE LATE BLANCAN OF THE SAN SIMON VALLEY IN SOUTHEASTERN ARIZONA

11:45 **Breithaupt, B., Matthews, N., Noble, T.** STATE-OF-THE-ART DIGITAL DATA COLLECTION OF PALEONTOLOGICAL RESOURCES: COMPARING METHODS OF CAPTURE AND QUANTIFYING RESULTS OF 3D POINT CLOUD DATA

12:00 **Brown, M., Davidson, A., Fox, M., Jabo, S., Smith, M.** VERTEBRATE PALEONTOLOGICAL PREPARATION CORE COMPETENCIES AND TRAINING CURRICULUM: RESULTS FROM THE 2012 AUSTIN WORKSHOP

THURSDAY AFTERNOON, OCTOBER 18, 2012
TECHNICAL SESSION VI

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Martin Sander and Nathan Smith

1:45 **Bourke, J., Porter, W., Witmer, L.** DORSAL OR ROSTRAL NOSTRILS? TESTING FLESHY NOSTRIL POSITION AND AIRFLOW IN SAUROPODS USING COMPUTATIONAL FLUID DYNAMICS

2:00 **Schmitt, A., Sander, P., Ruf, I.** SEMICIRCULAR CANAL DIMENSIONS IN SAUROPODOMORPHA: PALEOBIOLOGICAL IMPLICATIONS

2:15 **Bonnan, M., Wilhite, D., Masters, S., Yates, A., Gardner, C.** WHAT LIES BENEATH: SUB-ARTICULAR LONG BONE SHAPE SCALING IN EUTHERIAN MAMMALS AND SAURISCHIAN DINOSAURS SUGGESTS DIFFERENT LOCOMOTOR ADAPATIONS

2:30 **Holtz, Jr., T.** LIASSIC DAWN: PHYLETIC DIVERGENCE ANALYSIS SUPPORTS EARLY TO MIDDLE JURASSIC ESTABLISHMENT OF PRIMARY DINOSAURIAN DIVERSITY

2:45 **Smith, N., Hellert, S., Mathews, J., Hammer, W., Makovicky, P.** NEW DINOSAURS FROM THE EARLY JURASSIC HANSON FORMATION OF ANTARCTICA, AND PATTERNS OF PHYLOGENETIC DIVERSITY IN EARLY JURASSIC SAUROPODOMORPHS

THURSDAY AFTERNOON, OCTOBER 18, 2012
TECHNICAL SESSION VI (CONTINUED)

3:00 **Upchurch, P., D'Emic, M., Mannion, P., Benson, R., Pang, Q.** NEW INFORMATION ON THE ANATOMY AND RELATIONSHIPS OF TITANOSAURIFORM SAUROPODS FROM THE CRETACEOUS OF EAST ASIA

3:15 **Mannion, P., Upchurch, P., Barnes, R.** THE EVOLUTIONARY HISTORY OF TITANOSAURIFORM SAUROPODS

3:30 **Sander, P., Klein, N.** CERVICAL RIB HISTOLOGY OF SAUROPOD DINOSAURS SUGGESTS FUNCTION IN THE MUSCULAR CONTROL OF THE NECK

3:45 **Stein, K., Prondvai, E.** NO FIBROUS (WOVEN) BONE IN SAUROPOD FIBROLAMELLAR BONE?

4:00 **D'Emic, M., Wilson, J.** BONE HISTOLOGY OF A DWARF SAUROPOD DINOSAUR FROM THE LATEST CRETACEOUS OF JORDAN AND A POSSIBLE BIOMECHANICAL EXPLANATION FOR "TITANOSAUR-TYPE" BONE HISTOLOGY

THURSDAY AFTERNOON, OCTOBER 18, 2012
TECHNICAL SESSION VII

RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATORS: Sarah Werning and Robert Burroughs

1:45 **Sereno, P., Ibrahim, N., Mabee, P., Vision, T., Lapp, H.** PHENOSCAPE: A NEW ANATOMICAL ONTOLOGY OF VERTEBRATES

2:00 **Lamm, K.** TOWARD A QUANTITATIVE WAY TO IDENTIFY ANCESTORS IN THE FOSSIL RECORD: A BAYESIAN APPROACH

2:15 **Ferrer, E.** USING PHYLOGENY AS A FRAMEWORK FOR DIVERSITY STUDIES

2:30 **Burroughs, R.** EXPLORING AND EVALUATING THE IMPACT OF ANATOMICAL PARTITIONS ON MORPHOLOGY-BASED PHYLOGENETIC ANALYSES

2:45 **Alroy, J.** SIMPLE EQUATIONS FOR ESTIMATING BODY MASS IN MAMMALS (AND DINOSAURS)

3:00 **Werning, S.** HOW DOES A "TYPICAL" MAMMAL GROW? SAMPLING AND THE INTERPRETATION OF FOSSIL BONE TISSUE

3:15 **Koyabu, D., Maier, W., Sánchez-Villagra, M.** RESOLVING THE HOMOLOGY AND MIXED EMBRYONIC ORIGIN OF A MAMMALIAN SKULL BONE: THE IDENTITY OF THE INTERPARIETAL BASED ON PALEONTOLOGICAL AND DEVELOPMENTAL DATA

3:30 **Halliday, T., MacKenzie, P., Goswami, A.** TESTING THE INHIBITORY CASCADE MODEL IN MESOZOIC AND CENOZOIC MAMMALIAFORMS

3:45 **Asher, R., Pattinson, D., Tabuce, R., Gheerbrant, E., Hautier, L.** PATTERNS OF DENTAL ERUPTION AND VARIABILITY IN MAMMALS

4:00 **Sánchez-Villagra, M.** THE MARSUPIAL-PLACENTAL DICHOTOMY REVISITED: THE RELEVANCE OF GEOGRAPHY AND PHYSIOLOGY ON EVOLUTIONARY PATTERNS OF DIVERSITY AND DISPARITY

THURSDAY AFTERNOON, OCTOBER 18, 2012
TECHNICAL SESSION VIII

RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Catherine Badgley and Samantha Hopkins

1:45 **Tomiya, S.** GENERIC DURATIONS OF TERRESTRIAL MAMMALS IN THE OLIGO-HOLOCENE OF NORTH AMERICA AND IMPLICATIONS FOR THE UTILITY OF BODY SIZE AS A PREDICTOR OF SUPRASPECIFIC EXTINCTION RISK

THURSDAY AFTERNOON, OCTOBER 18, 2012
TECHNICAL SESSION VIII (CONTINUED)

2:00 **Hopkins, S., Maguire, K., McLaughlin, W.** FAUNAL HETEROGENEITY IN BARSTOVIAN MAMMALS OF THE NORTHWEST: WHAT DOES FAUNAL DIVERSITY TELL US ABOUT TECTONICS AND HABITAT DIVERSITY?

2:15 **Badgley, C., Finarelli, J.** DIVERSITY DYNAMICS OF MAMMALS IN RELATION TO LANDSCAPE HISTORY FOR THREE NEOGENE RECORDS FROM NORTH AMERICA

2:30 **McLaughlin, W., Hopkins, S.** RECONCILING FAUNAL AND FLORAL CLIMATIC INTERPRETATIONS ACROSS THE EARLY BARSTOVIAN OF THE NORTHWEST U.S.A.

2:45 **Campbell, K., Prothero, D., Beatty, B., Frailey, C.** NEW LATE MIOCENE NORTH AMERICAN ARTIODACTYL FROM THE AMAZON BASIN: IMPLICATIONS FOR INTERCHANGE DYNAMICS

3:00 **Kay, R., Vizcaíno, S., Bargo, M.** THE PALEOENVIRONMENT AND PALEOECOLOGY OF THE COASTAL MIOCENE SANTA CRUZ FORMATION (LATE EARLY MIOCENE, ARGENTINA)

3:15 **Domingo, M., Badgley, C., Azanza, B., Alberdi, M.** NEW INSIGHTS ON MAMMALIAN FAUNAL DYNAMICS FROM THE MIOCENE OF SPAIN

3:30 **Casanovas-Vilar, I., Van Den Hoek Ostende, L., Furió, M., Madern, A.** PATTERNS AS PRETTY AS CAN BE: THE RANGE AND EXTENT OF THE VALLESIAN CRISIS (LATE MIOCENE) IN THE VALLÈS-PENEDÈS BASIN (CATALONIA, SPAIN)

3:45 **Fraser, D., Hassall, C., Gorelick, R., Rybczynski, N.** WARMER CLIMATES WEAKEN BIOTIC LATITUDINAL GRADIENTS

4:00 **Moore, J.** WHITE RIVER GROUP MAMMALS EXHIBIT ECOLOGICAL RESPONSE TO THE EARLIEST OLIGOCENE CLIMATE TRANSITION

THURSDAY AFTERNOON, OCTOBER 18, 2012
POSTER SESSION II

RALEIGH CONVENTION CENTER, EXHIBIT HALL A, LEVEL 1
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Lesser, S., Santucci, V., Jorstad, T.** NATIONAL PARK SERVICE VERTEBRATE COLLECTIONS AT THE SMITHSONIAN:COLLABORATION TO SUPPORT SCIENCE AND STEWARDSHIP

2 **De La Garza, R., Lewis, P., Primm, T.** THE BACTERIAL FLORA OF REPOSITORY FOSSILS: SOURCES, SURVIVAL AND REMOVAL

3 **Jabo, S., Kroehler, P., Makos, K., Peters, D.** CONTROL OF HAZARDOUS PARTICULATE EXPOSURE DURING FOSSIL PREPARATION THROUGH THE USE OF LOCAL EXHAUST SYSTEMS

4 **Kazumi, W., Ikeda, T., Saegusa, H., Shinya, A.** STYLUS SHARPENING INSTRUMENT FOR FOSSIL PREPARATION

5 **Patterson, D., Du, A., Bobe, R., Behrensmeyer, A., Reed, D.** TAPHONOMIC COMPARISON OF MODERN EAST AFRICAN OWL PELLETS AND THE KANAPOI FOSSIL MICROMAMMAL ASSEMBLAGE

6 **Higgins, P., Potapova, O., Agenbroad, L.** MINERALIZATION OF MAMMOTH MOLARS

7 **Bravo-Cuevas , V., Cabral-Perdomo, M.** PROBOSCIDEAN DIVERSITY FROM THE PLIO-PLEISTOCENE OF HIDALGO, CENTRAL MEXICO

8 **Meade-Hunter, D., Stucky, R., Holen, S., Hunter, M.** A NEW PLIO-PLEISTOCENE VERTEBRATE SITE IN PHILLIPS COUNTY, COLORADO, PRESERVING EXCEPTIONAL REMAINS OF *STEGOMASTODON*

9 **Smith, G., Graham, R.** DENTAL WEAR AND LAMELLAR FREQUENCY ANALYSIS TO CONSTRAIN THE IDENTITY OF THE NORTH AMERICAN MAMMOTH SPECIES

10 **Smith, K., Stynder, D.** PROBLEMATIC IDENTIFICATION OF PROBOSCIDEANS AT THE MIDDLE PLEISTOCENE PALEONTOLOGICAL/ARCHAEOLOGICAL LOCALITY OF ELANDSFONTEIN (WESTERN CAPE PROVINCE, SOUTH AFRICA)

11 **Maschenko, E., Potapova, O., Boeskorov, G., Plotnikov, V., Agenbroad, L.** PRELIMINARY DATA ON THE NEW PARTIAL CARCASS OF THE WOOLLY MAMMOTH, *MAMMUTHUS PRIMIGENIUS,* FROM YAKUTIA, RUSSIA

12 **Nabavizadeh, A.** JAW MECHANICS OVER PROBOSCIDEAN EVOLUTION

13 **Cavin, J., Samuels, J.** THE FIRST RECORD OF AN APATEMYID FROM OREGON: *SINCLAIRELLA DAKOTENSIS* FROM THE TURTLE COVE MEMBER OF THE JOHN DAY FORMATION

14 **Silcox, M., Bloch, J., Gunnell, G.** CRANIAL ANATOMY OF PALEOGENE MICROSYOPIDAE (MAMMALIA, EUARCHONTA) AND ITS RELEVANCE TO UNDERSTANDING EUARCHONTAN RELATIONSHIPS

15 **Kristjanson, H., Prufrock, K., Silcox, M.** BODY MASS AND SHEARING QUOTIENTS OF MICROSYOPIDAE (MAMMALLIA, PRIMATES) FROM THE EARLY EOCENE, BIGHORN BASIN, WY (WASATCHIAN, NALMA): PALEOECOLOGICAL IMPLICATIONS FOR DIET

16 **Lopez-Torres, S., Silcox, M., Bloch, J.** PATTERNS OF ENCEPHALIZATION IN THE EARLY EVOLUTION OF PRIMATES

17 **Allen, K., Kay, R.** ENDOCAST SHAPE AND BRAIN PROPORTIONS IN PRIMATES

18 **Gebo, D., Smith, T., Dagosto, M.** NEW POSTCRANIAL ELEMENTS FOR *TEILHARDINA BELGICA*, AN EARLY EOCENE FOSSIL PRIMATE

19 **Coster, P., Ni, X., Beard, K.** THE MIDDLE EOCENE ADAPIFORM PRIMATES FROM THE SHANGHUANG FISSURE FILLINGS, JIANGSU PROVINCE, PEOPLE'S REPUBLIC OF CHINA

20 **Perry, J., MacNeill, K., Heckler, A., Hartstone-Rose, A.** METHODS FOR ESTIMATING CHEWING MUSCLE SIZE, BITE FORCE AND GAPE IN FOSSIL PRIMATES

21 **Roig, I., Moyà-Solà, S.** FIRST DESCRIPTION OF THE TALAR MORPHOLOGY OF *PSEUDOLORIS PYRENAICUS* (OMOMYIDAE, PRIMATES) AND IMPLICATIONS FOR ITS LOCOMOTOR BEHAVIOUR

22 **Minwer-Barakat, R., Marigó, J., Moyà-Solà, S.** NEW MATERIAL OF A LARGE-SIZED MICROCHOERINAE (OMOMYIDAE, PRIMATES) FROM THE LATE EOCENE SITE OF SOSSÍS (NE SPAIN)

23 **Kato, T.** LATE OLIGOCENE BEAVER (CASTORIDAE, RODENTIA) FROM WESTERN JAPAN

24 **Stevens, N., O'Connor, P., Roberts, E.** A NEW TAXON OF DIAMANTOMYS FROM THE LATE OLIGOCENE NSUNGWE FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA

25 **Petermann, H.** IMPLICATIONS FOR MUSCLE RECONSTRUCTION IN FOSSILS FROM HISTOLOGICAL EVIDENCE FOR MUSCLE INSERTION IN EXTANT AMNIOTE FEMORA

26 **Hawthorn, J., Reisz, R.** TESTING EVOLUTIONARY SIZE TRENDS IN THE OPHIACODONTID (SYNAPSIDA, EUPELYCOSAURIA) SKULL

27 **Brink, K., Leblanc, A., Sander, M., Reisz, R.** DENTAL HISTOLOGY AND TOOTH IMPLANTATION IN EARLY PERMIAN NON-MAMMALIAN SYNAPSIDS

28 **Dentzien-Dias, P., Paes, V., Schultz, C.** FIRST RECORD OF TRACKS IN THE PERMIAN (LOPINGIAN) OF THE PARANÁ BASIN, SOUTHERN BRAZIL

29 **Newham, E., Goswami, A., Benson, R., Upchurch, P.** MAMMALIAFORM TAXONOMIC DIVERSITY AND TURNOVER THROUGH THE MESOZOIC

30 **Simon, R.** REPRESENTATION OF EXTANT MONOTREME DIVERSITY EFFECTS PHYLOGENETIC RESULTS OF EXTINCT AND CROWN-GROUP MAMMALS

31 **Sartin, C., Rose, K.** INTRASPECIFIC VARIATION IN THE STYLAR CUSPS OF DIDELPHIS VIRGINIANA

32 **Heckert, A., Schneider, V., Mitchell, J., Sload, E., Olsen, P.** THE CURRENT KNOWLEDGE OF TRIASSIC VERTEBRATE ASSEMBLAGES OF THE DEEP RIVER BASIN (NEWARK SUPERGROUP: CHATHAM GROUP), NORTH CAROLINA, BASED ON RECENT DISCOVERIES

33 **Clark, J., Xu, X., Choiniere, J., Eberth, D., Chu, H.** THE VERTEBRATE FAUNA OF THE MIDDLE-LATE JURASSIC SHISHUGOU FORMATION OF XINJIANG, CHINA: RECENT DISCOVERIES

34 **Santucci, V., Milner, A., Birthisel, T., Clites, E., Kirkland, J.** LIFE AMONG THE DUNES, A LOWER JURASSIC "MEGATRACK BLOCK" FROM THE NAVAJO SANDSTONE, GLEN CANYON NATIONAL RECREATION AREA, UTAH

35 **King, L., Foster, J., Heckert, A.** A COMPARISON OF THE MICROVERTEBRATE FOSSILS FROM THE GARDEN PARK FOSSIL AREA IN COLORADO AND THE LITTLE HOUSTON QUARRY NEAR SUNDANCE, WYOMING (BOTH LATE JURASSIC, MORRISON FORMATION)

36 **Yamamura, D., Schmitt, J.** SANDSTONE DIAGENESIS AS AN INDICATOR OF DIAGENETIC PATHWAYS IN VERTEBRATE SKELETAL REMAINS AND HEMATITE CONCRETIONS FROM A CREVASSE SPLAY SANDSTONE, HELL CREEK FORMATION (UPPER CRETACEOUS), EASTERN MONTANA

37 **Callapez, P., Barroso-Barcenilla, F., Cambra-Moo, Ó., Pérez-García, A., Torices, A.** NEW DATA ON THE CENOMANIAN VERTEBRATE SITE OF NAZARÉ (WEST CENTRAL PORTUGAL)

38 **Bennett, III, G., Main, D., Noto, C., Anderson, B., Vranken, N.** MICROVERTEBRATE PALEOECOLOGY, WILDFIRES AND BIODIVERSITY OF COASTAL APPALACHIA IN THE CRETACEOUS (CENOMANIAN) WOODBINE FORMATION AT THE ARLINGTON ARCHOSAUR SITE, NORTH TEXAS

39 **Schein, J., Poole, J., Lacovara, K.** A SHARK-BITTEN HADROSAURID FEMUR FROM THE BASAL HORNERSTOWN FORMATION, NEW JERSEY, U.S.A.: ONE OF THE YOUNGEST NON-AVIAN DINOSAUR REMAINS KNOWN

40 **Turner, S., Snyder, D., Daeschler, E., Sullivan, R.** SUPER SPINY OR SPINY SUPPER: *GYRACANTHIDES SHERWOODI* (NEWBERRY), AN UPPER DEVONIAN CARTILAGINOUS FISH FROM PENNSYLVANIA, U.S.A.

41 **Snyder, D., Turner, S.** A DEVONIAN 'IN-GROWING' FINSPINE: PATHOLOGICAL DEFORMITY IN A GYRACANTH FISH

42 **Ryan, M., Cumbaa, S.** THE VERTEBRAL COLUMN OF THE PACHYOSTEOMORPH ARTHRODIRE *DUNKLEOSTEUS TERRELLI*

43 **Boyle, J., Ryan, M., Snively, E., Hlavin, W., Scott, E.** THE JAW ONTOGENY OF *DUNKLEOSTEUS TERRELLI* (PLACODERMI: ARTHRODIRA) SUGGESTS AN ACTIVE PREDATORY HABIT THROUGHOUT GROWTH

44 **Richards, K., Clack, J.** CHONDRICHTHYANS IN THE CARBONIFEROUS OF THE BRITISH DERBYSHIRE PEAK DISTRICT

45 **Itano, W.** FUNCTION OF THE SYMPHYSEAL TOOTH WHORLS OF *EDESTUS*

46 **Ivanov, A.** CHONDRICHTHYANS FROM THE MIDDLE PERMIAN OF RUSSIA

47 **Johnson, G.** SHARKS FROM THE GERALDINE BONEBED, LOWER PERMIAN OF TEXAS

48 **Ngasala, S.** PARSIMONY ANALYSIS OF ENDEMICITY (PAE) OF LUNGFISH GENERA

49 **Devlin, K., Sumida, S.** NEW INFORMATION ON THE HYPOBRANCHIAL SKELETON OF THE EARLY PERMIAN LEPOSPONDYL LYSOROPHID AMPHIBIAN *BRACHYDECTES*

50 **Hosgor, I., Fortuny, J.** NEW PERMIAN AND TRIASSIC VERTEBRATES FROM TURKEY (SE ANATOLIA)

51 **Fortuny, J., Marcé-Nogué, J., Steyer, J.** 3D FINITE ELEMENT ANALYSIS OF A CAPITOSAURIAN SKULL (TEMNOSPONDYLI) FROM THE TRIASSIC OF MADAGASCAR

52 **Henrici, A., Baez, A., Grande, L.** FIRST REPORT OF AN ANURAN FROM THE FOSSIL BUTTE MEMBER (EARLY EOCENE, WASATCHIAN) OF THE GREEN RIVER FORMATION, WYOMING

53 **Parham, J., Ksepka, D., Polly, P., Van Tuinen, M., Benton, M.** THE FOSSIL CALIBRATION DATABASE: A NEW BIOINFORMATIC TOOL FOR DATING DIVERGENCES OF EXTANT LINEAGES BY SYNTHESIZING PALEONTOLOGICAL AND MOLECULAR SEQUENCE DATA

54 **Warnock, R., Joyce, W., Parham, J., Lyson, T., Donoghue, P.** EXPLORING UNCERTAINTY IN THE CALIBRATION OF THE MOLECULAR CLOCK

55 **Lawver, D.** FOSSIL AND MODERN TURTLE EGGSHELL: TESTING THE VALIDITY OF EGGSHELL CHARACTERS IN CLADISTIC ANALYSES

56 **Moscato, D., Jasinski, S.** FIRST RECORD OF FOSSIL CHELYDRIDAE AND TRIONYCHIDAE FROM THE PLEISTOCENE OF SONORA, MEXICO

57 **Vermillion, W., Polly, P.** SPECIES DELIMITATION BASED ON THE LIMITS OF CLIMATE AND MORPHOLOGY IN PALEONTOLOGY: A GEOMETRIC MORPHOMETRIC ANALYSES OF CHRYSEMYS PICTA PLASTRONS

58 **Ehret, D., Atkinson, B.** THE FOSSIL RECORD OF THE DIAMONDBACK TERRAPIN, *MALACLEMYS TERRAPIN* (TESTUDINES: EMYDIDAE)

59 **Bourque, J., Hulbert Jr., R., Wood, A.** ASSESSING SPECIES DIVERSITY AND INTRASPECIFIC VARIABILITY IN SHIELD-TAILED TORTOISES (TESTUDINIDAE, *HESPEROTESTUDO*) SPANNING THE EARLY CLARENDONIAN THROUGH LATE RANCHOLABREAN OF FLORIDA

60 **Chapman, S., Sterli, J., Lyson, T., Joyce, W.** THE ANATOMY AND PHYLOGENETIC PLACEMENT OF THE CRETACEOUS STEM TURTLE *NAOMICHELYS SPECIOSA*

61 **Vineyard, D., Mateus, O., Jacobs, L., Polcyn, M., Schulp, A.** A NEW MARINE TURTLE FROM THE MAASTRICHTIAN OF ANGOLA

62 **Doman, J., Roach, B., Lyson, T.** EVIDENCE FOR PERIODS OF INCREASED ARIDITY DURING THE LATEST CRETACEOUS OF NORTH AMERICA: A DESCRIPTION OF SEVERAL MASS DEATH ASSEMBLAGES OF TURTLES

63 **Williams, S., Lyson, T.** TAPHONOMIC AND PALEOENVIRONMENTAL IMPLICATIONS OF A NEW MASS DEATH ASSEMBLAGE OF BAENID TURTLES FROM THE HELL CREEK FORMATION (LATEST MAASTRICHTIAN) OF SOUTHEASTERN MONTANA

64 **Jansen, M., Klein, N.** A NEARLY COMPLETE TURTLE (TESTUDINES: EUCRYPTODIRE) FROM THE UPPER JURASSIC OF CENTRAL GERMANY, AND ITS PALEOECOLOGY

65 **Hendricks, S., Yacobucci, M.** THE BIOMECHANICAL IMPLICATIONS OF CRYSTALLITE ORIENTATION IN CROCODILIAN TOOTH ENAMEL

66 **Dzikiewicz, K.** BUILDING A BETTER DATABASE: PROTEIN IDENTIFICATION AND LONGEVITY IN CROCODYLIAN BONE AND TEETH

67 **Holbrook, L., Geisler, J.** TAXA AS HYPOTHESES

68 **Marquart, C.** THE TAXONOMIC CHALLENGES OF UNDERSTANDING PHENOTYPE IN THE FOSSIL RECORD

69 **Martin, A., Page, M., Skaggs, S., Vance, R.** DENS OF THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*) AS TRACES AND THEIR PREDICTIVE VALUE FOR FINDING LARGE ARCHOSAUR BURROWS IN THE GEOLOGIC RECORD

70 **Fortier, D., Rincón, A.** PLEISTOCENE CROCODYLIANS FROM VENEZUELA, AND THE DESCRIPTION OF A NEW SPECIES OF *CAIMAN*

71 **Furui, S., Kobayashi, Y., Chiba, K.** A NEW TOMISTOMINE FROM THE OSAKA GROUP IN KISHIWADA CITY, OSAKA PREFECTURE, JAPAN

72 **Carter, A., Boles, Z., Schroeter, E., Lacovara, K.** A JUVENILE *HYPOSAURUS ROGERSII* SKULL FROM THE HORNERSTOWN FORMATION OF NEW JERSEY

73 **Boles, Z., Lacovara, K.** THE FIRST HISTOLOGICAL DESCRIPTION OF THORACOSAURUS NEOCESARIENSIS: CRETACEOUS/PALEOGENE HORNERSTOWN FORMATION OF NEW JERSEY

74 **Voegele, K., Patel, A., Ullmann, P., Schein, J., Lacovara, K.** INSIGHTS FROM A NEW SPECIMEN OF THE GAVIALOID CROCODYLIAN *THORACOSAURUS NEOCESARIENSIS* FROM THE MAASTRICHTIAN-DANIAN HORNERSTOWN FORMATION, SEWELL, NJ

75 **Xu, A., Henn, M., Woodward, S., Farke, A.** ANATOMY, SYSTEMATICS AND TAPHONOMY OF AN ALLIGATOROID CROCODYLIAN SKELETON FROM THE KAIPAROWITS FORMATION (LATE CAMPANIAN) OF SOUTHERN UTAH

76 **Adams, T.** CROCODYLIFORM DIVERSITY FROM THE EARLY CRETACEOUS TRINITY GROUP (APTIAN-ALBIAN) OF TEXAS, WITH THE DESCRIPTION OF NEW TAXA FROM THE TWIN MOUNTAINS FORMATION

77 **Allen, E.** INVESTIGATION OF NORTH AMERICAN GONIOPHOLIDID CROCODYLIFORMS IN A PHYLOGENETIC CONTEXT

78 **Fronimos, J.** MORPHOMETRIC ANALYSIS OF INTRACOLUMNAR AND INTRASPECIFIC VARIATION IN CERVICAL VERTEBRAE OF THE GREAT BLUE HERON (*ARDEA HERODIAS*): IMPLICATIONS FOR PHYLOGENETIC CHARACTER SELECTION IN SAUROPOD DINOSAURS

79 **Chiba, K., Brink, K., Kobayashi, Y., Suzuki, D.** MORPHOMETRICS OF RATITE FEMORA AND IMPLICATIONS FOR SEXUAL DIMORPHISM IN DINOSAURS

80 **Bourdon, E., Milner, A., Walsh, S.** VIRTUAL BRAIN ENDOCASTS SHED NEW LIGHT ON THE EARLY EVOLUTION OF MODERN BIRDS (NEORNITHES)

81 **Seymour, K., Hinic-Frlog, S., Evans, D.** A NEW FOSSIL BIRD FROM THE UPPER EOCENE GREEN RIVER FORMATION OF WYOMING

82 **Stidham, T., Hoganson, J., Person, J.** NEW MIDDLE PALEOCENE (TIFFANIAN NALMA) BIRDS FROM NORTH DAKOTA

83 **Thomas, D., James, H., Carrano, M., Madden, O.** SEARCHING FOR EVIDENCE OF FOSSIL FEATHER COLOR WITH SPECTROSCOPY

84 **Yury-Yáñez, R., Ossa, L., Rubilar-Rogers, D., Sallaberry, M.** INFERRING GROWTH IN GIANT PENGUINS FROM THE PALEOGENE OF ANTARCTICA AND THE NEOGENE OF SOUTH AMERICA

85 **Chavez-Hoffmeister, M.** MEASURING THE PENGUIN HUMERUS: THE IMPACT OF INTRASPECIFIC VARIATION ON QUANTITATIVE CHARACTERS

86 **Romick, C., Witmer, L.** ONTOGENY OF THE BRAIN ENDOCASTS OF OSTRICHES (AVES: *STRUTHIO CAMELUS*), WITH IMPLICATIONS FOR INTERPRETING EXTINCT DINOSAUR ENDOCASTS

87 **Early, C., Sclafani, M., Balanoff, A., Ksepka, D.** COMPARATIVE NEUROANATOMY OF FOSSIL AND LIVING WATERBIRDS

88 **Weeks, S., Chadwick, A.** A REGIONALLY EXTENSIVE LANCIAN SEISMITE SERVES AS A TIME SYNCHRONOUS STRATIGRAPHIC MARKER FOR MAPPING DINOSAUR BONEBEDS IN NORTHEASTERN WYOMING

FRIDAY MORNING, OCTOBER 19, 2012
SYMPOSIUM: PHYLOGENETIC AND COMPARATIVE PALEOBIOLOGY: NEW QUANTITATIVE APPROACHES TO THE STUDY OF VERTEBRATE MACROEVOLUTION
RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Tobin Hieronymus, Kerin Claeson, Patrick O'Connor, Lars Schmitz and Graham Slater

8:00 **Clarke, J., Middleton, K.** BAYESIAN APPROACHES TO THE INVESTIGATION OF MORPHOLOGICAL RATE HETEROGENEITY IN DISTINCT ANATOMICAL SUBREGIONS

8:15 **Brown, J., Slater, G.** ON THE UTILITY OF LIKELIHOOD MODELS FOR PHYLOGENETIC RECONSTRUCTION FROM DISCRETE MORPHOLOGICAL CHARACTERS

8:30 **Mounce, R., Wills, M.** EXAMINING CHARACTER CONGRUENCE AND COMPATIBILITY OF VERTEBRATE CLADISTIC DATA - EMPIRICAL APPROACHES APPLIED COMPARATIVELY ACROSS CLADES

8:45 **Bapst, D.** TIME-SCALING TREES IN THE FOSSIL RECORD

9:00 **Lloyd, G., Friedman, M., Bell, M.** CONFIDENCE INTERVALS ON NODE AGE ESTIMATES IN VERTEBRATE PHYLOGENY

9:15 **Simpson, C.** MEASURING SPECIES SELECTION IN THE MOLECULAR PHYLOGENETIC RECORD

9:30 **Slater, G.** FOSSILS, PHYLOGENIES AND MODELS OF QUANTITATIVE TRAIT EVOLUTION

9:45 **Marcot, J., Glynn, A.** A PHYLOGENETIC APPROACH TO DETERMINE THE CONTRIBUTION OF LINEAGE EVOLUTION TO PALEOECOLOGICAL CHANGE: AN EXAMPLE USING MAMMALIAN UNGULATES OF NORTH AMERICA

10:00 BREAK

10:15 **Hunt, G., Fitzjohn, R., Carrano, M.** EVOLUTIONARY DYNAMICS OF LARGE BODY SIZE IN NON-AVIAN DINOSAURS

10:30 **Organ, C., Janes, D.** EVOLUTION OF SEX CHROMOSOMES IN DINOSAURS

10:45 **Schmitz, L., Hinic-Frlog, S., Motani, R.** GLOSSY FEATHERS AND NOCTURNAL ACTIVITY: INFERENCE OF *MICRORAPTOR* FEATHER COLORS USING A PHYLOGENETIC FRAMEWORK

11:00 **Price, S., Hopkins, S., Botero, C.** UNDERSTANDING MAMMALIAN DIETARY EVOLUTION USING A PHYLOGENETIC AND COMPARATIVE APPROACH

11:15 **Hieronymus, T., Simons, E.** BONY ATTACHMENTS OF FLIGHT FEATHERS IN NEORNITHINE BIRDS: ANATOMY, HISTOLOGY AND FUNCTIONAL VARIATION

11:30 **O'Connor, P., Hieronymus, T., Stevens, N., Sertich, J.** MORPHOLOGICAL EVOLUTION IN BASAL MESOEUCROCODYLIANS: TRACKING BODY SIZE AND DENTAL TRENDS IN NOTOSUCHIA

11:45 **Claeson, K., Aschliman, N., Underwood, C.** GUITARFISH PARAPHYLY AND THE ORIGIN OF SKATES AND RAYS: ESTIMATING ACCUMULATION RATES OF VERTEBRAL FUSION AMONG BATOID FISHES

12:00 **Wainwright, P.** THE IMPACT OF CORAL REEFS ON FISH DIVERSIFICATION

FRIDAY MORNING, OCTOBER 19, 2012
TECHNICAL SESSION IX
RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATORS: Randall Irmis and Michelle Stocker

8:00 **Bever, G., Lyson, T., Bhullar, B.** THE QUADRATOMAXILLARY LIGAMENT AND ITS IMPLICATIONS FOR THE EVOLUTION OF CRANIAL FENESTRATION IN REPTILES

8:15 **Rabi, M., Wings, O., Joyce, W.** THE HOMOLOGY OF THE BASIPTERYGOID PROCESS IN EUCRYPTODIRAN TURTLES AND ITS PHYLOGENETIC IMPLICATIONS

FRIDAY MORNING, OCTOBER 19, 2012
TECHNICAL SESSION IX (CONTINUED)

8:30 **Vitek, N., Burroughs, R.** VARIATION IN COMPLEX SYSTEMATIC PROBLEMS: A CASE STUDY

8:45 **Lively, J.** TESTING LATE CRETACEOUS LARAMIDIAN PALEOBIOGEOGRAPHIC HYPOTHESES: EVIDENCE FROM THE EVOLUTION OF BAENID TURTLES

9:00 **Gignac, P., Kley, N.** LUGOL'S IODINE AS A CONTRAST AGENT IN X-RAY μCT IMAGING: METHODOLOGICAL REFINEMENTS AND POTENTIAL SIGNIFICANCE FOR INFERRING SOFT-TISSUE ANATOMY IN FOSSIL VERTEBRATES

9:15 **Butler, R., Stocker, M., Rauhut, O., Lautenschlager, S., Bronowicz, R.** SYSTEMATIC AND ANATOMICAL RE-EVALUATION OF BASAL PHYTOSAURS FROM THE LATE TRIASSIC OF CENTRAL EUROPE, WITH IMPLICATIONS FOR LATE TRIASSIC BIOSTRATIGRAPHY

9:30 **Nesbitt, S., Sidor, C., Angielczyk, K., Smith, R., Parker, W.** DERIVATION OF THE AETOSAUR OSTEODERM CARAPACE: EVIDENCE FROM A NEW, EXCEPTIONALLY PRESERVED "STEM AETOSAUR" FROM THE MIDDLE TRIASSIC (ANISIAN) MANDA BEDS OF SOUTHWESTERN TANZANIA

9:45 **Irmis, R., Nesbitt, S.** THE EVOLUTION OF EARLY CROCODYLOMORPH DISPARITY AND LOCOMOTOR STYLES: NEW EVIDENCE FROM THE LATEST TRIASSIC OF NEW MEXICO

10:00 BREAK

10:15 **Molnar, J., Pierce, S., Turner, A., Hutchinson, J.** VERTEBRAL MORPHOLOGY AND AXIAL MECHANICS IN EARLY CROCODYLOMORPHS AND MODERN CROCODILES

10:30 **Young, M., Brusatte, S., Beatty, B., De Andrade, M., Desojo, J.** CRANIODENTAL ANATOMY AND FEEDING MECHANICS OF *DAKOSAURUS MAXIMUS* AND *PLESIOSUCHUS MANSELII*, TWO CONTEMPORARY LARGE-BODIED, MACROPHAGOUS METRIORHYNCHID CROCODYLOMORPHS FROM THE LATE JURASSIC OF EUROPE

10:45 **Stocker, M., Brochu, C., Kirk, E.** SPATIAL AND TEMPORAL SHIFTS IN PALEOGENE CROCODYLIFORM DIVERSITY AND A NEW GLOBIDONT ALLIGATOROID FROM THE MIDDLE EOCENE OF WEST TEXAS

11:00 **Conrad, J., Jenkins, K., Dunsworth, H., Harcourt-Smith, W., McNulty, K.** NEW SPECIMENS OF 'CROCODYLUS' PIGOTTI (CROCODYLIDAE) FROM RUSINGA ISLAND, KENYA, AND A REFINED UNDERSTANDING OF THE SPECIES

11:15 **Watanabe, A., Slice, D.** THE ONTOGENY OF CRANIAL MORPHOLOGY IN CROCODILIANS AND ITS PHYLOGENETIC SIGNIFICANCE: A GEOMETRIC MORPHOMETRIC APPROACH

11:30 **Schachner, E., Sarrazin, J., Farmer, C.** UNIDIRECTIONAL AIRFLOW AND PULMONARY ARCHITECTURE IN *ALLIGATOR MISSISSIPPIENSIS* AND THE IMPLICATIONS FOR THE EVOLUTION OF THE AVIAN RESPIRATORY SYSTEM

11:45 **Hutchinson, J.** HOW DID BOUNDING AND GALLOPING GAITS EVOLVE IN CROCODYLOMORPHA?

12:00 **Nestler, J., Wilberg, E., Patterson, J.** EXPLORING CROCODYLIAN DIVERSITY IN AN ENVIRONMENTAL CONTEXT: IMPLICATIONS FOR THE FOSSIL RECORD

FRIDAY MORNING, OCTOBER 19, 2012
TECHNICAL SESSION X
RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Kenneth Angielczyk and Robin Beck

8:00 **Angielczyk, K., Roopnarine, P.** DO TETRAPOD HERBIVORES MATTER? ECOSYSTEM ROBUSTNESS, OLSON'S COMMUNITY TYPES AND THE PRIMACY OF INSECTS

8:15 **Castanhinha, R., Araújo, R., Costa Júnior, L., Angielczyk, K., Martins, R.** A NEW TATARIAN DICYNODONT FROM MOZAMBIQUE

FRIDAY MORNING, OCTOBER 19, 2012
TECHNICAL SESSION X (CONTINUED)

8:30 **Beck, A., Scheckel, J.** MORPHOLOGIC INDICATORS OF FOSSORIALITY AND THE EVOLUTION OF BURROWING IN DICYNODONTS (AMNIOTA: SYNAPSIDA)

8:45 **Abdala, F., Jasinoski, S., Fernandez, V.** ONTOGENY OF THE EARLY TRIASSIC *THRINAXODON LIORHINUS* (THERAPSIDA, CYNODONTIA). DENTAL MORPHOLOGY AND REPLACEMENT

9:00 **Blob, R., Butcher, M., Gosnell, W., Maie, T.** LOCOMOTOR LOADING OF THE FEMUR IN OPOSSUMS PROVIDES INSIGHT INTO THE EVOLUTION OF FEMORAL SHAPE IN SYNAPSIDS

9:15 **Huttenlocker, A., Sidor, C., Botha-Brink, J.** BODY SIZE EVOLUTION IN PERMO-TRIASSIC EUTHERIODONTS AND THE EFFECTS OF THE END-PERMIAN MASS EXTINCTION

9:30 **Kammerer, C., Fröbisch, J., Angielczyk, K., Smith, R.** PERMIAN ORIGINS OF THE POST-EXTINCTION THERAPSID RECOVERY FAUNA

9:45 **Sidor, C., Vilhena, D., Angielczyk, K., Nesbitt, S., Peecook, B.** A NETWORK APPROACH TO STUDYING FAUNAL PROVINCES ACROSS SOUTHERN PANGEA DURING THE PERMIAN AND TRIASSIC

10:00 BREAK

10:15 **O'Meara, R., Asher, R.** DETERMINATE GROWTH IN *MORGANUCODON WATSONI*

10:30 **Schultz, J.** MAJOR TRANSFORMATION IN MASTICATORY AND DENTAL FUNCTIONS IN EARLY MAMMALS

10:45 **Krause, D., Hoffmann, S., Groenke, J.** THE FIRST CRANIAL REMAINS OF A GONDWANATHERIAN MAMMAL

11:00 **Smith, T., Codrea, V.** A TRANSYLVANIAN CRETACEOUS MAMMAL WITH RED IRON PIGMENTS IN TOOTH ENAMEL

11:15 **Chen, M.** LOCOMOTOR INFERENCE OF FOSSIL MAMMALS BASED ON QUANTITATIVE MORPHOMETRIC ANALYSIS OF THE POSTCRANIAL SKELETON OF SMALL-BODIED EXTANT TAXA

11:30 **Grossnickle, D.** THE EFFECT OF THE CRETACEOUS ANGIOSPERM RADIATION ON EARLY MAMMAL TAXONOMIC DIVERSITY AND MORPHOLOGICAL DISPARITY

11:45 **Wilson, G., Ekdale, E., Hoganson, J.** A PARTIAL SKULL OF *DIDELPHODON VORAX* FROM THE LANCIAN-AGE HELL CREEK FORMATION OF SOUTHWESTERN NORTH DAKOTA, U.S.A.

12:00 **Beck, R., Voss, R., Jansa, S.** A COMPREHENSIVE GENUS-LEVEL PHYLOGENY OF LIVING AND EXTINCT MARSUPIALS BASED ON CRANIODENTAL AND MOLECULAR DATA

FRIDAY AFTERNOON, OCTOBER 19, 2012
TECHNICAL SESSION XI

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Oliver Rauhut and Martin Ezcurra

1:45 **Persons, W., Currie, P.** ADAPTIVE CURSORIAL TRENDS AMONG THEROPOD DINOSAURS AND AN ATTEMPT TO LOOK BEYOND ALLOMETRY

2:00 **Leary, B., Kavanagh, K.** PEDAL DIGIT IV PROPORTIONS REVEAL BODY-SIZE ASSOCIATED CONSTRAINT ON DINOSAUR FOOT MORPHOLOGY

2:15 **Noto, C.** WHAT BIG CLAWS YOU HAVE: IMPLICATIONS OF MORPHOLOGICAL VARIATION IN THEROPOD MANUAL UNGUALS

2:30 **Ezcurra, M.** PHYLOGENETIC ANALYSIS OF LATE TRIASSIC - EARLY JURASSIC NEOTHEROPOD DINOSAURS: IMPLICATIONS FOR THE EARLY THEROPOD RADIATION

2:45 **Rauhut, O., Diego, P.** A NEW BASAL TETANURAN THEROPOD FROM THE EARLY MIDDLE JURASSIC OF PATAGONIA, ARGENTINA

FRIDAY AFTERNOON, OCTOBER 19, 2012
TECHNICAL SESSION XI (CONTINUED)

3:00 **Araújo, R., Castanhinha, R., Mateus, O., Martins, R.** LATE JURASSIC THEROPOD EMBRYOS FROM PORTO DAS BARCAS, LOURINHÃ FORMATION, PORTUGAL

3:15 **Mateus, O., Carrano, M., Taquet, P.** OSTEOLOGY OF THE EMBRYONIC THEROPODS FROM THE LATE JURASSIC OF PAIMOGO, PORTUGAL

3:30 **Simon, D., Varricchio, D., Jackson, F., Robison, S.** GIANT THEROPOD EGGS FROM THE ALBIAN-CENOMANIAN WAYAN FORMATION OF IDAHO: TAXONOMIC, PALEOGEOGRAPHIC AND REPRODUCTIVE IMPLICATIONS

3:45 **Lamanna, M., Casal, G., Martínez, R.** A NEW ABELISAURID (THEROPODA: CERATOSAURIA) SKELETON FROM THE UPPER CRETACEOUS BAJO BARREAL FORMATION OF CHUBUT PROVINCE, ARGENTINA

4:00 **Wilson, J.** SMALL THEROPOD DINOSAURS FROM THE LATEST CRETACEOUS OF INDIA

FRIDAY AFTERNOON, OCTOBER 19, 2012
TECHNICAL SESSION XII

RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Jacques Gauthier and Derek Larson

1:45 **Jiang, D., Motani, R., Tintori, A., Rieppel, O., Sun, Z.** TWO NEW EARLY TRIASSIC MARINE REPTILES FROM CHAOHU, ANHUI PROVINCE, SOUTH CHINA

2:00 **O'Keefe, F., Byrd, C.** THE ONTOGENY OF THE SHOULDER IN *POLYCOTYLUS LATIPPINUS* (PLESIOSAURIA: POLYCOTYLIDAE) AND ITS BEARING ON PLESIOSAUR VIVIPARITY

2:15 **Strganac, C., Ferguson, K., Jacobs, L., Polcyn, M., Mateus, O.** AGE AND PALEOECOLOGY OF MOSASAURS AND PLESIOSAURS FROM THE LATE CRETACEOUS SOUTH ATLANTIC MARGIN AT BENTIABA, ANGOLA

2:30 **Konishi, T.** A NEW RECONSTRUCTION OF THE HIP IN HYDROPEDAL MOSASAURS (SQUAMATA, MOSASAURIDAE): FROM ATTACHED TO DETACHED

2:45 **Lindgren, J., Kaddumi, H., Polcyn, M.** TAIL FIN EVOLUTION IN MOSASAURS (SQUAMATA, MOSASAURIDAE)

3:00 **Gauthier, J., Kearney, M., Maisano, J., Rieppel, O.** ASSEMBLING THE SQUAMATE TREE OF LIFE: PERSPECTIVES FROM THE PHENOTYPE AND THE FOSSIL RECORD

3:15 **Simoes, T., Kellner, A.** THE PHYLOGENETIC POSITION OF THE MESOZOIC LIZARDS OF BRAZIL AND THE DESCRIPTION OF A NEW SPECIES

3:30 **Demar, Jr., D., Varricchio, D., Head, J., Moore, J., Wilson, G.** A NEARLY COMPLETE FOSSIL IGUANIAN FROM THE UPPER CRETACEOUS (CAMPANIAN) TWO MEDICINE FORMATION OF WESTERN MONTANA

3:45 **McCartney, J., Stevens, N.** A NEW OPHIDIOFAUNA FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA AND THE RISE OF COLUBROID SNAKES (REPTILIA, SERPENTES)

4:00 **Larson, D., Evans, D.** TOOTH VARIATION IN *VARANUS KOMODOENSIS* AND IMPLICATIONS FOR INTRASPECIFIC VARIATION IN EXTINCT XIPHODONT CARNIVORES

FRIDAY AFTERNOON, OCTOBER 19, 2012
TECHNICAL SESSION XIII
RALEIGH CONVENTION CENTER, ROOM 306 A-C, LEVEL 3
MODERATORS: Wighart Koenigswald and Stephen Chester

1:45 **De Bast, E., Smith, T.** DIVERSITY OF THE MAMMALS FROM HAININ, BELGIUM, THE OLDEST PALEOCENE MAMMAL FAUNA OF EUROPE

2:00 **Clemens, W., Wilson, G.** PATTERN OF IMMIGRATION OF PURGATORIIDS AND OTHER EUTHERIANS INTO THE NORTHERN NORTH AMERICAN WESTERN INTERIOR

2:15 **Chester, S., Bloch, J., Clemens, W.** TARSAL MORPHOLOGY OF THE OLDEST PLESIADAPIFORM *PURGATORIUS* INDICATES ARBOREALITY IN THE EARLIEST PRIMATES

2:30 **Williamson, T., Silcox, M.** NEW DISCOVERIES OF PRIMATES FROM THE EARLY PALEOCENE NACIMIENTO FORMATION (TORREJONIAN NALMA), SAN JUAN BASIN, NEW MEXICO: A WINDOW ON THE FIRST PRIMATE ADAPTIVE RADIATION

2:45 **Atwater, A., Holroyd, P., Davis, E.** EXTRINSIC AND INTRINSIC FACTORS IN THE EVOLUTION AND EXTINCTION OF NORTH AMERICAN FOSSIL PRIMATES

3:00 **Ramdarshan, A., Marivaux, L., Merceron, G.** ADAPTIVE RADIATIONS AND ECOLOGICAL DIVERSITY OF EUROPEAN ADAPIFORMS IN WESTERN EUROPE

3:15 **Gingerich, P.** EOCENE *DARWINIUS*, *EUROPOLEMUR* AND *NOTHARCTUS* (PRIMATES, ADAPOIDEA): WHAT IS A CLAW, WHAT IS A GROOMING CLAW, AND WHEN DID GROOMING CLAWS EVOLVE?

3:30 **Koenigswald, W.** HYPOTHETICAL MODEL FOR THE EVOLUTION AND DIFFERENTIATION IN PEDAL DISTAL PHALANGES OF PRIMATES

3:45 **Kirk, E., Kemp, A., Simons, E., Seiffert, E.** MORPHOLOGY OF THE PETROSAL AND BONY LABYRINTH IN *AFRADAPIS LONGICRISTATUS* (PRIMATES, ADAPIFORMES)

4:00 **Beard, K., Chaimanee, Y., Chavasseau, O., Lazzari, V., Jaeger, J.** THE COLONIZATION OF AFRICA BY EARLY CENOZOIC ANTHROPOID PRIMATES: NEW DATA FROM THE EOCENE PONDAUNG FORMATION OF MYANMAR

FRIDAY AFTERNOON, OCTOBER 19, 2012
POSTER SESSION III
RALEIGH CONVENTION CENTER, EXHIBIT HALL A, LEVEL 1
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Miguel , R., Gallo, V., Morrone, J.** DISTRIBUTIONAL PATTERNS OF †MAWSONIIDAE (SARCOPTERYGII: ACTINISTIA): A TRACK ANALYSIS

2 **Gibson, S.** SEMIONOTID FISHES (NEOPTERYGII: SEMIONOTIFORMES) FROM THE UPPER TRIASSIC CHINLE FORMATION OF SOUTHERN UTAH: NEW SPECIES AND COMMENTS ON THE RELATIONSHIPS OF FISHES WITHIN THE FAMILY SEMIONOTIDAE

3 **Wilson, L., Furrer, H., Colombo, M., Salzburger, W., Sánchez, M.** PATTERNS OF CRANIOFACIAL SHAPE CHANGE IN THE EXTINCT SPECIES FLOCK OF THE ACTINOPTERYGIAN FISH GENUS *SAURICHTHYS*: PALAEOBIOLOGICAL AND PALAEOECOLOGICAL IMPLICATIONS AND A COMPARISON WITH EXTANT SPECIES FLOCKS

4 **Lin, H., Sun, Z., Tintori, A., Lombardo, C., Jiang, D.** PERLEIDIFORM ACTINOPTERYGIANS FROM THE PELSONIAN (MIDDLE ANISIAN, MIDDLE TRIASSIC) OF YUNNAN PROVINCE, SOUTHWESTERN CHINA

5 **Wu, F., Sun, Y., Hao, W., Jiang, D.** ABASAL SAURICHTHYIFORM (ACTINOPTERGII) WITH A PECULIAR NEUROCRANIUM AND JAW MECHANISM FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

6 **Martín-Abad, H., Newbrey, M., Brinkman, D., Neuman, A., Poyato-Ariza, F.** DIVERSITY AND PALAEOECOLOGY OF THE AMIIDAE OF THE DINOSAUR PARK AND OLDMAN FORMATIONS (CAMPANIAN) OF ALBERTA, CANADA

7 **Stringer, G.** LATE CRETACEOUS FISH OTOLITHS FROM NORTHEAST MISSISSIPPI: IMPLICATIONS FOR NORTH AMERICAN TELEOSTEAN EVOLUTION AND DISTRIBUTION

8 **Murray, A., Wilson, M.** THREE NEW BASAL ACANTHOMORPH FISHES FROM THE LATE CRETACEOUS OF MOROCCO

9 **Sload, E., Heckert, A., Schneider, V.** MEASURING MICROVERTEBRATES: A CASE STUDY USING A RARE RECORD OF A HYBODONT SHARK FROM THE UPPER TRIASSIC OF NORTH CAROLINA

10 **Mehling, C., Callahan, W., Maisey, J., Martin, G.** THE RISE OF *ISCHYRHIZA*: A ROSTRUM FROM ALABAMA

11 **Shimada, K.** DENTITION OF LATE CRETACEOUS SHARK, *PTYCHODUS MORTONI* (ELASMOBRANCHII: PTYCHODONTIDAE)

12 **Wilson, A., Newbrey, M., Brinkman, D., Neuman, A.** AGE AND GROWTH IN *MYLEDAPHUS BIPARTITUS,* A LATE CRETACEOUS FRESHWATER GUITARFISH FROM ALBERTA, CANADA

13 **De Figueiredo, A., Pinheiro, F., Dentzien-Dias, P., Fortier, D., Schultz, C.** A NEW FRESH-WATER HYBODONTID SHARK FROM LIMA CAMPOS BASIN (EARLY CRETACEOUS), BRAZIL, AND ITS PALEOGEOGRAPHIC CONTEXT

14 **Gates, T.** VARIATIONS IN ECOMORPHOLOGICAL DIVERSITY OF SHARK TEETH FROM LATE CRETACEOUS THROUGH MODERN MARINE ECOSYSTEMS OF NORTH CAROLINA

15 **Gallardo, C., Shimada, K., Schumacher, B.** A NEW LATE CRETACEOUS MARINE VERTEBRATE ASSEMBLAGE FROM THE BASAL GREENHORN LIMESTONE IN SOUTHEASTERN COLORADO, U.S.A.

16 **Bice, K., Shimada, K., Kirkland, J.** LATE CRETACEOUS MARINE FISHES FROM THE UPPER GREENHORN LIMESTONE IN SOUTHEASTERN NEBRASKA, U.S.A.

17 **Morgan, M., Barry, J., Cerling, T., Nelson, S., Pilbeam, D.** ISOTOPIC VARIATION AND NICHE SPACE IN MIDDLE AND LATE MIOCENE SIWALIK MAMMALS FROM PREDOMINANTLY C3 ECOSYSTEMS

18 **Eastham, L., Begun, D., Kordos, L.** ISOTOPIC INDICATORS OF SEASONAITY AT A LATE MIOCENE PRIMATE LOCALITY IN HUNGARY

19 **Tucker, S., Voorhies, M.** ARTIODACTYLS FROM THE LATE MIOCENE (HEMPHILLIAN) WYMAN CREEK LOCAL FAUNA, KEYA PAHA COUNTY, NEBRASKA

20 **Bormet, A., Lawing, A.** ECOMORPHOLOGICAL VARIATION OF THE DISTAL PHALANX IN THE CERVIDAE: DO CAPTIVE MODERN ANALOGUES SKEW RESULTS?

21 **Kaufman, A., Schubert, B., DeSantis, L.** A PALEOECOLOGICAL ANALYSIS OF LATE PLEISTOCENE CERVID REMAINS FROM GUY WILSON CAVE, SOUTHERN APPALACHIANS, TENNESSEE

22 **Heckeberg, N., Rössner, G., Asher, R., Wörheide, G.** PHYLOGENETIC POSITION OF *PROCERVULUS* (CERVIDAE, ARTIODACTYLA, MAMMALIA) AND IMPLICATIONS OF CHARACTER EVOLUTION IN CERVIDS

23 **Hoffman, J., Clementz, M.** SILICA INGESTION IN GRAZING *BISON* AND ARIDITY: IMPLICATIONS FOR MICROWEAR ANALYSIS

24 **Boeskorov, G., Potapova, O., Protopopov, A., Kolesov, S., Tikhonov, A.** THE YUKAGIR BISON: A COMPLETE FROZEN MUMMY OF THE EXTINCT *BISON PRISCUS* FROM YAKUTIA, RUSSIA

25 **Sheets, H., Prothero, D.** PECCARIES (MAMMALIA, ARTIODACTYLA, TAYAUSSIDAE) FROM THE MIOCENE-PLIOCENE PIPE CREEK SINKHOLE LOCAL FAUNA, INDIANA

26 **Montellano, M., Rincón, A., Solorzano, A.** RECORD OF TAYASSUIDS IN ?PLIOCENE-QUATERNARY DEPOSITS IN VENEZUELA

27 **Marín-Moratalla, N., Jordana, X., García-Martínez, R., Moncunill-Solé, B., Köhler, M.** WHAT DOES THE LIFE HISTORY OF A FOSSIL BOVID TELLS US ABOUT PALEOENVIRONMENT?

28 **Schellhorn, R.** RECONSTRUCTING HABITATS WITH CANNON BONES

29 **O'Brien, H.** THE ROLE OF FOSSIL EVIDENCE IN INFERRING ANCESTRAL CHARACTER STATES: A CASE-STUDY USING ARTIODACTYL THERMOREGULATORY CRANIAL VASCULATURE

30 **Evans, T.** ELONGATE BONE ORIENTATION IN RIVERS: BONE AZIMUTHS AND POLARITIES DO NOT CORRELATE WITH FLOW DIRECTION

31 **Hu, H., Pagnac, D., Martin, J., Wu, M., Fang, J.** FIRST OCCURRENCES OF FELIDAE AND CANIDAE (MAMMALIA: CARNIVORA) FROM THE CHITING FORMATION (PLEISTOCENE) OF SOUTHWESTERN TAIWAN

32 **Alba, D., Fortuny, J., De Esteban-Trivigno, S., Robles, J., Almécija, S.** ENCEPHALIZATION AND BRAIN MORPHOLOGY IN EXTINCT, FALSE SABER-TOOTHED CATS (BARBOUROFELIDAE)

33 **Orcutt, J., Davis, E., Hopkins, S.** GIANT FELID POSTCRANIA & THE EARLY EVOLUTION OF NORTH AMERICAN CATS

34 **Kennedy, N., Bhatt, R.** A GEOMETRIC AND KINEMATIC BACKBONE MODEL OF THE CHEETAH, ACINONYX JUBATUS, AND ITS APPLICATION TO UNDERSTANDING THE SPINAL KINETICS OF MIRACINONYX TRUMANI

35 **King, L., Wallace, S.** PHYLOGENETIC PLACEMENT OF *PANTHERA ATROX* BASED ON CRANIALMANDIBULAR CHARACTERS

36 **Hartstone-Rose, A., Kuhn, B., Nalla, S., Werdelin, L., Berger, L.** A NEW SPECIES OF CANID FROM THE MALAPA HOMININ SITE, GAUTENG, SOUTH AFRICA

37 **Fox-Dobbs, K., Lightner, E., Clementz, M.** PALEOECOLOGICAL AND PALEOENVIRONMENTAL RECONSTRUCTIONS OF LATE QUATERNARY MAMMALIAN FAUNAS FROM EASTERN WYOMING AND COLORADO

38 **Smith, M., Polly, D.** REGIONAL PATTERNS OF MODERN SYMPATRY IN NORTH AMERICAN QUATERNARY MAMMAL FAUNAS

39 **Lynch, E., Schubert, B.** NEW INSIGHT INTO THE LOCOMOTOR BEHAVIOR OF THE GIANT SHORT-FACED BEAR, *ARCTODUS SIMUS*, REVEALED BY 3D LANDMARK MORPHOMETRIC ANALYSIS OF THE FORELIMB

40 **Milideo, L., Graham, R.** TAPHONOMIC DIFFERENCES BETWEEN FOX AND WOLF DENS

41 **Balisi, M., Badgley, C.** DIETARY BEHAVIOR AND RESOURCE PARTITIONING AMONG LARGE CARNIVORANS OF LATE PLEISTOCENE RANCHO LA BREA

42 **Haupt, R., DeSantis, L.** INTEGRATING DENTAL MICROWEAR TEXTURE ANALYSIS AND GEOCHEMICAL DATA IN AN EXTANT CARNIVORE (*PUMA CONCOLOR*): LESSONS LEARNED FROM MODERN ECOLOGY OF APPLICATION TO PALEOECOLOGICAL STUDIES

43 **Strait, S.** MYRMECOPHAGOUS MAMMAL MICROWEAR

44 **Hartman, S.** INVESTIGATING THE IMPACT OF COMPETING INTERPRETATIONS OF PECTORAL GIRDLE PLACEMENT AND APPENDICULAR FUNCTION ON SAUROPOD HEAD HEIGHT

45 **Tschopp, E., Mateus, O.** EVIDENCE FOR PRESENCE OF CLAVICLES AND INTERCLAVICLES IN SAUROPOD DINOSAURS AND ITS IMPLICATIONS ON THE FURCULA-CLAVICLE HOMOLOGY

FRIDAY AFTERNOON, OCTOBER 19, 2012
POSTER SESSION III (CONTINUED)

46 **Fiorillo, A., Tykoski, R., May, P.** THE FIRST ARTICULATED CERVICAL SERIES OF AN ADULT *ALAMOSAURUS SANJUANENSIS* (DINOSAURIA: TITANOSAURIA) AND AN *ALAMOSAURUS* SKELETAL RECONSTRUCTION AT THE PEROT MUSEUM OF NATURE AND SCIENCE

47 **Schroeter, E., Lacovara, K.** HISTOLOGY OF NORMAL AND DEFORMED ARGENTINEAN TITANOSAUR FEMORA

48 **Fanti, F., Contessi, M., Andrea, C.** A NEW REBBACHISAURID SAUROPOD FROM TUNISIA

49 **Paulina Carabajal, A.** FIRST INSIGHTS INTO THE DICRAEOSAURID (SAUROPODA: DIPLODOCOIDEA) INNER EAR: THE ENDOCRANIAL MORPHOLOGY OF *AMARGASAURUS CAZAUI* STUDIED USING CT SCANS

50 **Knoll, F., Witmer, L., Ridgely, R., Ortega, F., Sanz, J.** 3D RECONSTRUCTIONS OF THE BRAIN ENDOCAST AND INNER EAR OF A TITANOSAUR (SAUROPODA: TITANOSAURIA) FROM THE LATE CRETACEOUS OF SPAIN

51 ***WITHDRAWN***

52 **Woodruff, C., Horner, J.** A RE-EVALUATION OF THE VERTEBRAL SOFT TISSUE RECONSTRUCTION WITHIN DINOSAURIA BASED ON ALTERNATE EXTANT ANALOGUES

53 **Whitlock, J., Lamanna, M.** A REANALYSIS OF CM 11162, A SKULL OF *APATOSAURUS* (SAUROPODA: DIPLODOCIDAE)

54 **Otero, A., Pol, D., Powell, J.** PHYLOGENETIC RELATIONSHIPS OF *MUSSAURUS PATAGONICUS*: TESTING THE EFFECT OF ONTOGENETICALLY VARIABLE CHARACTERS ON TREE TOPOLOGY

55 **Sverdlova, N., Fechner, R., Perry, S.** PARAMETRIC COMPUTATIONAL FLUID DYNAMICS SIMULATION OF THE RESPIRATORY HEAT LOSS IN SAUROPODOMORPH DINOSAURS: THE ROLE OF LONG TRACHEA

56 **O'Connell, T., Wilson, J., Zalmout, I.** AIR SPACE PROPORTION IN A DORSAL VERTEBRA OF A NEW TITANOSAUR (DINOSAURIA: SAUROPODA) FROM JORDAN

57 **Burns, M., Currie, P.** QUANTITATIVE ANALYSES OF CRANIAL CHARACTERS IN *PANOPLOSAURUS* AND *EDMONTONIA* (ANKYLOSAURIA: NODOSAURIDAE) AND THEIR TAXONOMIC IMPLICATIONS FOR THE CLADE

58 **Vanburen, C., Arbour, V., Evans, D.** CERVICAL FUSION IN ANKYLOSAURIA: ANATOMY AND FUNCTION

59 **Krumenacker, L., Britt, B.** THE FIRST RADIOMETRIC DATES FOR THE WAYAN FORMATION OF IDAHO, STRATIGRAPHIC PLACEMENT OF FOSSIL LOCALITIES, AND REGIONAL CORRELATIONS

60 **Gay, R.** DOES THE EARLY JURASSIC KAYENTA FORMATION PRESERVE MORE THAN ONE SPECIES OF SCUTELLOSAURUS?

61 ***WITHDRAWN***

62 **Hayashi, S., Zhao, Q., Watabe, M., Carpenter, K., Xu, X.** PHYLOGENETIC AND ONTOGENTIC VARIATIONS OF BONE HISTOLOGY IN THYREOPHORAN OSTEODERMS

63 **Spencer, M.** POSTCRANIAL OSTEOLOGY OF EARLY ORNITHISCHIAN DINOSAURS AND THE ANCESTRAL BODY PLAN OF ORNITHISCHIA

FRIDAY AFTERNOON, OCTOBER 19, 2012
POSTER SESSION III (CONTINUED)

64 **Fechner, R., Gößling, R., Sverdlova, N.** ON THE MECHANICAL LOADING OF THE PUBIS IN EXTANT ARCHOSAURS AND ITS RELEVANCE FOR THE RECONSTRUCTION OF SOFT TISSUES IN ORNITHISCHIAN DINOSAURS

65 **Fearon, J., Varricchio, D.** COMPARATIVE PECTORAL AND FORELIMB MORPHOLOGY OF ORNITHOPODA: DOES *ORYCTODROMEUS CUBICULARIS* EXHIBIT SPECIALIZATION FOR DIGGING?

66 **Jackson, F., Varricchio, D., Corsini, J.** AVIAN EGGS FROM THE EOCENE CHADRON FORMATION, NEBRASKA, AND WILLWOOD FORMATION, WYOMING

67 **Kirchner-Smith, M.** INFERRING LOCOMOTOR CAPABILITIES OF THE EXTINCT TERROR BIRD *GASTORNIS* USING GEOMETRIC MORPHOMETRICS

68 **Stubbs, A., Ksepka, D.** COMPUTER TOMOGRAPHY INVESTIGATIONS INTO CRANIAL PNEUMATICITY IN A SMALL OLIGOCENE SULID (STEGANOPODES:SULIDAE)

69 **Moyer, A., Schweitzer, M.** MELANOSOMES....OR MICROBES?

70 **Wang, X., Dyke, G.** ASYMMETRIC VANES OF LIVING AND FOSSIL BIRD FEATHERS INDICATE MECHANICAL FUNCTION RATHER THAN FLIGHT ABILITY

71 **O'Connor, J.** DIETARY EVOLUTION IN MESOZOIC BIRDS

72 **Aotsuka, K., Hatcher, J., Janzic, A., Sato, T.** DIVERSITY OF THE HESPERORNITHIFORMES (AVES) FROM THE UPPER CRETACEOUS PIERRE SHALE IN SOUTHERN MANITOBA, CANADA

73 **Tanaka, T., Kobayashi, Y., Kano, M., Kurihara, K.** THE FIRST RECORD OF A HESPERORNITHIFORM FROM JAPAN

74 **Chiappe, L., Pomeroy, D.** A TAXONOMIC REVISION OF THE SAPEORNITHIDAE (AVES: PYGOSTYLIA) FROM LIAONING PROVINCE, CHINA

75 **Li, Z., Zhou, Z., Clarke, J.** A LARGE-BODIED BASAL ENANTIORNITHINE BIRD FROM THE EARLY CRETACEOUS OF CHINA WITH A PROPOSED RAPTORIAL FEEDING ECOLOGY

76 **Smith, D., Harris, J.** A RECONSIDERATION OF THE STATUS OF THE UPPER JURASSIC PTERODACTYLOID PTEROSAUR *MESADACTYLUS ORNITHOSPHYOS* FROM THE MORRISON FORMATION OF COLORADO

77 **Wilkins, P., Senter, P.** A PALEONTOLOGICAL AND NEONTOLOGICAL INVESTIGATION OF THE CLAIM THAT THE PTEROSAUR *SCAPHOGNATHUS CRASSIROSTRIS* SURVIVED INTO THE SEVENTEENTH CENTURY

78 **Foth, C., Brusatte, S., Butler, R.** CRANIAL MORPHOMETRICS, DISPARITY AND EVOLUTIONARY HISTORY OF PTEROSAURIA (DIAPSIDA: ARCHOSAURIA)

SATURDAY MORNING, OCTOBER 20, 2012
TECHNICAL SESSION XIV

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Ryosuke Motani and Erin Maxwell

8:00 **Leblanc, A., Reisz, R.** DENTAL HISTOLOGY OF DIADECTOMORPHA AND THE EVOLUTION OF CEMENTUM AND ALVEOLAR BONE WITHIN AMNIOTA

8:15 **Chen, J., Norell, M.** AN EARLY SPADEFOOT TOAD (ANURA: PELOBATIDAE) FROM THE LATE PALEOCENE - EARLY EOCENE OF TSAGAN KHUSHUU, MONGOLIA, AND ITS IMPLICATION FOR THE PHYLOGENY AND BIOGEOGRAPHY OF THE PELOBATIDAE

8:30 **Marjanović, D., Witzmann, F.** FINALLY GROWN UP: IS THIS WHAT A MORPHOLOGICALLY ADULT LISSAMPHIBIAN LOOKS LIKE? NEW DATA FOR ONTOGENETICS AND PHYLOGENETICS FROM AN OLIGOCENE NEWT (SALAMANDRIDAE: PLEURODELINAE)

SATURDAY MORNING, OCTOBER 20, 2012
TECHNICAL SESSION XIV (CONTINUED)

8:45 **Anderson, J., Maddin, H., Wilson, S., Pardo, J.** NEW INSIGHTS INTO THE ORIGIN OF EXTANT AMPHIBIANS FROM THE FOSSIL RECORD AND HIGH RESOLUTION COMPUTED TOMOGRAPHY

9:00 **Tsuji, L., Sidor, C.** CRANIAL ANATOMY, PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF *BUNOSTEGOS AKOKANENSIS* (PARAREPTILIA: PAREIASAURIDAE)

9:15 **Reisz, R., MacDougall, M., Modest, S.** NEW SMALL PARAREPTILES FROM THE LOWER PERMIAN OF RICHARDS SPUR, OKLAHOMA, AND THE EARLY DIVERSIFICATION OF PARAREPTILES IN LAURASIA

9:30 **Müller, J., Danto, M.** THE ENIGMATIC REPTILE *KADALIOSAURUS* FROM THE LOWER PERMIAN OF GERMANY AND THE MONOPHYLY OF ARAEOSCELIDIAN DIAPSIDS

9:45 **Schoch, R., Sues, H.** A DISTINCTIVE NEW ARCHOSAURIFORM REPTILE FROM THE MIDDLE TRIASSIC (LADINIAN) OF GERMANY AND ITS PHYLOGENETIC RELATIONSHIPS

10:00 BREAK

10:15 **Pritchard, A., Turner, A., Nesbitt, S., Irmis, R., Smith, N.** A NEW DREPANOSAURID FROM THE LATE TRIASSIC OF NEW MEXICO: INSIGHTS INTO THE FORELIMB EVOLUTION AND BIOGEOGRAPHY OF DREPANOSAURS

10:30 **Fraser, N., Li, C., Rieppel, O.** A LONG-SNOUTED PROTOROSAURIAN FROM THE MIDDLE TRIASSIC OF SOUTHERN CHINA

10:45 **Peecook, B., Sidor, C., Nesbitt, S., Angielczyk, K., Steyer, J.** A NEW SILESAURID DINOSAURIFORM FROM THE MIDDLE TRIASSIC (ANISIAN) NTAWERE FORMATION OF ZAMBIA REINFORCES PATTERNS OF ASSEMBLAGE DISSIMILARITY ACROSS SOUTHERN PANGAEA

11:00 **Sookias, R., Benson, R., Butler, R.** MACROEVOLUTIONARY TRENDS IN BODY SIZE DURING THE THERAPSID-ARCHOSAUROMORPH TRANSITION

11:15 **Morris, Z., Werning, S.** HISTOLOGICAL VARIATION SUGGESTS UNUSUAL LEVELS OF DEVELOPMENTAL PLASTICITY IN THE STEM ARCHOSAUR *VANCLEAVEA*

11:30 **Kelley, N., Motani, R., Embree, P.** A NEW LOWER TRIASSIC ICHTHYOPTERYGIAN FAUNA FROM FOSSIL HILL, NEVADA

11:45 **Motani, R., Ji, C., Tomita, T., Jiang, D.** ABSENCE OF SUCTION FEEDERS AMONG ICHTHYOSAURS AND IMPORTANCE OF MECHANISM-BASED QUANTIFICATION IN FUNCTIONAL INFERENCES

12:00 **Maxwell, E., Vincent, P.** CHANGES IN ICHTHYOSAUR BODY SIZE DURING THE EARLY TOARCIAN EXTINCTION EVENT

SATURDAY MORNING, OCTOBER 20, 2012
TECHNICAL SESSION XV

RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATORS: Clint Boyd and Eric Morschhauser

8:00 **Pei, R.** GEOMETRIC MORPHOMETRIC STUDY OF THE EVOLUTION OF THE HIND LIMB IN NON-AVIAN DINOSAURS

8:15 **Prieto-Marquez, A., Gates, T., Zanno, L.** LATE CRETACEOUS TECTONIC EVENTS TRIGGERED NORTH AMERICAN MEGAHERBIVORE DINOSAUR CLADOGENESIS

8:30 **Mallon, J.** DIETARY NICHE PARTITIONING AS A MEANS FOR THE COEXISTENCE OF MEGAHERBIVOROUS DINOSAURS FROM THE DINOSAUR PARK FORMATION (UPPER CAMPANIAN) OF ALBERTA, CANADA

8:45 **Boyd, C.** ADDRESSING THE 'HYPSILOPHODONTID' PROBLEM IN ANALYSES OF BASAL ORNITHISCHIAN RELATIONSHIPS: NEW TAXA, NEW DATA, NEW HYPOTHESIS

SATURDAY MORNING, OCTOBER 20, 2012
TECHNICAL SESSION XV (CONTINUED)

9:00 **Osi, A., Prondvai, E., Butler, R., Weishampel, D.** PHYLOGENY, HISTOLOGY AND INFERRED BODY-SIZE EVOLUTION IN A NEW RHABDODONTID DINOSAUR FROM THE LATE CRETACEOUS OF HUNGARY

9:15 **Druckenmiller, P., Erickson, G., Brinkman, D., Brown, C.** DINOSAUR DIVERSITY IN THE ARCTIC: NEW RECORDS OF POLAR DINOSAURS BASED ON MICROVERTEBRATE ANALYSIS FROM THE UPPER CRETACEOUS PRINCE CREEK FORMATION, NORTHERN ALASKA

9:30 **Erickson, G., Krick, B., Norell, M., Sawyer, W.** COMPLEX DENTAL STRUCTURE AND WEAR BIOMECHANICS IN HADROSAURID DINOSAURS

9:45 **Woodward, H., Horner, J., Farlow, J.** PALEOBIOLOGICAL IMPLICATIONS OF GROWTH HISTORY AND HISTOVARIABILITY IN A POPULATION OF THE HADROSAURID DINOSAUR *MAIASAURA PEEBLESORUM*

10:00 BREAK

10:15 **Forster, C., Poole, K., De Klerk, W., Chinsamy-Turan, A., Roberts, E.** A NEW TAXON OF IGUANODONTOID DINOSAUR FROM THE KIRKWOOD FORMATION (VALANGINIAN) OF SOUTH AFRICA BASED ON AN ASSEMBLAGE OF JUVENILE SPECIMENS

10:30 **Dalla Vecchia, F., Prieto-Marquez, A., Gaete, R., Galobart, À.** PHYLOGENY, BIOGEOGRAPHY AND HIGH CLADE DIVERSITY OF LAMBEOSAURINE DINOSAURS OF THE EUROPEAN ARCHIPELAGO

10:45 **Morschhauser, E.** PHYLOGENETIC SIGNIFICANCE OF *AURORACERATOPS RUGOSUS* (ORNITHISCHIA: CERATOPSIA) AND THE PHYLOGENY OF BASAL NEOCERATOPSIA

11:00 **Levitt, C.** VARIATION IN CERATOPSIAN HISTOLOGY AND GROWTH: NEW DATA FROM SOUTHERN LARAMIDIA AND IMPLICATIONS FOR PALEOENVIRONMENTAL DIFFERENCES

11:15 **Maiorino, L., Farke, A., Piras, P., Ryan, M., Terris, K.** EVOLUTIONARY TRENDS IN THE SHAPE OF THE SQUAMOSAL IN CERATOPSID DINOSAURS

11:30 **Makovicky, P., Erickson, G., Gao, K., Zhou, C.** CERATOPSIANS DIDN'T JUST GET BIGGER: EVIDENCE FOR DWARFISM IN *PSITTACOSAURUS*

11:45 **Bykowski, R.** USING TRAIT-BASED ANALYSES TO UNDERSTAND CERATOPSIAN COMMUNITIES IN LARAMIDIA DURING THE LATE CRETACEOUS

12:00 **Arbour, V., Badamgarav, D., Currie, P.** A NEW ANKYLOSAURID DINOSAUR FROM THE UPPER CRETACEOUS BARUUNGOYOT FORMATION OF MONGOLIA: NEW CRANIAL CHARACTERS FOR ANKYLOSAURINE ANKYLOSAURIDS AND A REASSESSMENT OF ANKYLOSAURID POSTCRANIAL SPECIMENS FROM MONGOLIA

SATURDAY MORNING, OCTOBER 20, 2012
TECHNICAL SESSION XVI

RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Anthony Friscia and Larisa DeSantis

8:00 **Famoso, N., Feranec, R., Davis, E.** THE RELATIONSHIP BETWEEN LOPHODONTY, HYPSODONY, BODY MASS, AND DIET IN EXTINCT AND EXTANT UNGULATES

8:15 **Beatty, B., Mihlbachler, M.** COMPARISONS OF LIGHT MICROSCOPY-BASED DENTAL MICROWEAR AND DENTAL MICROWEAR TEXTURE ANALYSIS: IMPLICATIONS FOR TESTING HYPOTHESES OF FEEDING ECOLOGY IN EXTINCT VERTEBRATES

8:30 **Semprebon, G., Solounias, N., Rivals, F., Hulbert Jr., R.** ELUCIDATING PALEODIETARY TRENDS IN NORTH AMERICAN HORSES FROM *HYRACOTHERIUM* TO *EQUUS* USING TOOTH WEAR ANALYSES

8:45 **DeSantis, L., Schubert, B., Scott, J., Ungar, P.** TIMES NOT SO TOUGH AT LA BREA: DENTAL MICROWEAR TEXTURE ANALYSIS CLARIFIES THE FEEDING BEHAVIOR OF THE SABER-TOOTHED CAT *SMILODON FATALIS* AND AMERICAN LION *PANTHERA ATROX*

SATURDAY MORNING, OCTOBER 20, 2012
TECHNICAL SESSION XVI (CONTINUED)

9:00 **Meachen, J., O'Keefe, F.** MORPHOLOGICAL VARIATION IN THE MANDIBLES OF *SMILODON FATALIS* FROM RANCHO LA BREA IN RESPONSE TO CLIMATE AND ENVIRONMENTAL CHANGES

9:15 **Wroe, S., Chamoli, U., Parr, W., Ridgely, R., Witmer, L.** 3D BIOMECHANICAL MODELLING OF MARSUPIAL AND PLACENTAL SABRE-TOOTHS: A DIFFERENT KIND OF BITE FOR AN EXTREME POUCHED PREDATOR

9:30 **Rizk, O., Carr, M., Hlusko, L.** PALEOBIOLOGY OF PREVIOUSLY UNEXAMINED DIRE WOLVES (*CANIS DIRUS*) FROM THE EARLIEST EXCAVATIONS OF THE LA BREA TAR PITS

9:45 **Figueirido, B., Janis, C., Wu, D.** ON THE PREDATORY BEHAVIOUR OF THE THYLACINE: A COMPARATIVE APPROACH BASED ON FORELIMB ANATOMY

10:00 BREAK

10:15 **Friscia, A., Slater, G.** TEMPO AND MODE OF ECOMORPHOLOGICAL DIVERSIFICATION IN CARNIVORA

10:30 **Werdelin, L.** COLLAPSE OF THE EASTERN AFRICAN LARGER CARNIVORE GUILD: CAUSES AND CONSEQUENCES

10:45 **Bibi, F., Kraatz, B., Craig, N., Beech, M., Hill, A.** COMPLEX SOCIAL STRUCTURE IN PROBOSCIDEA FROM A REMARKABLE LATE MIOCENE TRACKWAY SITE IN THE UNITED ARAB EMIRATES

11:00 **Cherney, M., Fisher, D., Rountrey, A., Calamari, Z.** ISOTOPE ANALYSES SUPPORT USE OF CT SCANS FOR IDENTIFYING ANNUAL INCREMENTS IN SNOWMASS MASTODON MANDIBULAR TUSKS

11:15 **Wicks, T., Shanahan, T., Maupin, C., Gorman, M., Bell, C.** THE ISOTOPIC RECORD OF LAGOMORPHS AT HALL'S CAVE

11:30 **Kimura, Y., Uno, K., Cerling, T., Patnaik, R.** ISOTOPIC DIETARY SIGNALS IN MURINE RODENTS FROM THE NEOGENE SIWALIK GROUP LAGS LARGE MAMMALS BY ONE MILLION YEARS

11:45 **Flynn, L.** SYNERGISM IN DENSER FOSSIL RECORDS: ECOLOGICAL COMPLEXITY EMERGES FOR MIDDLE MIOCENE SIWALIK RHIZOMYINE RODENTS

12:00 **Smiley, T., Badgley, C., Behrensmeyer, A.** STABLE OXYGEN AND CARBON ISOTOPES RECORD SEASONAL VARIATION IN DRINKING WATER AND DIET OF MODERN LARGE HERBIVORES IN AMBOSELI NATIONAL PARK, KENYA

SATURDAY AFTERNOON, OCTOBER 20, 2012
TECHNICAL SESSION XVII

RALEIGH CONVENTION CENTER, BALLROOM A, LEVEL 4
MODERATORS: Michael Habib and Jonathan Mitchell

1:45 **Hall, J., Habib, M., Hone, D., Chiappe, L.** A NEW MODEL FOR HINDWING FUNCTION IN THE FOUR-WINGED THEROPOD DINOSAUR *MICRORAPTOR GUI*

2:00 **Habib, M., Hall, J., Hone, D., Chiappe, L.** AERODYNAMICS OF THE TAIL IN *MICRORAPTOR* AND THE EVOLUTION OF THEROPOD FLIGHT CONTROL

2:15 **Kambic, R., Gatesy, S.** TURNING IN THEROPODS

2:30 **Balanoff, A., Bever, G., Rowe, T., Norell, M.** THE ORIGIN OF THE AVIAN BRAIN BASED ON A VOLUMETRIC ANALYSIS OF ENDOCRANIAL EVOLUTION WITHIN COELUROSAURIA

2:45 **Wilson, L.** THE EFFECTS OF CLIMATE AND BEHAVIOR ON AVIAN BONE MICROSTRUCTURE: A COMPARATIVE OSTEOHISTOLOGY STUDY OF HESPERORNITHIFORMS FROM THE LATE CRETACEOUS WESTERN INTERIOR SEAWAY

3:00 **Mitchell, J., Makovicky, P., Gao, K.** PALEOECOLOGY OF THE JEHOL BIRDS INFERRED FROM MODERN BIRD ECOMORPHOLOGY

SATURDAY AFTERNOON, OCTOBER 20, 2012
TECHNICAL SESSION XVII (CONTINUED)

3:15 **Ksepka, D., Ware, J., Lamm, K.** FLYING ROCKS AND FLYING CLOCKS: EXPLAINING DISCREPANCIES BETWEEN FOSSIL AGES AND MOLECULAR DATES IN BIRDS

3:30 **Smith, N., Clarke, J.** VARIATION IN THE ENDOCRANIAL ANATOMY OF THE CHARADRIIFORMES (AVES): SENSORY SYSTEM EVOLUTION ASSOCIATED WITH THE TRANSITION TO WING-PROPELLED DIVING

3:45 **Ando, T., Fordyce, R.** DID MARINE MAMMALS OUTCOMPETE GIANT DIVING BIRDS?

4:00 **Meijer, H., James, H., Sutikna, T., Due, R., Tocheri, M.** COMPARING LATE PLEISTOCENE WITH PRESENT-DAY AVIAN COMMUNITY STRUCTURE ON FLORES ISLAND, INDONESIA

SATURDAY AFTERNOON, OCTOBER 20, 2012
TECHNICAL SESSION XVIII

RALEIGH CONVENTION CENTER, BALLROOM B, LEVEL 4
MODERATORS: Ross Secord and Carly Manz

1:45 **Secord, R., Williamson, T., Weil, A.** STABLE ISOTOPE ECOLOGY OF EARLY PALEOCENE (PUERCAN AND TORREJONIAN) MAMMALS FROM THE SAN JUAN BASIN, NEW MEXICO

2:00 **Yapuncich, G., Boyer, D., Maiorino, S., Bolortsetseg, M.** NEW DATA FOR EVALUATING FUNCTIONAL MORPHOLOGY IN PTILODONTIDAE (ALLOTHERIA, MULTITUBERCULATA) USING DIGITAL PREPARATION

2:15 **Habersetzer, J., Gunnell, G.** FIRST APPEARANCE OF ENLARGED INNER EARS IN ECHOLOCATING BATS

2:30 **Manz, C., Bloch, J., Silcox, M.** BASICRANIAL MORPHOLOGY OF PALEOGENE NYCTITHERIIDAE (MAMMALIA, EULIPOTYPHLA?) AND EVIDENCE FOR EULIPOTYPHLAN AFFINITIES

2:45 **Ruf, I., Volpato, V., Billet, G., De Muizon, C., Lehmann, T.** INNER EAR ANATOMY OF *LEPTICTIDIUM AUDERIENSE* (LEPTICTIDA, MAMMALIA) REVEALS HIGHLY AGILE LOCOMOTION

3:00 **Ahrens, H., Ruff, C., Rose, K.** THE MECHANICS OF FOSSORIALITY IN MAMMALIA AND THE LOCOMOTOR BEHAVIOR OF PALAEANODONTA (PHOLIDOTAMORPHA)

3:15 **Hooker, J.** THE OLDEST PSEUDORHYNCOCYONIDS: THEIR BEARING ON RELATIONSHIPS OF THIS EUROPEAN STEM PLACENTAL FAMILY

3:30 **Spaulding, M., Flynn, J.** A VIRTUAL ENDOCAST AND ENDOCRANIAL FEATURES OF *OODECTES* (MAMMALIA: CARNIVORAMORPHA)

3:45 **Solé, F., Smith, R., Coillot, T., De Bast, E., Smith, T.** REFERRAL OF *MIACIS LATOURI* TO NEW GENUS, AND A PHYLOGENETIC ANALYSIS OF THE EARLIEST "MIACIDS" (CARNIVORAMORPHA)

4:00 **Stucky, R., Miller, I., Clyde, W., Bowring, S., Chinnery, B.** BIOSTRATIGRAPHY AND CORRELATION OF VERTEBRATE AND PLANT FOSSILS FROM THE WIND RIVER FORMATION (YPRESIAN, EARLY TO MIDDLE EOCENE) OF CENTRAL WYOMING IN NORTH AMERICA

SATURDAY AFTERNOON, OCTOBER 20, 2012
TECHNICAL SESSION XIX

RALEIGH CONVENTION CENTER, BALLROOM C, LEVEL 4
MODERATORS: Joshua Miller and Anthony Barnosky

1:45 **Shoemaker, L., Clauset, A.** THE EVOLUTION OF BODY MASS DISTRIBUTION AND DIVERSIFICATION WITHIN EQUIDAE

2:00 **Marcy, A., Hadly, E., Fendorf, S.** AT THE BEST ANGLE: INCREASED INCISOR PROCUMBENCY ALLOWED POCKET GOPHERS (*THOMOMYS BOTTAE*) TO CLAIM CLIMATE-HARDENED SOILS

SATURDAY AFTERNOON, OCTOBER 20, 2012
TECHNICAL SESSION XIX (CONTINUED)

2:15 **Polly, P.** DR JESTER AND MR QUEEN: SPECIATION IN MAMMALS WITH LARGE GEOGRAPHIC RANGES IS A BIOTIC AND ABIOTIC PROCESS THAT REQUIRES MANY GLACIAL-INTERGLACIAL CYCLES

2:30 **Davis, E., McGuire, J., Koo, M.** TESTING THE ACCURACY OF ECOLOGICAL NICHE MODELS USING THE LAST GLACIAL MAXIMUM FOSSIL RECORD OF MAMMALS

2:45 **Yann, L., DeSantis, L.** EFFECTS OF PLEISTOCENE CLIMATIC REGIMES ON DIETARY NICHES AND ENVIRONMENTAL HETEROGENEITY IN FLORIDA

3:00 **Du, A., Faith, J., Behrensmeyer, A., Patterson, D., Villasenor, A.** THE EFFECTS OF CRANIODENTAL SAMPLING ON ECOLOGICAL VARIABLES IN MODERN AND FOSSIL MAMMAL LANDSCAPE ASSEMBLAGES

3:15 **Miller, J.** TEMPORAL MEGABIAS: LATITUDINAL CONTROLS ON TIME-AVERAGING OF TERRESTRIAL DEATH ASSEMBLAGES AND THEIR ECOLOGICAL DATA

3:30 **Behrensmeyer, A., Western, D., Badgley, C., Miller, J., Odock, F.** THE IMPACT OF MASS MORTALITY ON THE LAND SURFACE BONE ASSEMBLAGE OF AMBOSELI PARK, KENYA

3:45 **Boessenecker, R., Schmitt, J.** TAPHOFACIES ANALYSIS OF THE NEOGENE PURISIMA FORMATION IN NORTHERN CALIFORNIA INDICATES STRONG DEPOSITIONAL CONTROL ON MARINE VERTEBRATE PRESERVATION IN SHALLOW MARINE DEPOSITS

4:00 **Barnosky, A., IB286 Working Group** PRELUDE TO THE ANTHROPOCENE: TWO NEWLY-DEFINED NORTH AMERICAN LAND-MAMMAL AGES

SATURDAY AFTERNOON, OCTOBER 20, 2012
POSTER SESSION IV

RALEIGH CONVENTION CENTER, EXHIBIT HALL A, LEVEL 1
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Miyashita, T.** CRANIAL MUSCULATURE OF LIVING JAWLESS FISHES TESTS CYCLOSTOME MONOPHYLY AND CONSTRAINS THE HEAD ANATOMY OF A GNATHOSTOME ANCESTOR

2 **Chang, M., Chen, G., Liu, H.** REVISION OF A MIOCENE *CARASSIUS*-LIKE CYPRINID *LUCYPRINUS* (TELEOSTEI, PISCES) FROM EAST CHINA AND ITS BEARING ON FRESHWATER FAUNAL EXCHANGE BETWEEN EUROPE AND ASIA

3 **Divay, J., Murray, A.** THE ICHTHYOFAUNA, PALAEOENVIRONMENT AND PALAEOCLIMATE OF THE MID-MIOCENE WOOD MOUNTAIN FORMATION, SASKATCHEWAN, CANADA

4 **Horner, V., Horner, J.** STURGEON DORSAL OSTEODERM ONTOGENY: A TRANSFORMATIONAL MODEL FOR MARGINOCEPHALIAN SQUAMOSAL ORNAMENTS

5 **Tulu, Y., Chinsamy-Turan, A.** MIO-PLIOCENE ELASMOBRANCH FAUNAS OF WESTERN CAPE, SOUTH AFRICA: SALDANHA STEEL VERSUS LANGEBAANWEG “E” QUARRY

6 **Andrianavalona, T., Ramihangihajason , T., Rasoamiaramanana, A., Ward, D., Samonds, K.** MIOCENE SHARK FAUNA FROM NOSY MAKAMBY (MAHAJANGA BASIN, NORTHWESTERN MADAGASCAR)

7 **Argyriou, T., Cook, T., Murray, A.** NEW ADDITIONS TO THE ELASMOBRANCH FAUNA FROM THE MIOCENE OF JABAL ZALTAN, LIBYA

8 **Nance, J., Symister, C., MacFadden, B., Godfrey, S.** RARE EARTH ELEMENT GEOCHEMISTRY OF CALVERT CLIFFS (MIOCENE, CHESAPEAKE GROUP): A PRELIMINARY REPORT

9 **Symister, C., MacFadden, B., Hendy, A., Pimiento, C., Degracia, C.** DIAGENESIS AND PALEOENVIRONMENTAL CHANGES IN NEOGENE FOSSILS AND ENVIRONMENTS FROM PANAMA: EVIDENCE FROM REE PROXIES

SATURDAY AFTERNOON, OCTOBER 20, 2012
POSTER SESSION IV (CONTINUED)

10 **Carpenter, N., Smith, G.** BEGINNINGS OF NEOGENE FISH DIVERSITY IN WESTERN NORTH AMERICA: THE 15 MA SUCKER CREEK FORMATION, IDAHO AND OREGON

11 **Liu, J., Tseng, Z., Wilson, M., Murray, A.** BODY SHAPE DIFFERENCES BETWEEN NORTH AMERICAN AND ASIAN FOSSIL CATOSTOMIDS AND ONTOGENETC CHANGE IN EARLY CYPRINIFORMS

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

13 **Callahan, W., Schein, J., Schroeter, E., Parris, D., Lacovara, K.** FIRST RECORD OF THE SYNECHODONTIFORM SHARK *SPHENODUS* (NEOSELACHII, ORTHACODONTIDAE) FROM THE DANIAN OF NORTH AMERICA

14 **Odunze, S., Stevens, N., Cooper, L., Obi, G.** PALEOGENE ICHTHYOFAUNA OF THE IMO AND AMEKI FORMATIONS, SOUTHEASTERN NIGERIA

15 **Marivaux, L., Salas-Gismondi, R., Tejada, J., Antoine, P.** A PLATYRRHINE TALUS FROM THE EARLY MIOCENE OF THE AMAZONIAN MADRE DE DIOS SUB-ANDEAN ZONE: THE FIRST FOSSIL PRIMATE FROM PERU

16 **Gilbert, C., Patel, B., Patnaik, R., Fleagle, J.** RENEWED PALEONTOLOGICAL INVESTIGATIONS IN THE UPPER AND LOWER SIWALIKS OF INDIA: IMPLICATIONS FOR PRIMATE EVOLUTION VIS A VIS PALEOCLIMATE CHANGE

17 **Pérez De Los Ríos, M., Alba, D., Moyà-Solà, S.** TAXONOMIC ATTRIBUTION OF THE DRYOPITHECINE TEETH (PRIMATES: HOMINIDAE) FROM THE MIDDLE MIOCENE OF LA GRIVE (FRANCE)

18 **Constantino, P., Godfrey, L., Meador, L., Schwartz, G.** RECONSTRUCTION OF SUBFOSSIL LEMUR BITE FORCES USING DENTAL FRACTURE MECHANICS

19 **Muldoon, K., Godfrey, L., Crowley, B.** THE ROLE OF ELEVATION IN UNDERSTANDING THE BIOGEOGRAPHIC DISTRIBUTION OF THE EXTINCT LEMURS OF MADAGASCAR

20 **Abdel Gawad, M., Miller, E., Hamdan, M., El Barkooky, A., El Sharkawi, M.** VERTEBRATE AND GEOLOGICAL SIGNATURES ON THE CONSTRUCTION OF MOGHRA FORMATION, NORTH WESTERN DESERT, EGYPT

21 **Villasenor, A., Behrensmeyer, A., Bobe, R., Reed, K.** A TALE OF TWO BASINS: COMMUNITY STRUCTURE DYNAMICS THROUGH SPACE AND TIME IN THE HADAR AND TURKANA BASINS, ETHIOPIA AND KENYA

22 **Hensley-Marschand, B.** PRELIMINARY FAUNAL ANALYSIS OF THE DONGGUTUO SITE, NIHEWAN BASIN, CHINA

23 **Hatala, K., Richmond, B., Harcourt-Smith, W., Liutkus, C., Zimmer, B.** A SNAPSHOT OF THE ANATOMY, LOCOMOTION AND SOCIAL BEHAVIOR OF EARLY MODERN HUMANS AS EVIDENCED BY FOSSIL FOOTPRINTS AT ENGARE SERO, TANZANIA

24 **Gatesy, S., Ellis, R.** A BIPLANAR X-RAY METHOD FOR 3-D ANALYSIS OF TRACK FORMATION

25 **Calede, J.** COMPARATIVE TAPHONOMY OF ARIKAREEAN DEPOSITS OF OREGON AND MONTANA

26 **López-Antoñanzas, R., Flynn, L., Knoll, F.** MULTIPLE INTERCONTINENTAL DISPERSALS OF THE RHIZOMYINAE (SPALACIDAE, RODENTIA)

27 **Tomida, Y.** A NEW GENUS OF THE FAMILY OCHOTONIDAE (LAGOMORPHA, MAMMALIA) AND LAGOMORPH FAUNAL CHANGES AT THE AOERBAN AREA IN CENTRAL INNER MONGOLIA, CHINA

28 **Bamba, K., Croft, D.** VARIATION WITHIN MODERN CHINCHILLID POPULATIONS AND IMPLICATIONS FOR TAXONOMY OF FOSSIL POPULATIONS

29 **Rinaldi, C., Martin, L., Timm, R., Cole, III, T., Kumar, V.** LATE PLEISTOCENE GIANT BEAVERS: THE PARALLEL EVOLUTION OF GIANT SIZE AND RIDGED ENAMEL IN TWO SPECIES

30 **Stegner, M., Ferrer, E.** DRIVERS OF JAW SHAPE IN *NEOTOMA*: MANDIBULAR GEOMETRIC MORPHOMETRICS AND IMPLICATIONS FOR MORPHOLOGICAL PARTITIONING

31 **Thies, M., Tutalo, R., Labbe, M., Lewis, P.** ASSESSING THE DIFFICULTIES OF GENUS-LEVEL DIAGNOSES OF FOSSIL RODENTS

32 **Villavicencio, N., Maguire, K., McGuire, J.** USING STABLE ISOTOPES AND TOOTH MORPHOLOGY TO RECONSTRUCT PALEOECOLOGY: A PILOT STUDY USING *MICROTUSCALIFORNICUS*

33 **Lightner, E., Clementz, M., Fox-Dobbs, K., Minckley, T., Kornfeld, M.** USING STABLE ISOTOPE ANALYSIS OF COPROLITES TO DETERMINE PALEODIET OF LATE PLEISOTOCENE MAMMALS

34 **Ferrusquía-Villafranca, I., De Anda-Hurtado, P., Ruiz-González, J.** EXTINCT AND EXTANT QUATERNARY MAMMALS FROM SAN LUIS POTOSÍ, EAST-CENTRAL MEXICO: FAUNAL TURNOVER AND CLIMATE CHANGE

35 **Jass, C., Horne, G., Critchley, D.** NEW QUATERNARY VERTEBRATE RECORDS FROM CAVE DEPOSITS IN JASPER NATIONAL PARK, ALBERTA, CANADA

36 **Buchholtz, E.** SOMITE - LATERAL PLATE INTERACTION AS A DEVELOPMENTAL CONTROL ON EVOLUTION OF TETRAPOD AXIAL MORPHOLOGY

37 **Uhen, M.** NEW SPECIMENS OF MIDDLE EOCENE WHALES (CETACEA, PROTOCETIDAE) FROM NEW JERSEY

38 **Corrie, J.** FUNCTIONAL MORPHOLOGY OF ELONGATED VERTEBRAE IN *BASILOSAURUS* TO INTERPRET AQUATIC LOCOMOTION PATTERNS

39 **Murakami, M., Hirayama, R.** FIRST RECORD OF A PONTOPORIID CETACEAN (ODONTOCETI: INIOIDEA) FROM LATE MIOCENE OF CHIBA, JAPAN

40 **Tanaka, Y., Fordyce, R.** ANOTHER LOOK AT THE ORIGIN OF THE ENIGMATIC GANGES RIVER DOLPHIN *PLATANISTA*, AND THE CONTENT OF THE SUPERFAMILY PLATANISTOIDEA (ODONTOCETI: CETACEA)

41 **Churchill, M., Clementz, M., Kohno, N.** BODY SIZE RECONSTRUCTION FOR FOSSIL NORTH PACIFIC PINNIPEDIA (MAMMALIA: CARNIVORA): PROBLEMS AND IMPLICATIONS

42 **Valenzuela-Toro, A., Gutstein, C., Varas-Malca, R., Suárez, M., Pyenson, N.** PINNIPED TURNOVER IN THE SOUTH PACIFIC OCEAN: NEW EVIDENCE FROM THE PLIO-PLEISTOCENE OF THE ATACAMA DESERT, CHILE

43 **Fletcher, T.** PALEOCLIMATE OF THE DINOSAUR-BEARING, MID-CRETACEOUS WINTON FORMATION, CENTRAL-WESTERN QUEENSLAND, AUSTRALIA: NEW OBSERVATIONS BASED ON LEAF MARGIN ANALYSIS, CLIMATE LEAF ANALYSIS MULTIVARIATE PROGRAM, BIOCLIMATIC ANALYSIS AND FOSSIL WOOD GROWTH INDICES

44 **Kirkland, J., Deblieux, D., Madsen, S., Hunt, G.** NEW DINOSAURS FROM THE BASE OF THE CRETACEOUS IN EASTERN UTAH SUGGEST THAT THE 'SO-CALLED' BASAL CRETACEOUS CALCRETE IN THE YELLOW CAT MEMBER OF THE CEDAR MOUNTAIN FORMATION, WHILE NOT MARKING THE JURASSIC-CRETACEOUS UNCONFORMITY, REPRESENTS EVOLUTIONARY TIME

45 ***WITHDRAWN***

46 **Watabe, M., Tsogtbaatar, K.** DINOSAURIAN OOFAUNA FROM THE UPPERMOST CRETACEOUS NEMEGT FORMATION IN MONGOLIA

47 **Oser, S.** FLUVIAL SEDIMENT AND EGGSHELL INTERACTIONS: A METHOD FOR ASSESSING TRANSPORT IN FOSSIL EGGSHELL ACCUMULATIONS

48 **May, K., Druckenmiller, P.** TRACKS IN THE ARCTIC: A DINOSAUR ICHNOFOSSIL ASSEMBLAGE FROM THE UPPER CRETACEOUS PRINCE CREEK FORMATION, NORTHERN ALASKA

49 **Schanz, T., Lins, Y., Viefhaus, H., Sander, M.** QUANTITATIVE INTERPRETATION OF DINOSAUR TRACKS REVISITED

50 **Falkingham, P., Gatesy, S.** RECONSTRUCTING LIMB KINEMATICS OF SMALL BIPEDAL DINOSAURS TRAVERSING SEMI-FLUID SUBSTRATES

51 **Deblieux, D., Madsen, S., Kirkland, J., Inkenbrandt, P., Santucci, V.** SIGNIFICANT MESOZOIC VERTEBRATE FOSSIL LOCALITIES DISCOVERED DURING CONTINUING PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING AT ARCHES NATIONAL PARK

52 **Ribeiro, V., Mateus, O.** CHRONOLOGY OF THE LATE JURASSIC DINOSAUR FAUNAS, AND OTHER REPTILIAN FAUNAS, FROM PORTUGAL

53 **Hattori, S.** ANALYSIS OF THE THEROPOD HALLUX FOR UNRAVELLING THE EVOLUTION OF FOOT FUNCTION

54 **Sorkin, B.** AERIAL ABILITY IN BASAL DEINONYCHOSAURIA

55 **Cuff, A., Rayfield, E.** FUNCTIONAL MECHANICS OF ORNITHOMIMOSAUR CRANIA COMPARED TO OTHER THEROPODS

56 **Hendrickx, C., Araújo, R., Mateus, O.** THE NONAVIAN THEROPOD QUADRATE: SYSTEMATICS USEFULNESS, MAJOR TRENDS AND PHYLOGENETIC MORPHOMETRICS ANALYSIS

57 **Sissons, R., Gilbert, M., Snively, E.** LOCOMOTOR FORCES AND STRESS IN THE METAPODIA OF ADULT OSTRICH *STRUTHIO CAMELUS* AND JUVENILE *ALBERTOSAURUS SARCOPHAGUS* (TYRANNOSAURIDAE): CORRELATING ANATOMY, DYNAMICS AND FINITE ELEMENT ANALYSIS

58 **Tsuihiji, T., O'Connor, P.** RECONSTRUCTION OF MUSCULAR AND PNEUMATIC SYSTEMS IN THE NECK AND ANTERIOR TRUNK OF ABELISAURIDAE: INSIGHTS FROM *MAJUNGASAURUS CRENATISSIMUS* (DINOSAURIA: THEROPODA)

59 **Sankey, J.** SOMETHING'S FISHY: WAS ONE OF THE MOST ABUNDANT LATEST CRETACEOUS THEROPODS A FISH-EATER?

60 **Fowler, D., Scannella, J., Goodwin, M., Horner, J.** HOW TO EAT A *TRICERATOPS*: LARGE SAMPLE OF TOOTHMARKS PROVIDES NEW INSIGHT INTO THE FEEDING BEHAVIOR OF *TYRANNOSAURUS*

61 **Rothschild, B.** WHOLEY SMOKE: BRACKETING AND EMPIRICAL RECOGNITION OF DISEASE IN THE FOSSIL RECORD, AS APPLIED TO THE TYRANNOSAURUS REX, SUE

62 **Evers, S., Rauhut, O., Milner, A.** WAS STROMER RIGHT? THE AFFINITIES OF *SIGILMASSASAURUS BREVICOLLIS* (THEROPODA, TETANURAE)

63 **Choiniere, J., Forster, C., Forster, C., De Klerk, W.** NEW INFORMATION ON *NQWEBASAURUS THWAZI*, A COELUROSAURIAN THEROPOD FROM THE EARLY CRETACEOUS (HAUTERIVERIAN?) KIRKWOOD FORMATION IN SOUTH AFRICA

64 **Lü, J., Xu, L., Zhang, X., Pu, H., Chang, H.** NEW ALVAREZSAURID (DINOSAURIA, THEROPODA) FROM UPPERMOST CRETACEOUS OF LUANCHUAN, HENAN PROVINCE OF CHINA

65 **Dalman, S., Paulina Carabajal, A., Currie, P.** A NEW LARGE-BODIED THEROPOD DINOSAUR FROM THE UPPER MORRISON FORMATION (LATE JURASSIC, TITHONIAN) OF COLORADO

66 **Schultze, H., Rothschild, B., Pellegrini, R.** IDENTIFYING THE ORIGINS AND IMPLICATIONS OF BONE PATHOLOGY IN FOSSIL REPTILES

67 **Kemp, M., Hadly, E.** IS MODAL BODY SIZE AN EVOLUTIONARY ATTRACTOR? *ANOLIS* AS A CASE STUDY

SATURDAY AFTERNOON, OCTOBER 20, 2012
POSTER SESSION IV (CONTINUED)

68 **Folie, A., Smith, T.** THE OLDEST SCOLECOPHIDIAN SNAKE

69 **Croghan, J., Caldwell, M.** *OGMOPHIS, CALAMAGRAS*, AND THE 32 MILLION YEAR OLD AGGREGATION OF SNAKES FROM THE WHITE RIVER FORMATION: ARE THEY ERYCINES?

70 **Palci, A., Caldwell, M.** ON THE POSTORBITAL AND SUPRAORBITAL OSSIFICATIONS OF SNAKES: NEW INSIGHTS FROM OLD BONES

71 **Caldwell, M., Palci, A.** ON THE CRISTA CIRCUMFENESTRALIS OF SNAKES: COMPARATIVE ANATOMY, SIMILARITY, FUNCTION AND THE FOSSIL SNAKES *DINILYSIA* AND *NAJASH*

72 **Nydam, R., Rowe, T., Cifelli, R.** LIZARDS AND SNAKES OF THE TERLINGUA LOCAL FAUNA (LATE CAMPANIAN), AGUJA FORMATION, TEXAS AND THE DISTRIBUTION OF PARACONTEMPORANEOUS SQUAMATES IN WESTERN NORTH AMERICA

73 **Jimenez-Huidobro, P., Caldwell, M.** *HAINOSAURUS* VERSUS *TYLOSAURUS*: IS THE FORMER DISTINCT FROM THE LATTER?

74 **Albright, III, L., Titus, A., Richardson, H., Clites, E., Birthisel, T.** A BASAL MOSASAUROID FROM THE EARLY TURONIAN OF UTAH

75 **Holwerda, F., Beatty, B., Schulp, A.** DENTAL MICROWEAR IN THE MAASTRICHTIAN MOSASAUR *CARINODENS BELGICUS*

76 **Yi, H., Sampath, D., Schoenfeld, S., Norell, M.** RECONSTRUCTION OF INNER EAR SHAPE AND SIZE IN MOSASAURS (REPTILIA: SQUAMATA) REVEALS COMPLEX ADAPTATION STRATEGIES IN SECONDARY AQUATIC REPTILES

77 **Yamashita, M., Konishi, T., Sato, T.** DIVERSITY OF DIVING BEHAVIOR OF MOSASAURS (SQUAMATA: MOSASAURIDAE) INFERRED FROM OPTICAL SYSTEM

78 **Behlke, A., Field, D.** TWO NEONATE MOSASAURS (SQUAMATA) FROM THE NIOBRARA FORMATION

79 **Street, H., Caldwell, M.** RE-EXAMINING THE AFFINITIES OF *MOSASAURUS GRACILIS* - IS IT TRULY A *MOSASAURUS*?

WEDNESDAY, OCTOBER 17, THROUGH SATURDAY, OCTOBER 20
SVP 2012 EDUCATION AND OUTREACH POSTER SESSION

RALEIGH CONVENTION CENTER, EXHIBIT HALL A, LEVEL 1
Authors will be present at their posters: Wednesday, October 17, from 4:15 – 5:15 p.m.
Posters must be removed by 6:30 p.m., Saturday, October 20

1 **Nakasone, S., Pyenson, N.** THE FIELD BOOK PROJECT: CONNECTING FIELD BOOKS WITH THE WORLD

2 **Donohue, S., DeSantis, L., Yann, L., Loffredo, L.** TRADITIONAL CLASSROOM VISITS ARE NECESSARY WHEN EVOLUTION IS TAUGHT AS A CONTROVERSY: BROADENING THE IMPACT OF INDIVIDUAL CLASSROOM VISITS

3 **Dewar, E.** WRITING ABOUT VERTEBRATE PALEONTOLOGY AND MORPHOLOGY AS A WAY TO IMPROVE COLLEGE STUDENTS' WRITING SKILLS

4 **Matthews, N., Christensen, T., Haines, M., Noble, T., Breithaupt, B.** TAKING SCIENCE AND EDUCATION OUTSIDE AT THE BLM MOCCASIN MOUNTAIN TRACKSITE, UTAH

5 **Parks, H., Williams, S., Rawlings, S., Carlson, E., Fivecoat, S.** JURASSIC JOURNEY: INTRODUCING THE PUBLIC TO "SCIENCE-IN-PROGRESS" AT AN ACTIVE DINOSAUR QUARRY

6 **Carlson, E., Rawlings, S., Williams, S.** THE JANE COLLABORATIVE: PALEONTOLOGY IN THE PUBLIC SQUARE

WEDNESDAY, OCTOBER 17, THROUGH SATURDAY, OCTOBER 20
SVP 2012 EDUCATION AND OUTREACH POSTER SESSION (CONTINUED)

7 **Oviedo, L., Grant, C., Ellis, S., MacFadden, B.** COMMUNICATING SCIENCE IN THE DIGITAL ERA: THE PCP-PIRE E-NEWSLETTER

8 **ElShafie, S., Thompson, K., Caland Puymartin, G.** NEW SCIENCE OUTREACH MODEL FROM STUDENT-RUN PILOT PROGRAM, *PARADIGM SHIFT*

9 **Cushing, P., Stucky, R., Garneu, N., Miller, I., Petrie, L.** TEEN SCIENCE SCHOLARS AT THE DENVER MUSEUM OF NATURE AND SCIENCE: NURTURING THE NEXT GENERATION OF SCIENTIFIC LEADERS

WEDNESDAY, OCTOBER 17, THROUGH SATURDAY, OCTOBER 20
SVP 2012 EDWIN H. AND MARGARET M. COLBERT PRIZE COMPETITION POSTERS

RALEIGH CONVENTION CENTER, EXHIBIT HALL A, LEVEL 1
Authors will be present at their posters: Thursday, October 18, from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m., Saturday, October 20

1 **Ushimura, E**. MICROSTRUCTURE OF THE SERRATED MARGIN OF EXTANT AND FOSSIL SHARKS WITH ORTHODENTINE AND OSTEODENTINE

2 **Pelletier, V.** 1:1 POSTCRANIAL RECONSTRUCTION OF THE BASAL EUPELYCOSAUR AEROSAURUS WELLESI

3 **Miller-Camp, J.** ARE LYSTROSAURUS DECLIVIS AND LYSTROSAURUS MURRAYI SEPARATE SPECIES OR SEXUAL DIMORPHS?

4 **Melstrom, K.** DESCRIPTION OF A JUVENILE DIPLODOCUS FROM DINOSAUR NATIONAL MONUMENT, UTAH AND ITS ONTOGENETIC IMPLICATIONS

5 **Brocklehurst, N.** SKULL SHAPE VARIATION IN LEPIDOSAURS: THE INFLUENCE OF ECOLOGY AND PHYLOGENY

6 **Yamada, E.** EFFECTS OF DIETARY DIFFERENCES BETWEEN TWO EXTANT RUMINANTS IN SYMPATRIC HABITAT ON ENVIRONMENTAL RECONSTRUCTION BY MESOWEAR ANALYSIS

7 **Crofts, S.** MODELING FUNCTIONAL TRADE-OFFS OF TEETH FROM EXTINCT AND EXTANT HARD PREY CRUSHING TAXA

8 **DeBlois, M.** PLESIOSAUR FLIPPER HYDRODYNAMICS AND ITS IMPLICATIONS ON PLESIOSAUROMORPH AND PLIOSAUROMORPH ECOMORPHOLOGY

9 **van Heteren, A.** THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSES OF URSIDAE ARE ABLE TO PREDICT FUNCTIONAL ADAPTATIONS OF FOSSILS

Technical Session X (Friday, October 19, 8:45 am)

ONTOGENY OF THE EARLY TRIASSIC *THRINAXODON LIORHINUS* (THERAPSIDA, CYNODONTIA). DENTAL MORPHOLOGY AND REPLACEMENT

ABDALA, Fernando, Bernard Price Institute for Palaeontological Research, Johannesburg, South Africa; JASINOSKI, Sandra, Department of Zoology, Cape Town, South Africa; FERNANDEZ, Vincent, Bernard Price Institute for Palaeontological Research, Johannesburg, South Africa

The non-mammaliaform cynodont *Thrinaxodon liorhinus* is one of the most common representatives of the post Permian-extinction fauna of the *Lystrosaurus* Assemblage Zone of the South African Karoo Basin. *Thrinaxodon* is also one of the best known Triassic cynodonts with a well-known cranio-dental and postcranial anatomy. Here we present a detailed study on variation of the dental morphology and replacement in *Thrinaxodon liorhinus*. For this study we analysed five specimens ranging from 37 to 87 mm in skull length using micro computed tomography (μCT) scanning techniques, which were supplemented by detailed anatomical analysis of 41 specimens with a basal skull length of approximately 30 mm to 96 mm. Our results confirm the alternate replacement of the postcanines and the posterior migration of the postcanine series (including the loss without replacement of the anteriormost postcanines). Even when most of the observations point to a posterior-to-anterior replacement wave, the evidence is not clear-cut. A new classification was designed to describe accurately the morphology of postcanines, taking into consideration the number of sectorial cusps, presence and pattern of the lingual cingulum, and presence of labial cingular cusps. The lower postcanines are clearly more complex (and more numerous) than the upper postcanines; only the lower postcanines have more than three sectorial cusps and a cingular collar on the lingual margin. Complexity of the postcanines increases from the smallest individual to specimens of 75 mm of skull length, but complexity decreases in larger specimens. On several specimens, erupting canines can be observed through the replacement pit while the complexity of the replacement pattern was assessed using X-ray micro-computed tomography. The virtual extraction of functional and replacement teeth permitted us to conclude that in most of the cases, the upper canines were replaced anteriorly while lower canines were replaced posteriorly. The presence of two simultaneous replacements of the upper canine tooth was observed in two small juveniles, suggesting a higher rate of canine replacement at younger age. Incisors also had a sequential replacement pattern, and more replacement teeth were present in medium-sized individuals.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

VERTEBRATE AND GEOLOGICAL SIGNATURES ON THE CONSTRUCTION OF MOGHRA FORMATION, NORTH WESTERN DESERT, EGYPT

ABDEL GAWAD, Mohamed K., Cairo University, Giza, Egypt; MILLER, Ellen, Wake Forest University, Winston-Salem, NC, United States; HAMDAN, Mohamed, Cairo University, Giza, Egypt; EL BARKOOKY, Ahmed, Cairo University, Giza, Egypt; EL SHARKAWI, Mohamed, Cairo University, Giza, Egypt

Information from the geology and paleontology of Wadi Moghra, early Miocene, Qattara Depression, Egypt combine to indicate the Moghra animals occupied a tide-dominated estuary paleoenvironment. Work on the sedimentology of the area reveals that the Moghra Formation is characterized by a series of shale-sandstone interbedded units, with an ichnofossil assemblage comprised of *Ophiomorpha*, which indicate an intertidal zone, and *Thalassinoides*, which indicate a subtidal environment. The root system of mangrove trees is present in some places, which also suggests the presence of tidelands or beaches. In addition, a large number of silicified tree trunks representing an *in situ* petrified forest is also preserved, and levels with silicified wood also contain lag deposits in which coprolites (primarily crocodile) are common.

Fossil vertebrates recovered from Moghra include aquatic animals such as gavials, crocodiles, turtles, catfish and rays, all of which can tolerate wet, low energy environments. The mammalian assemblage includes some hydrophilic taxa such as sirenians and anthracotheres, as well as suite of more terrestrial animals including suids, sanitheres, giraffoids, rhinocerotids, proboscideans, creodonts, carnivores, and primates. Taken together, geological, ichnofossil and vertebrate signatures give a detailed picture of the Moghra depositional paleoenvironment.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

CROCODYLIFORM DIVERSITY FROM THE EARLY CRETACEOUS TRINITY GROUP (APTIAN-ALBIAN) OF TEXAS, WITH THE DESCRIPTION OF NEW TAXA FROM THE TWIN MOUNTAINS FORMATION

ADAMS, Thomas L., Natural Sciences Department, San Antonio College, San Antonio, TX, United States

Crocodyliforms have been recognized as some of the most abundant tetrapods in the Early Cretaceous Trinity Group (Aptian–Albian) of Texas. However, their remains have typically been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Atoposauridae, and Goniopholididae. Most are inadequately described, with the exception of the small neosuchian *Pachycheilosuchus trinquei* from the Glen Rose Formation. Within the Twin Mountains Formation, three previously undescribed crocodyliforms from the Jones Ranch and Proctor Lake localities are represented by cranial and post cranial material. The Jones Ranch crocodyliform is comprised of skulls from two individuals. The skull of the smaller of the two lacks only the premaxillae, pterygoids, and left palatine, while the larger specimen consists of a left angular and left ectopterygoid. This taxon is notable for having an extremely elongate anterolateral process of the postorbital, large and rounded supratemporal fenestra, and a narrow, rod-like posterior ramus of the jugal. These features indicate affinities with goniopholidids, pholidosaurids, and thalattosuchians. The first of two small taxa from Proctor Lake is represented by a partial skeleton with complete dentary, long, slender limbs, pelvic elements, amphicoelus vertebrae, and small, square osteoderms. The second crocodyliform taxon from Proctor Lake includes skulls from two individuals, limb elements, procoelous vertebrae, and isolated teeth. This last taxon represents one of the most derived taxon of non-eusuchian Crocodyliformes in Texas with an internal choanae situated at the posterior edge of the suborbital fenestrae and bordered anteriorly by the palatines and by the pterygoids posteriorly and laterally. A phylogenetic analysis recovered this new crocodyliform as the sister taxon to the Glen Rose form. Together, all three expand the taxonomic diversity of the Early Cretaceous units of Central Texas and increase our knowledge on the evolutionary patterns within Crocodylomorpha.

Technical Session XVIII (Saturday, October 20, 3:00 pm)

THE MECHANICS OF FOSSORIALITY IN MAMMALIA AND THE LOCOMOTOR BEHAVIOR OF PALAEANODONTA (PHOLIDOTAMORPHA)

AHRENS, Heather E., Johns Hopkins School of Medicine, Baltimore, MD, United States; RUFF, Christopher B., Johns Hopkins School of Medicine, Baltimore, MD, United States; ROSE, Kenneth D., Johns Hopkins School of Medicine, Baltimore, MD, United States

Fossoriality has evolved multiple times within Mammalia, providing numerous examples of adaptive convergence. Some of the most cited examples of morphological convergence in the postcranium include additional fusions in the vertebral column, a stout humerus with prominent muscle attachment sites, a long and inflected olecranon process, and a broad manus with fusions and additional sesamoids. Despite many descriptive studies, there are few taxonomically broad biomechanical analyses of fossoriality in mammals. The goals of this project were to use beam modeling and mechanical advantage of long bones to determine whether different digging modes could be distinguished in extant taxa and to determine the locomotor behavior of Palaeanodonta, an extinct Paleogene group that includes taxa hypothesized to be moderately to extremely fossorial. The extant sample included eleven species, nine fossorial and two generalized, and the fossil sample included five specimens of paleanodonts. The number of fossils was restricted by the requirement for nearly complete specimens. Anteroposterior and mediolateral breadth measurements of the humerus and femur were used to calculate polar section modulus (Zp) and polar second moment of area (J), which measure bending and torsional strength and rigidity, respectively. Length of the olecranon process and total length of the ulna were used to calculate mechanical advantage of the ulna. 95% prediction intervals constructed from non-armored scratch diggers (our largest modern sample) and analyses of variance (ANOVA) on the residuals from the regression of scratch diggers were used to assess whether there was a distinction between the following locomotor modes: generalized (non-fossorial), scratch, hook and pull, humeral rotation, and head lift. Humeral rotation and head-lift digging can be distinguished from scratch digging on the basis of humeral bending and torsional strength and rigidity, as well as the mechanical advantage of the ulna on the basis of both the ANOVA and examination of prediction intervals. Femoral strength and rigidity were significantly different based on the ANOVA; however, individuals of all locomotor modes fell within the 95% prediction intervals. Though none of the palaeanodonts sampled exhibited mechanical measures outside the range of extant mammals, the group is characterized by an increased mechanical advantage of the ulna compared to extant fossorial mammals of similar body size. Most palaeanodonts were likely scratch diggers, with only *Dipassalus oryctes* recovered as a head-lift digger. The discrimination of more than one locomotor style in Palaeanodonta provides promising results that suggest these three mechanical properties can detect differences in digging mode in other extinct mammals.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ENCEPHALIZATION AND BRAIN MORPHOLOGY IN EXTINCT, FALSE SABER-TOOTHED CATS (BARBOUROFELIDAE)

ALBA, David M., Institut Català de Paleontologia Miquel Crusafont, UAB, Barcelona, Spain; FORTUNY, Josep, Institut Català de Paleontologia Miquel Crusafont, UAB, Barcelona, Spain; DE ESTEBAN-TRIVIGNO, Soledad, Institut Català de Paleontologia Miquel Crusafont, UAB, Barcelona, Spain; ROBLES, Josep M., Institut Català de Paleontologia Miquel Crusafont, UAB, Barcelona, Spain; ALMÉCIJA, Sergio, American Museum of Natural History & NYCEP, New York, NY, United States

Barbourofelids are an extinct family of feliform carnivorans from the Miocene of Africa, Eurasia and North America, including the paraphyletic Afrosmilini and the more derived and monophyletic Barbourofelini (*Sansanosmilus*, *Albanosmilus* and *Barbourofelis*). Barbourofelids evolved a sabertooth craniodental morphology independently from nimravids and the saber-toothed felids (Machairodontinae). In North America, barbourofelins coexisted for several million years with machairodonts, but in Europe the former became extinct short after the arrival of the latter. According to published endocast descriptions of *Sansanosmilus* and *Barbourofelis*, barbourofelids would display an archaic brain sulcal pattern more similar to that of nimravids than to that shared by machairodontines and modern felids, thus suggesting the existence of cognitive differences between both groups. This is tentatively supported by published brain volume estimations based on external neurocranium measurements. In order to further evaluate the differences in brain morphology and encephalization between barbourofelids and machairodontines, here we report two barbourofelin virtual endocasts based on computed tomography (CT) scans of

the following two crania: *Albanosmilus jourdani* IPS49575 from Abocador de Can Mata sector C8-B/C (Vallès-Penedès Basin, Spain; ca. 11.5 Ma, Aragonian, Middle Miocene), housed at the Institut Català de Paleontologia Miquel Crusafont (Spain); and *Barbourofelis morrisi* AMNH FAM 61870 from the *Leptarctus* Quarry (Merritt Dam Member, Ash Hollow Formation, Nebraska, USA; ca. 11.5-9.5 Ma, Clarendonian, Middle to Late Miocene), housed at the American Museum of Natural History (AMNH, USA). On morphologic grounds, *Albanosmilus* and *Barbourofelis* differ from extant felids and resemble the more primitive barbourofelid *Sansanosmilus* in several features, such as displaying two main neocortical sulci (coronolateral and suprasylvian). Moreover, compared to extant felids, the two barbourofelids studied here display a higher rhinal fissure and less developed simoid gyri, indicating the possession of lower auditory abilities and a smaller portion of the neocortex devoted to processing postcranial somatic and motor inputs. Finally, our brain volume measurements (78 cm^3 for *A. jourdani* and 112 cm^3 for *B. morrisi*) and the body mass estimates based on the length of these crania (46 and 61 kg, respectively) confirm that barbourofelids displayed a lower degree of encephalization compared to both nimravids and felids. Barbourofelins especially contrast with machairodontines, which appear slightly more encephalized on average than extant felids. Overall, our results confirm the hypothesis that barbourofelids differed in neuroanatomical traits and associated cognitive features from sabertooth felids.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A BASAL MOSASAUROID FROM THE EARLY TURONIAN OF UTAH

ALBRIGHT, III, L. B., University of North Florida, Jacksonville, FL, United States; TITUS, Alan L., Grand Staircase-Escalante National Monument, Kanab, UT, United States; RICHARDSON, H. S., Grand Staircase-Escalante National Monument, Kanab, UT, United States; CLITES, Erica C., Glen Canyon National Recreation Area, Page, AZ, United States; BIRTHISEL, Tylor A., Grand Staircase-Escalante National Monument, Kanab, UT, United States

The early history of Mosasauridae in North America is shrouded in obscurity. Specimens are extremely rare and diagnostic material has previously been found only in middle Turonian marine strata of Kansas and Texas, and in early Turonian strata of Mexico. In early 2012 a new basal mosasauroid specimen was found in the late Cenomanian-middle Turonian age Tropic Shale of southern Utah, in Glen Canyon National Recreation Area. The nature of its recovery suggests that the specimen was originally mostly articulated but broke up during Holocene weathering and transport. Fragments of the cranium and mandible were recovered, along with a significant portion of the cervical, dorsal, and caudal vertebral series. The neural arches are missing, suggesting that a juvenile is represented, and the individual appears to have measured between 2-2.5 meters in length. The specimen was found entirely ex-situ, but can be readily constrained to have come from between the informally named "C" and "D" bentonite horizons, probably closer to the former. This places the specimen from within the lower portion of the *Mytiloides kossmati* biozone, probably within the *Vascoceras birchbyi* Ammonoid Biozone, and it is therefore middle early Turonian in age. Preliminary assessment of the cranial material suggests that a new taxon is represented, with significant differences in premaxillary morphology, but having gross postcranial similarity to *Dallasaurus turneri* and *Russellosaurus coheni* from the middle Turonian of Texas.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

INVESTIGATION OF NORTH AMERICAN GONIOPHOLIDID CROCODYLIFORMS IN A PHYLOGENETIC CONTEXT

ALLEN, Eric R., University of Iowa, Iowa City, IA, United States

Broad-scale phylogenetic analysis is predicated on a thorough understanding of constituent taxa. Phylogeny reconstruction in crocodyliforms is dependent on taxon sampling, though currently several crocodyliform clades are not well understood. The goniopholidids are a distinctive and common clade of crocodyliforms known from the Jurassic and Cretaceous of Europe, Asia, and North America. Their position within Neosuchia makes them vitally important to the study of crocodyliform evolution, but unfortunately their phylogenetic status remains contentious. Even which taxa constitute the clade is not fully known, as several taxa have been ascribed but their affinity never tested phylogentically. This study investigates the monophyly of Goniopholididae, its phylogenetic position within Crocodyliformes, and taxonomic relationships within the clade. A phylogenetic dataset is presented including a species-level sampling of currently-described North American goniopholidids in addition to novel coding for *Vectisuchus leptognathus* from the Early Cretaceous Upper Wessex Formation, Isle of Wight, and *Denazinosuchus kirtlandicus* from the Late Cretaceous Kirtland Formation of New Mexico. Additionally, the Early Cretaceous goniopholidids *Goniopholis willetti* from the Grinstead Clay Formation of West Sussex and *Anetophthalmosuchus hooleyi* from the Vectis Formation of the Isle of Wight are incorporated in a phylogenetic matrix for the first time. This is the broadest and most inclusive sampling of goniopholidids and putative goniopholidids to date. The affinity of North American and European members of *Goniopholis* is assessed, as are the taxonomic status of putative goniopholidids. Goniopholididae is monophyletic, and North American goniopholidids form a nested clade united by a distinctive palate morphology with a long, channel-like choana excluding the palatines from contact at the midline. Furthermore, all Jurassic Morrison Formation goniopholidids are further nested in the North American clade and defined by a distinctive lachrymal and prefrontal anatomy not seen in other goniopholidids. North American "*Goniopholis*" are generically distinct from European forms, and should be ascribed to *Amphicotylus*. Additionally, *Denazinosuchus* and *Vectisuchus* are not constituents of Goniopholididae, and instead are more closely related to pholidosaurs and thalattosuchians, with *Vectisuchus* falling basal to the clade and *Denazinosuchus* either as sister to *Vectisuchus* or nested within Pholidosauria, depending on the inclusion of a new crocodyliform from the Early Cretaceous Woodbine Formation of Texas.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

ENDOCAST SHAPE AND BRAIN PROPORTIONS IN PRIMATES

ALLEN, Kari L., Department of Evolutionary Anthropology, Duke University, Durham, NC, United States; KAY, Richard F., Department of Evolutionary Anthropology, Duke University, Durham, NC, United States

Qualitative differences in endocranial form have been described between extant strepsirrhine and anthropoid (platyrrhine and catarrhine) primates. It has been assumed that these trends are related to differences in relative brain size and brain proportions between these clades. However, global endocast shape and its relationship to brain proportions has yet to be quantitatively explored across the order. This problem is addressed here using three-dimensional geometric morphometric (GM) techniques.

Endocranial shape is quantified via GM analysis of fourteen landmark coordinates, taken on three-dimensional virtual endocasts. The analysis includes data from four extant strepsirrhine, twelve platyrrhine, and four catarrhine species. Virtual endocasts were segmented and rendered from microCT scans of dry skulls. Overall endocast shape was explored via a Principal Components Analysis of Procrustes-aligned landmark data. Principal Component (PC) scores were examined for correlations to species means for body mass and residual endocranial volume, via phylogenetic regression techniques.

PC1 accounts for 42% of the variance in the data. This axis separates anthropoid from strepsirrhine primates, with strepsirrhines demonstrating higher scores for PC1. Shape changes associated with higher PC1 scores include: decreased superior-inferior height of the endocast, a decreased degree of brain base flexion, increase in the size and rostral projection of the olfactory bulb, and a more caudal placement of the cerebellar poles relative to the cerebral poles. PC1 scores were found to have a high degree of phylogenetic signal (lambda=1.0). Scores on this axis are not significantly correlated with log centroid size ($p=0.69$), or species means for log endocranial volume ($p=0.19$) and log body mass ($p=0.99$); however, PC1 scores are correlated with relative brain size, even when phylogenetic effects are controlled for ($p=0.0002$). PC2 accounts for an additional 20% of the variance, and is primarily driven by the maximum breadth of the cerebrum and cerebellum. This axis fails to distinguish modern taxonomic groups. PC2 scores are not significantly correlated with residual endocranial volume ($p=0.83$), and are marginally related to log body mass ($p=0.057$).

These data provide support for qualitative observations that differences in encephalization are associated with endocranial shape differences between strepsirrhine and anthropoid primates. This analysis further suggests that geometric morphometric methods will be useful for quantifying the distribution of endocast shape across primate evolution, and inferring functionally and phylogenetically important shifts in brain proportions in the primate fossil record.

Technical Session VII (Thursday, October 18, 2:45 pm)

SIMPLE EQUATIONS FOR ESTIMATING BODY MASS IN MAMMALS (AND DINOSAURS)

ALROY, John, Macquarie University, Sydney, Australia

Body mass is a major topic of paleobiological research, but it is notoriously difficult to estimate. Methods that are relevant to dinosaurs tend to either focus on one limb element at a time or require reconstructions of entire skeletons. Most of the former methods extrapolate from scaling patterns in mammals, which is problematic because scaling relationships among elements are greatly different in dinosaurs. Such methods are also unable to handle tradeoffs in limb lengths across different locomotor categories, with equations for bipedal taxa being virtually free of data. All such methods ignore the scapula. However, a comprehensive new data set shows that scapula length is actually the best single predictor of mass in terrestrial mammals. The relationship is not only tight but close to isometric (linear and with a slope near 3 on a log scale). By contrast, scaling is nonlinear for other elements because of biomechanical tradeoffs that are well-known, and the resulting steep increases in slopes at large body sizes make extrapolations particularly dangerous. Nonetheless, accuracy in predictions is enhanced by also considering humerus length and, at least to some extent, either radius length or ulna length. The reasons are that (1) there is a small tradeoff between scapula and humerus length in general, and (2) mammals such as primates that have long limbs tend to have both disproportionately long distal forelimbs and lower than expected body masses. By contrast, facultatively bipedal mammals have relatively short distal forelimbs. Therefore, distal forelimb length is a mildly helpful inverse predictor of mass in equations that control for the other variables. The new equations grossly underestimate mass in amphibious or fully aquatic mammals, but this shortcoming comes as no surprise because most aquatic species rely upon the hindlimb for propulsion. When swimming forms are put aside the new equations yield no systematic differences across clades. Estimates are accurate even for primates, which are so distinctive that previous studies had to exclude them. Values for partially or fully quadrupedal dinosaurs are also consistent with published figures based on reconstructions. The new equations are not intended to replace estimators based on variables other than limb bone lengths, and they are not applicable when dealing with fully bipedal organisms such as tyrannosaurids. However, their simplicitly and lack of systematic bias make them advantageous when (say) complete skeletal restorations do

not exist, restoration is untenable because hind limbs are not preserved, crushing makes it impossible to measure circumferences, or standard published measurements are the only available information.

Technical Session XIV (Saturday, October 20, 8:45 am)

NEW INSIGHTS INTO THE ORIGIN OF EXTANT AMPHIBIANS FROM THE FOSSIL RECORD AND HIGH RESOLUTION COMPUTED TOMOGRAPHY

ANDERSON, Jason S., University of Calgary, Calgary, AB, Canada; MADDIN, Hillary C., Harvard University, Cambridge, MA, United States; WILSON, Sian C., University of Calgary, Calgary, AB, Canada; PARDO, Jason D., University of Calgary, Calgary, AB, Canada

The origin of frogs, salamanders, and caecilians (collectively Lissamphibia) has been contentious question for a number of years. This controversy stems from the fact that extant amphibians and various archaic fossil groups represent two non-overlapping data sets; the morphology of lissamphibians are highly derived with respect to characters found in archaic fossils, and the fossils are not available for molecular work. With the publication of the stem batrachian *Gerobatrachus,* many of the morphological gaps were spanned at least between frogs and salamanders and one group of fossil amphibians, the amphibiamid temnospondyls. However, that study hypothesized that caecilians were sister group to another group, the brachystelechid lepospondyls. This topology, assuming the consensus placement of lepospondyls as sister group to amniotes and their stem is correct, is at odds with all molecular studies, which find support for a monophyletic origin of lissamphibians.

Subsequent to this study, work has continued to test this lepospondyl-caecilian relationship, primarily though the exploration of internal braincase anatomy in extant and fossil amphibians using micro-Computed Tomography (micro-CT). Our work has extensively documented the range of variation within the braincase of caecilians, and has found a number of morphological characters that are congruent with current molecular phylogenies of this group. Work on the morphology of caecilian inner ears has highlighted previous studies that suggest that there is a progressive regression, and ultimate loss, of sensory epithelia related to both high-frequency tympanic and low-frequency opercular hearing pathways, which would be inconsistent with a lepospondyl origin for caecilians. Detailed micro-CT studies of lepospondyls have demonstrated some new potential characters linking microsaurs and caecilians, but the preponderance of characters linking these two groups is correlated with fossorial locomotion. Further research has documented tooth development and replacement patterns in a taxonomically compresensive sample of fossil and extant amphibians. Additionally, we have raised a staged series and using synchrotron-CT we have established the 3D morphometric change during ontogeny of the salamander cranium as a baseline for comparisons with other salamanders with different life history strategies.

Technical Session XVII (Saturday, October 20, 3:45 pm)

DID MARINE MAMMALS OUTCOMPETE GIANT DIVING BIRDS?

ANDO, Tatsuro, Ashoro Museum of Paleontology, Ashoro, Japan; FORDYCE, Robert E., University of Otago, Dunedin, New Zealand

The demise of "giant" flightless wing-propelled divers (Sphenisciformes, Plotopteridae, Mancallinae, and *Pinguinus*) is one of the unresolved questions in their evolutionary histories. Contrary to "Cope's Rule", the largest species have disappeared from the lineages of those diving birds. "Giant penguin" indicates any fossil species of penguin (Sphenisciformes) for which size estimates are much larger than living species; the largest living form, Emperor penguin (*Aptenodytes forsteri*) measures about 115 cm (stretched length) and weighs about 40 kg at maximum. "Giant" species appeared in penguin history by the Early Eocene (Ypresian), flourished for 25 million years, and disappeared in the Late Oligocene (Chattian). Their fossils are known widely from Antarctica (*Anthropornis*, *Palaeeudyptes*), New Zealand (*Pachydyptes*, *Kairuku*), South America (*Icadyptes*, *Incayaku*), and Australia (*Pachydyptes*, "*Palaeeudyptes*"), suggesting that "giants" were not just unusual localised occurrences. Some early studies speculated that extinct penguin body size reached more than 2 m in length. Recent studies that extrapolate from regression curves of living species, however, have identified the largest giant penguin, *Anthropornis* sp., as possibly about 1.6 m high, with 90 kg mass; even then, size estimates are based on a few elements of uncertain proportion to the total skeleton. Northern counterparts of penguins include giant forms of Plotopteridae (Pelicaniformes), such as *Copepteryx* and *Hokkaidornis*, known only from the Late Oligocene (Chattian). Because northern and southern flightless wing-propelled divers have different evolutionary histories, the coincidental "parallel demise" of giant forms in the Northern and Southern Hemispheres induced a common "competition hypothesis," which suggested that the evolution of marine mammals might explain extinction through competitive displacement. Such an idea is here assessed via diversity trends reported in the Paleobiology Database. At global to basin scales, flightless divers and marine mammals indeed show contrasting patterns of diversity from Chattian to Aquitanian, with diving birds decreasing in diversity with increase in marine mammal taxa, especially Odontoceti. However, a closer comparison reveals that long-term pattern are compositional and result from scaling effects rather than from competitive displacement: evolution of marine mammals did not clearly cause the extinction of "giant" divers. Large body size is suited to long-distance swimming and to deep-diving; it seems possible, then, that the extinction of large diving birds might reflect changes in profile of continental shelves and/or location of upwelling regions, in turn governed by global tectonics, sea level, and climate.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

MIOCENE SHARK FAUNA FROM NOSY MAKAMBY (MAHAJANGA BASIN, NORTHWESTERN MADAGASCAR)

ANDRIANAVALONA, Tsiory H., University of Antananarivo, Antananarivo, Madagascar; RAMIHANGIHAJASON, Tolotra N., University of Antananarivo, Antananarivo, Madagascar; RASOAMIARAMANANA, Armand, University of Antananarivo, Antananarivo, Madagascar; WARD, David, The Natural History Museum London, London, Great Britain; SAMONDS, Karen E., University of Queensland, St. Lucia, Australia

Madagascar is well known for producing exceptional fossils. However, the selachian fossil record remains relatively poorly known because research is largely lacking on Malagasy marine organisms, despite the fact that nearly all of the island's Cenozoic rocks are mapped as marine. Malagasy selachians are currently reported from the Late Cretaceous deposits of the Mahajanga Basin and a few reports of isolated teeth from the Eocene and Miocene.

Here we report the first comprehensive fossil selachian assemblage from the Miocene of Madagascar from Nosy Makamby, a small island off the northwest coast of Madagascar offshore of the delta of the Mahavavy River, approximately 50 km west along the coast from the regional capital of Mahajanga. Very little geological information has been reported from Nosy Makamby and surrounding areas; the only comprehensive description of the island's fossils is the result of reconnaissance work done in the early part of the century. The age of the section is currently under investigation but is thought to be early or middle Miocene.

Based on isolated teeth, seven genera have been identified, including *Carcharhinus*, *Galeocerdo*, *Negaprion*, *Rhizoprionidon* and *Sphyrna* (Carcharhinidae), *Hemipristis* (Hemigaleidae), and *Squatina* (Squatinidae), marking the first description of *Rhizoprionodon*, *Squatina* and *Carcharhinus* from Madagascar's fossiliferous formations. In association with these specimens, fossil remains of foraminiferans, bivalves, gastropods, echinoids, bony fish, non-diagnostic reptiles (turtles and crocodylians), and sirenian mammals were also recovered. The vertebrate-bearing horizon is underlain by sandstone containing the giant teredinid shipworm, *Kuphus* and overlain by cress-bedded sands and oysters. All suggest shallow water brackish or close-shore marine conditions; the presence of *Kuphus* is usually indicative of mangrove swamps. In the vertebrate-yielding level, the presence of sirenian remains and plates of the cirripede *Balanus concavus* further support a shallow-water marine depositional environment.

Technical Session X (Friday, October 19, 8:00 am)

DO TETRAPOD HERBIVORES MATTER? ECOSYSTEM ROBUSTNESS, OLSON'S COMMUNITY TYPES AND THE PRIMACY OF INSECTS

ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; ROOPNARINE, Peter D., California Academy of Sciences, San Francisco, CA, United States

A major transition in tetrapod communities occurred in the Permian, as high-fiber herbivores diversified and became abundant. Using data from the Karoo Basin, we have shown that communities with low tetrapod herbivore diversity can display low robustness in the face of disturbances, with even small perturbations often causing high levels of extinction. These observations raise the possibility that ecosystem robustness was an important factor in the replacement of communities with low tetrapod herbivore diversity by those with greater herbivore diversity. To test this hypothesis, we used the Cascading Extinctions on Graphs (CEG) model to investigate the robustness of two communities with low tetrapod herbivore diversity: the fauna of the Carboniferous Upper Freeport Coal and the fauna of the Permian Wellington Formation. Despite both having few or no tetrapod herbivores, the two communities show divergent responses to perturbation: the Upper Freeport Coal fauna displays very low robustness, whereas the Wellington Fm. community is highly robust. Experimental manipulation of the communities shows that their levels of robustness do not stem directly from their tetrapod herbivore diversities. Instead, the Wellington Fm. community is stabilized largely by its diverse assemblage of insects, particularly herbivorous insects. The Upper Freeport Coal community also has a diverse insect assemblage, but the majority are detritivores or carnivores that appear not to have the same stabilizing effect. Taken together, these results suggest that the diversification of tetrapod herbivores may have had only limited effects on ecosystem robustness; instead the radiation of insect herbivores may have been much more important in this regard. In his seminal work on terrestrial community ecology, Everett Olson classified communities into three types based on the relative diversities of tetrapod herbivores and whether sources of primary productivity were dominantly terrestrial or aquatic. Based on its tetrapod fauna, the Wellington Fm. community should be a Type I community (characterized by low terrestrial herbivore diversity) in Olson's classification, but functionally it appears much more like a Type III community (with insect herbivores forming a key link between terrestrial producers and consumers). This raises the possibility that all of the classic Lower Permian faunas upon which Olson based his concept of Type I communities may not represent this community type at all, and that true Type I communities will need to be sought earlier in the fossil record (the Upper Freeport Coal may be an example).

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:15 am)

CENOZOIC MAMMALS FROM AMAZONIA: DIVERSITY, ENVIRONMENT, AND BIOGEOGRAPHY

ANTOINE, Pierre-Olivier, University Montpellier 2, Montpellier, France

The Amazon Basin constitutes more than one third of South America's emerged areas. Essentially covered by tropical rainforests and a dense river network, this area is today a major biodiversity hotspot, notably for mammals. Yet, the mode and timing of the settlement of the corresponding mammalian guilds are far from being well known, due to the virtual lack of well-constrained data, notably for the Paleogene period. Although dramatically under-investigated, pre-Holocene Cenozoic deposits from Western Amazonia contain a wide array of fossil mammals, most of them being highly relevant to test major evolutionary and/or biogeographic hypotheses.

The earliest Cenozoic mammals from Amazonia are middle Eocene in age (~41 Ma). They were recently recovered nearby Contamana, eastern Peru, and consist of both endemic groups (gondwanatherians, marsupials, xenarthrans and native ungulates of high latitude affinities) and early immigrants from Africa (South America's earliest rodents). Another locality of eastern Peru, Santa Rosa (?late Eocene-early Oligocene), yielded a somewhat similar mammalian guild, as well as a 'possible bat'. A new locality, nearby Contamana, documents the late Oligocene period, with affinities to both Santa Rosa and Salla, Bolivia. In the Madre de Dios Basin, southern Peru, a new early Miocene locality provides the earliest low-latitude platyrrhine primate. By contrast, several middle and late Miocene faunas discovered in the last decades, from western Brazil (Acre and Juruá) and eastern/southern Peru ('Fitzcarrald Local Fauna'; Madre de Dios), yield much more diversified mammalian guilds, including marsupials, xenarthrans, native ungulates, caviomorph rodents, primates, bats, aquatic placentals (river dolphins and trichechid sirenians), and perhaps an early proboscidean of North American origin. Younger faunas, late Pleistocene-Holocene in age, widely postdate the Great American Interchange (~3.5 Ma), and accordingly include Northern invaders, such as perissodactyls, artiodactyls, proboscideans, carnivores, and muroid rodents, together with xenarthrans and toxodontid ungulates.

Paleontological data as a whole point to the presence of tropical rainforests in Amazonia throughout the Cenozoic period, at least during mammal-yielding intervals, with obligate arboreal marsupials, rodents, and primates co-occurring with terrestrial hoofed ungulates. However, Western Amazonia hosted peculiar environments in the late early-early late Miocene interval, with marine ingressions and the settlement of the long-lived marine-like Pebas megalake. This episode played a pivotal role in the biotic differentiation of southern/northern South American ecosystems and corresponding mammalian guilds, as earlier faunas show relatively low degrees of endemism.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DIVERSITY OF THE HESPERORNITHIFORMES (AVES) FROM THE UPPER CRETACEOUS PIERRE SHALE IN SOUTHERN MANITOBA, CANADA

AOTSUKA, Keiichi, The University of Tokyo, Tokyo, Japan; HATCHER, Joseph, Canadian Fossil Discovery Centre, Morden, MB, Canada; JANZIC, Anita-Maria, Canadian Fossil Discovery Centre, Morden, MB, Canada; SATO, Tamaki, Tokyo Gakugei University, Tokyo, Japan

Hesperornithiformes (Aves; Ornithurae) is a group of Cretaceous foot-propelled diving birds. Their remains are most commonly reported from Campanian deposits in North America where the Western Interior Seaway existed during the Cretaceous, and numerous hesperornithiform fossils have been collected from the Pierre Shale (Campanian) between South Dakota (USA) and Manitoba (Canada). *Hesperornis regalis* was the only species of the Hesperornithiformes from the Pierre Shale for many years, but since 2002, an additional five species (*H. chowi, H. bairdi, H. macdonaldi*, *H. mengeli* and *Brodavis varneri*) were described from South Dakota and Manitoba, suggesting higher taxonomic diversity of the Hesperornithiformes in the Pierre Shale. The current study aims to update the taxonomic composition of the Hesperornithiformes in the Pierre Shale in southern Manitoba. Nearly 200 hesperornithiform specimens have been collected from the Pierre Shale in southern Manitoba and stored in the Canadian Fossil Discovery Centre in Morden since 1972, but these fossils have not been studied since 1989. This study follows previous taxonomic studies in which the diagnosis of most species of *Hesperornis* is based on the morphology of the tarsometatarsus and tibiotarsus. Consequently, five species of two genera (*Hesperornis regalis*, *H. chowi*, *H.* sp. A, *H.* cf. *rossicus*, *Baptornis advenus*) were identified in this study. *H.* sp. A likely represents a new species because it displays unique characters in the shaft and proximal view of the tarsometatarsus; the shaft is strongly constricted at midshaft and the proximal articulation displays a nearly D-shaped outline. Results indicate that the genus- and species-level diversity of the Hesperornithiformes in Manitoba is much higher than previously recognized. This study also demonstrates the wider geographic range of two hesperornithiform species; *H. chowi* and *B. advenus* were previously known only from South Dakota and Kansas respectively. In addition, *H. rossicus* was previously reported from Russia and Sweden but not reported from North America, and the *H.* cf. *rossicus* specimen from Manitoba possibly indicates a wider geographic distribution of this species as well.

Technical Session XI (Friday, October 19, 3:00 pm)

LATE JURASSIC THEROPOD EMBRYOS FROM PORTO DAS BARCAS, LOURINHÃ FORMATION, PORTUGAL

ARAÚJO, Ricardo, Southern Methodist University and Museu da Lourinhã, Dallas, TX, United States; CASTANHINHA, Rui, Instituto Gulbenkian de Ciência and Museu da Lourinhã, Lisboa, Portugal; MATEUS, Octávio, Faculdade Ciências e Tecnologia da Universidade Nova de Lisboa and Museu da Lourinhã, Lourinhã, Portugal; MARTINS, Rui, IST/Instituto Tecnológico Nuclear, Universidade Técnica de Lisboa, Centro de Física Nuclear da Universidade de Lisboa and Museu da Lourinhã, Lisboa, Portugal

A clutch of several crushed eggs and embryos from the Late Jurassic (near the Kimmeridgian-Tithonian boundary), Lourinhã Formation, Portugal contains a complete maxilla, erupted and scattered teeth, and presacral vertebrae. The maxilla bears four teeth separated by individualized interdental plates, the dorsal process of the maxilla is confluent with the maxillary body, the ventral rim of the antorbital fossa is parallel to the tooth row, and the anterior border of the maxilla forms a right angle with the ventral margin. The teeth are conical and recurved distally with carinae on mesial and distal sides. The vertebrae are amphiplatyan, with a ventral pair of neurovascular foramina and heavily pitted articular facets. These fossils allow unambiguous association of basal theropod osteology (Megalosauroidea) with a new eggshell morphotype. Synchrotron micro-computed tomographic scanning (SRμCT), scanning electron microscopy, and thin-sections under polarized and normal light revealed that the outer ornamentation of the eggshell is composed of anastomosing ridges and islets, the pores communicate near the outer region of the eggshells, and in radial section they are irregular canals that ramify towards the surface. Micro-proto induced x-ray emission (micro-PIXE) analysis of the eggshell (excluding pores) revealed the presence of Mg, Fe, Mn (0.33%, 0.27% and 0.18%, respectively) and several trace elements, with a corresponding loss of Ca (39.4% detected but 40.0% expected for calcite), which suggests minimal eggshell diagenesis. The eggshells do not luminesce, which could imply that no diagenetic alteration took effect. However, the quenching effect of Fe^{2+} has to be taken into consideration. Conversely, luminescence is observed in the pores since they are filled with sediment, composed of phyllosilicates, as revealed by SRμCT, micro-PIXE and x-ray diffraction analyses.

Technical Session XV (Saturday, October 20, 12:00 pm)

A NEW ANKYLOSAURID DINOSAUR FROM THE UPPER CRETACEOUS BARUUNGOYOT FORMATION OF MONGOLIA: NEW CRANIAL CHARACTERS FOR ANKYLOSAURINE ANKYLOSAURIDS AND A REASSESSMENT OF ANKYLOSAURID POSTCRANIAL SPECIMENS FROM MONGOLIA

ARBOUR, Victoria M., University of Alberta, Edmonton, AB, Canada; BADAMGARAV, Demchig, Paleontological Center, Mongolian Academy of Sciences, Ulaan Baatar, Mongolia; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

The Upper Cretaceous sediments of the Gobi Desert, Mongolia, have produced several ankylosaurid taxa with distinctive bulbous, pyramidal cranial ornamentation, including *Tarchia gigantea* (from the Nemegt Formation) and *Saichania chulsanensis* (from the Baruungoyot Formation). Although a third taxon, *Minotaurasaurus ramachandrani*, is of unknown provenance, it bears a strong similarity to both *Tarchia* and *Saichania* and may also derive from the Upper Cretaceous of Mongolia. A new ankylosaurid skull (Mongolian Paleontological Center [MPC] D100/1338) from the Baruungoyot Formation at Khermeen Tsav can be differentiated from *Saichania* and *Tarchia* based on the unusual double-layered appearance of the squamosal horns, and the presence of ornamentation posterior to the orbit. Several new ankylosaurid cranial characters are identified, including the presence or absence of a constriction behind the narial osteoderms, squamosal horn shape, the shapes of domed cranial osteoderms, number of discrete nuchal osteoderms, presence or absence of small osteoderms on the premaxilla between the narial osteoderms, and the shapes of the lateral edges of the supraorbitals.

The presence of a second potentially distinct ankylosaurid taxon in the Baruungoyot Formation necessitates a reevaluation of postcranial material referred to *Saichania*, previously the only known ankylosaurid in the formation. The holotype of *Saichania* (MPC 100/151) includes the skull and anterior part of the postcranial skeleton. A nearly complete skeleton with in situ osteoderms, but lacking a skull and cervical rings (MPC 100/1305), has been referred to *Saichania*, but no synapomorphies have been used to support this referral. The humerus of MPC 100/1305 appears to have a similar proximal concavity lateral to the humeral head, present in the holotype of *Saichania* but absent in other ankylosaurids, which may support the referral of MPC 100/1305 to this genus. Although ankylosaur postcranial remains are abundant in the Gobi Desert, postcranial remains associated with diagnostic skull material are rare, hindering efforts to identify additional characters for phylogenetic analyses.

A revised phylogenetic analysis of the ankylosaurine ankylosaurids using updated character codings and the new characters identified here shows a close relationship between MPC D100/1338, *Minotaurasaurus*, and *Pinacosaurus grangeri*. *Saichania* is more closely related to *Pinacosaurus mephistocephalus* than to MPC D100/1388. However, bootstrap supports for ankylosaurine interrelationships are low, highlighting the need for additional characters (possibly from the postcranial skeleton) to help resolve relationships within this clade.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW ADDITIONS TO THE ELASMOBRANCH FAUNA FROM THE MIOCENE OF JABAL ZALTAN, LIBYA

ARGYRIOU, Thodoris, University of Alberta, Edmonton, AB, Canada; COOK, Todd D., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

In 2010, excavations and prospecting in the early–middle Miocene deposits of Maradah Formation in Jabal Zaltan, Libya, yielded a sizable and diverse faunal sample. The collected material corresponds to a mixture of paleoenvironments of both terrestrial (e.g., proboscideans, rhinocerotids, bovids etc.) and aquatic nature (marine and freshwater fish, aquatic mammals, turtles, crocodiles etc.). A small but informative surface collection of elasmobranch remains was also made. The presence of fossil sharks and rays had been first noted almost 40 years ago, with the recognition of *Carcharias* (*Odontaspis*) *acutissima* (Odontaspididae), *Carcharodon* sp. (Lamnidae), *Hemipristis serra* (Hemigaleidae), *Pristis* sp. (Pristidae) and *Myliobatis* sp. (Myliobatidae). The newly available material allows us to confirm the presence of seven genera, five of which were previously unreported from the site. Lamniforms appear to be scarce as only one slender crowned tooth, attributed herein to *Carcharias* sp. (Odontaspididae), was found. Carcharhiniformes, on the other hand, appear to be better represented in our sample, as eleven teeth belonging to four genera were recovered. Three specimens are attributed to *Galeocerdo* sp. cf. *G. mayumbensis* (Carcharhinidae) on the basis of their similarity with specimens described from the lower Miocene of Cabinda and Bololo in Western Africa. *Carcharhinus* sp. (Carcharhinidae) is represented by one upper jaw and one lower jaw tooth. The upper jaw tooth bears a peculiar, strong serration pattern that is not seen in any Miocene representatives of the genus, but resembles *C. balochensis* from the late Eocene of Pakistan. Three specimens identified herein as *Negaprion* sp. (Carcharhinidae) were also collected. Moreover, two teeth allow us to ascertain the presence of *Hemipristis serra* (Hemigaleidae) in the site. The Jabal Zaltan batoid fauna is also enriched by the identification of *Aetobatus* sp. and *Rhinoptera* sp. (both Myliobatidae) based on three and one dental elements respectively. Unfortunately, no *Carcharodon, Pristis* or *Myliobatis* remains were recognized, a fact that could be attributed to our small sample size and collection bias. The elasmobranch finds, and their field association with other marine and terrestrial vertebrate fossils, are in accordance with the presumed depositional environment that corresponds to shallow estuarine to deltaic conditions.

Technical Session VII (Thursday, October 18, 3:45 pm)

PATTERNS OF DENTAL ERUPTION AND VARIABILITY IN MAMMALS

ASHER, Robert J., University of Cambridge, Cambridge, United Kingdom; PATTINSON, David, University of Cambridge, Cambridge, United Kingdom; TABUCE, Rodolphe, Universite Montpellier II, Montpellier, France; GHEERBRANT, Emmanuel, Muséum National d'Histoire Naturelle, Paris, France; HAUTIER, Lionel, University of Cambridge, Cambridge, France

Mammals are very conserved in their patterns of dental eruption. Nearly all known living and fossil mammals have no more than two generations at any given tooth locus. In addition, mammals typically undergo most replacement of their deciduous teeth prior or close to sexual maturity and the attainment of adult body size. Their eruption order is also conserved, with anterior molars erupting early. Major exceptions to these generalizations are found among afrotherians and armadillos (the only living xenarthrans that exhibit diphyodonty). Both groups tend to erupt fewer than half of their permanent cheek teeth by the time they reach adult body size; both show a relatively high level of variability in dental eruption order. In order to test the hypothesis that afrotherians and xenarthrans share late eruption of adult teeth as a synapomorphy, we present new data quantifying the relationship between skull size and proportion of fully erupted, permanent teeth in mammals. We also compare eruption sequences to test if dental eruption order is more variable in afrotherians and xenarthrans than in other groups. Our results show that in addition to afrotherians and diphyodont xenarthrans, late eruption of adult teeth is common among terrestrial artiodactyls and perissodactyls, and characterizes some feliforms and lemurids. In contrast, our sample of marsupials, erinaceids, caniforms, basal feliforms, scandentians, and most primates show extensive overlap between their period of growth and the eruption of most permanent cheek teeth, suggesting that these taxa erupt their permanent dentitions earlier in ontogeny than afrotherians and armadillos. Furthermore, we discuss material of Eocene afrotherians, including proboscideans at adult body size with few or no fully erupted, permanent cheek teeth. Mapped onto recent phylogenies of mammals, "late eruption" optimizes as an afrotherian, possibly atlantogenatan, synapomorphy despite homoplasy elsewhere in the mammalian tree of life. Finally, our results indicate that chrysochlorids (Afrotheria) are among the only mammals to deviate from early eruption at the first molar locus. Perhaps relatedly, afrotherians and xenarthrans show relatively high variation in eruption order across cheek tooth loci. We conclude that dental ontogeny is less constrained in both afrotherians and xenarthrans compared to other mammals, and may result from their shared ancestry.

Technical Session XIII (Friday, October 19, 2:45 pm)

EXTRINSIC AND INTRINSIC FACTORS IN THE EVOLUTION AND EXTINCTION OF NORTH AMERICAN FOSSIL PRIMATES

ATWATER, Amy L., University of Oregon Clark Honors College, Eugene, OR, United States; HOLROYD, Patricia A., University of California Museum of Paleontology, Berkeley, CA, United States; DAVIS, Edward B., Department of Geological Sciences and Museum of Natural and Cultural History University of Oregon, Eugene, OR, United States

The North American Eocene fossil record has unequaled preservation of the diversification of early mammal groups as well as the extinction of many lineages through a period of climatic changes that include fluctuations in temperature and precipitation. Early primates are a particularly well-understood group, and we focused on omomyid primates, whose evolutionary history is well documented in the context of regional climate change and that have been characterized dietarily. Our study investigates possible drivers of omomyid evolution and extinction in North America, documenting the different evolutionary trajectories of different omomyid clades and the role of changing body mass in differential diversification rates. As a proxy for body mass, we gathered measurements of lower m1 area from more than 750 specimens representing 28 genera and 51 species that range from earliest Eocene to late middle Eocene in age. We then analyzed these data in a phylogenetic framework to assess the relative importance of the different potential drivers of body mass evolution, and using differences in geologic age as an alternative to branch length in reconstructing ancestral body mass. Our results indicate that multiple factors, including interniche competition, climate change, and ecosystem evolution, affected the diversification and extinction of these primates in the Paleogene. Our study highlights the importance of understanding and considering both intrinsic and extrinsic factors in developing models for diversification and extinction. The details of omomyid extinction can be used to inform a model for primate extinction, which should help conservation efforts for extant organisms that share similar ecological niche spaces with Eocene primates.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

DENTAL WEAR AND FEEDING ECOLOGY IN NORTH AMERICAN LATE MIOCENE RHINOCEROTIDAE, *APHELOPS* AND *TELEOCERAS*

AYOUB, Michael, New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States; MIHLBACHLER, Matthew C., New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States

Rhinos have varied ecomorphologies and feeding ecologies but no living species have geographically overlapping distributions. The fossil record offers the only opportunities to study the comparative paleoecology of sympatric rhinos. Two rhinos, *Teleoceras* and *Aphelops*, were abundant megafauna in the North American Miocene. They co-occur in many localities and have distinctly different ecomorphologies, with *Teleoceras* more closely resembling a grazer and *Aphelops* a browser. We examined rhino dentitions (N=158) from late Miocene Mixson and Love Bone Beds, Florida, and the Long Island Rhino Quarry, Kansas, using mesowear and dental microwear analysis. For comparison, extant browsing (*Diceros*) and grazing (*Ceratotherium*) African rhinos (N=101) were examined.

Grazer microwear commonly differs from browser microwear by excessive numbers of microscratches, possibly due to higher concentrations of abrasive particles (phytoliths, sand) ingested by grazers. However, browsing and grazing extant rhinos have similar scratch and pit frequencies, suggesting that the relationship of dental microwear and diet are not simple. *Diceros* and *Ceratotherium* microwear differs most dramatically in the degree of intratooth heterogeneity. *Diceros* molars exhibit a lower scratch/pit ratio on the ectoloph than the protocone. *Ceratotherium* intratooth microwear distribution is more homogenous. In living and extinct rhinos, high labial scratch/pit ratios accompany blunt low-relief cusps (*Ceratotherium*) and low labial scratch/pit ratios accompany sharper and higher-relief cusps (*Diceros*).

Aphelops and *Teleoceras* dental wear patterns are consistent with low-abrasion diets. *Teleoceras* and *Aphelops* have higher degrees of intratooth microwear heterogeneity than extant rhinos, with very low labial scratch/pit ratios. Likewise, both fossil rhinos have sharper, higher relief cusps than *Diceros* and *Ceratotherium*. *Teleoceras* and *Aphelops* microwear patterns are broadly similar to each other and when multiple localities are compared, the minor differences between *Aphelops* and *Teleoceras* microwear are stochastic and possibly represent differences between localized habitats rather than systematic differences in dietary preference. The shortened limb proportions of *Teleoceras* have occasionally been interpreted as a short grass grazing adaptation. Stable isotopes suggest that *Teleoceras* consumed some grass, while *Aphelops* did not, although dental microwear does not suggest major differences in dietary abrasion among the paleopopulations investigated. Dental wear seems to contradict the hypothesis that *Teleoceras* was a short-grass specialist. Evidently, the feeding ecologies of both fossil species were non-analogous to extant browsing and grazing African rhinos.

Technical Session VIII (Thursday, October 18, 2:15 pm)

DIVERSITY DYNAMICS OF MAMMALS IN RELATION TO LANDSCAPE HISTORY FOR THREE NEOGENE RECORDS FROM NORTH AMERICA

BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States; FINARELLI, John A., University College Dublin, Dublin, Ireland

Here we evaluate the hypothesis that changes in landscape history that increase topographic complexity promote diversification of mammals at the regional scale. Tectonic uplift or erosion can increase topographic complexity, decreasing the physiographic continuity of bioclimatic zones, promoting fragmentation of species' geographic ranges, and increasing elevational gradients. Global climatic changes can magnify or reduce these landscape gradients. Regional topographic heterogeneity, compared to nearby topographically homogeneous regions, supports high species diversity today for mammals and many

other groups. This biogeographic pattern can be explained through either greater rates of diversification or greater species accommodation in topographically complex regions.

We compared Neogene diversification of rodents for three regions in North America. The Columbia Basin of the Pacific Northwest and the northern Rocky Mountains were tectonically active over much of the Cenozoic and feature high topographic complexity today. The northern Great Plains have been tectonically quiescent with low relief over the Cenozoic. These three regions have distinctive geologic histories and substantial, well-documented fossil records. All three regions showed significant changes in diversity and faunal composition over the Neogene. Rodent faunas from the three regions differed in composition almost completely at the species level, although most families and many genera were shared among the regions, indicating greater provincialism than in modern faunas. In the two montane regions, originations and extinctions peaked at the onset and close, respectively, of the Miocene Climatic Optimum (17-14 Ma), with significant changes in faunal composition accompanying these episodes of diversification. In the Great Plains, rodents showed considerable turnover, but infrequent diversification (i.e., significant change in species diversity). The highest Neogene diversity occurred during the cooling that succeeded the Miocene Climatic Optimum. These histories suggest that climatic changes interacting with topographic complexity intensify macroevolutionary processes. Moreover, the middle Miocene and modern elevational diversity gradients appear to be unusual biogeographic configurations for the Neogene, suggesting caution in inferring past ecogeographic patterns from modern distributions.

Technical Session XVII (Saturday, October 20, 2:30 pm)

THE ORIGIN OF THE AVIAN BRAIN BASED ON A VOLUMETRIC ANALYSIS OF ENDOCRANIAL EVOLUTION WITHIN COELUROSAURIA

BALANOFF, Amy M., American Museum of Natural History, New York, NY, United States; BEVER, Gabriel S., New York College of Osteopathic Medicine, Old Westbury, NY, United States; ROWE, Timothy B., The University of Texas at Austin, Austin, TX, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States

It has long been thought that, relative to other living reptiles, a distinct increase in endocranial volume diagnoses crown group birds. The common conclusion is that this volumetric jump is tied, at least in part, to the formidable coordination and cognitive requirements of avian powered flight. The intricacies of what may be a dynamic and complex transformational pattern, however, are poorly understood and cannot be established without dense and detailed sampling of the phylogenetically long avian stem. We undertook this task by concentrating on volumetric patterns of endocranial change within Coelurosauria, especially in the relatively narrow portion of the tree bracketing the origin of avian flight. Our novel approach uses high-resolution computed tomography to divide the endocranial cavity into homologous neuroanatomical partitions. These partitions correspond closely to the major regions of the brain, including the olfactory bulbs, cerebrum, optic lobes, cerebellum, and brain stem. Using a recent hypothesis of coelurosaurian relationships we inferred patterns of volumetric change, not only with regards to how these individual partitions are transforming relative to body size but relative to each other. This greatly expands on previous attempts whose scope was limited either to total endocranial volume or at most two regional partitions (cerebrum and non-cerebrum).

Our results confirm previous findings that total endocranial volume relative to body size does increase dramatically along the coelurosaurian backbone of the avian stem. We also found that this trend is driven primarily by at least three phases of cerebral volumetric expansion, none of which coincide with a phylogenetic position typically associated with the origin of avian flight. When the fossil record is considered, a volumetrically avialan brain is not readily apparent because *Archaeopteryx*-level endocranial volumes were established at a much earlier phylogenetic position—a pattern congruent with a host of other character complexes historically identified with birds (e.g., feathers, furcula). The acquisition of a "flight-ready" brain at a more inclusive position on the tree is congruent with the possibility that other non-avialan paravians may have been capable of some type of volant activity.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DIETARY BEHAVIOR AND RESOURCE PARTITIONING AMONG LARGE CARNIVORANS OF LATE PLEISTOCENE RANCHO LA BREA

BALISI, Mairin, University of California, Los Angeles, Los Angeles, CA, United States; BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States

The processing of food causes distinct patterns of microscopic wear on tooth enamel, patterns that represent indirect evidence of tooth use and diet. We examined dental microwear features of seven species of carnivorans from the late Pleistocene asphalt seeps at Rancho La Brea (Los Angeles, California, United States) to infer dietary resource use in the large-carnivoran assemblage. For a comparative database, we documented microwear features for seven species of extant North American carnivorans in order to characterize microwear differences among five dietary categories: hypercarnivore + bone, hypercarnivore, carnivore, omnivore, and herbivore/omnivore. Counts of total scratches, total pits, coarse scratches, fine scratches, large pits, small pits, and gouges were documented on light-microscopy photomicrographs of the anterior shearing facet of the lower first molar (carnassial). Length and direction of scratches were also recorded for the modern species. Among modern carnivorans, greater densities of microwear features, as well as greater length and consistent directionality of scratches, characterized more carnivorous versus more omnivorous diets. Among the Rancho La Brea carnivorans, *Smilodon fatalis*, the saber-tooth cat, was distinct in having a markedly low density of all features; *Panthera atrox*, the American lion, exhibited a high density of all features; and the remaining carnivorans clustered together in the intermediate range for most microwear variables. Discriminant analysis based on microwear variables of modern species classified *Smilodon*; the short-faced bear, *Arctodus simus*; the coyote, *Canis latrans*; the gray wolf, *Canis lupus*; and the cougar, *Puma concolor*, as omnivores. Like modern omnivores, these five Rancho La Brea carnivorans had more gouges and fewer fine scratches, large pits, and small pits. This surprising result may be the effect of the small size of the comparative database or an indication that the diet of the large carnivorans of Rancho La Brea, because of this locality's unique faunal composition and taphonomy, is not well described by the dental microwear of modern analogs.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

VARIATION WITHIN MODERN CHINCHILLID POPULATIONS AND IMPLICATIONS FOR TAXONOMY OF FOSSIL POPULATIONS

BAMBA, Kanvaly, Case Western Reserve University, Cleveland, OH, United States; CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States

Chinchillids (Family Chinchillidae) were among the earliest caviomorph rodents to differentiate in South America, dating back to at least the early Oligocene. Their present distribution is across the Andean and sub-Andean aspects of Argentina, Bolivia, Chile, Peru, Ecuador, and Paraguay. These generalist herbivores have a strong association with dry, high elevation environments. They appear in the Tinguiririan and Deseadan South American Land Mammal Ages (Oligocene) but are a major constituent of most Miocene and younger localities in the southern two-thirds of the continent. These rodents can be recognized in the fossil record by their hypselodont cheek teeth organized into transverse laminae. Identifying genera and species has proven more difficult as it is unclear which criteria are most useful for distinguishing genera and species. Today, only three genera and six (possibly more) species remain. Assessing morphological variation that distinguishes these species should provide a more robust way to distinguish extinct species. The goal of this study is to use variation in modern chinchillids to clarify the taxonomic identities of chinchillids at Quebrada Honda, Bolivia and other middle Miocene localities.

Seventy-nine modern chinchillid specimens from all three genera, five species and eight subspecies were examined. Several cranial characters were found to be useful in distinguishing genera: the size of the auditory bullae (enlarged in *Chinchilla*), shape of the external nares (consistently and strongly flared in Lagidium, occasionally and slightly flared in *Lagostomus*) and rostrum length (longer in *Lagidium* than *Chinchilla*). Useful dental characters were the number of laminae per cheek tooth (three for *Chinchilla* and *Lagidium*, two for *Lagostomus* save M3) and the morphology of the laminae. *Lagostomus* has rectangular-oval shaped laminae; the laminae of *Lagidium* are curved with especially large posterior laminae; laminae fusion is common in *Chinchilla* – the anterior two laminae of p4 express this consistently. Data suggest that the angle of the upper and lower tooth rows relative to the sagittal plane and relative tooth sizes may also be useful distinguishing characters. Among *Lagidium* species, variation was most evident in relative sizes of the posterior laminae (larger in *L. peruanum* than *L. viscacia*), morphology of the glabella (always flat in *L. peruanum*, often depressed in *L. viscacia*), and morphology of the supraorbital and nearby processes; *Lagidium* often has processes along the superior margin of the infraorbital foramen. Supraorbital processes are pronounced in *L. viscacia cuvieri* and *L. viscacia tucumanum* but reduced in *L. viscacia viscacia* and *L. viscacia famatina*.

Romer Prize Session (Thursday, October 18, 8:00 am)

LOCAL ENVIRONMENTAL CONDITIONS DROVE VERTEBRATE DIVERSITY IMMEDIATELY PRIOR TO THE K/PG EXTINCTION: EVIDENCE FROM CENTRAL CANADA

BAMFORTH, Emily L., McGill University, Montreal, QB, Canada

The causes and timing of the Cretaceous mass extinction have been the subject of much debate for decades. Preservational, geographic and taphonomic biases render trends in biodiversity difficult to assess, and complicate the coupling of these trends with abiotic drivers. Here a multidisciplinary approach is used to elucidate spatial and temporal relationships between vertebrate diversity and paleoenvironment during the last 300,000 years of the Cretaceous period. Stratigraphic surveys of the latest Maastrichtian (65.5Ma) Frenchman Formation in Grasslands National Park, SK, Canada reveal three distinct, successive depositional cycles. Each cycle is considered a 'time slice' across which vertebrate diversity and paleoclimate signals can be assessed. From these time slices, some 8,000 fossils from twenty-eight vertebrate microsites were collected. A further 7,000 fossils were collected from nine microsites near Eastend, SK (ca. 200km west) for use in spatial diversity analysis. Fossils were identified and catalogued, and this data was used to calculate abundance-based diversity metrics. Paleotemperature fluctuations were determined using stable $\delta^{18}O$ isotope data, while paleoclimate data was estimated from plant macrofossil assemblages. Vertebrate diversity was found to be highest in the oldest time slice. Diversity declined sharply in the middle time slice, then recovered to a second peak at the base of the youngest time slice, 10m below the K/Pg Boundary. Following this peak, there was a marked decrease in diversity towards the boundary. Sites with the highest diversity were often found in mudstones, associated with paleoenvironmental indicators such as fossil leaf impressions, charcoal deposits and desiccation horizons. Analyses of isotope data linking temperature fluctuations to the peaks in diversity are as of yet inconclusive. Spatially, the Eastend sites had consistently higher diversity than contemporaneous Grasslands sites. These results demonstrate that biodiversity does not show a consistent decreasing trend towards the K/Pg

Boundary, but suggests spatial and temporal differences were driven primarily by local scale (<200km) environmental conditions.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:45 am)

TIME-SCALING TREES IN THE FOSSIL RECORD
BAPST, David W., University of Chicago, Chicago, IL, United States

As phylogenetic approaches to paleobiology become increasingly common, it is necessary that we consider the impact of our choice of methodologies on results. The temporal scaling of paleontological cladograms is a critical step in applying tree-based analyses of trait evolution and diversity. There are several routines that have been applied previously to time-scale phylogenetic branches but there has been no synthetic work comparing these methods. I present a new sampling rate conditioned method for time-scaling trees which uses an estimated sampling rate to create random samples of time-scaled trees, in order to bracket the uncertainty in branching times for a given set of taxa. This method can also consider possible ancestor-descendant relationships and resolve polytomies with better accuracy than random. This method is included in the software package 'paleotree' for the open computing language R, along with an extensive toolbox for simulating diversification in the fossil record. Using these simulations to model realistic paleontological datasets, I tested how the choice of time-scaling methods affected the fidelity of various phylogeny-based analyses of macroevolution. To summarize, sampling-rate conditioned method performed best for estimating the rate of continuous trait evolution and had similar performance as other methods for fitting models of trait evolution. Estimates of phylogenetic signal had poor fidelity for all time-scaling methods. For estimating lineage richness, the time-scaling method with the most fidelity depended on the question being addressed.

Technical Session XIX (Saturday, October 20, 4:00 pm)

PRELUDE TO THE ANTHROPOCENE: TWO NEWLY-DEFINED NORTH AMERICAN LAND-MAMMAL AGES
BARNOSKY, Anthony D., University of California, Berkeley, CA, United States; IB286 WORKING GROUP, University of California, Berkeley, CA, United States

We propose criteria to recognize two new North American Land-Mammal Ages (NALMAs). Our goal is to clearly characterize (for North America) the progression of anthropogenically-driven biotic transitions that lead into the Anthropocene. By way of background, "Anthropocene" is an informal term now widely used to identify the period of Earth history that begins when *Homo sapiens* become a geological-scale force for planetary change. Discussions are underway about whether to formally recognize the Anthropocene as a new geological epoch, the beginning of which would be placed sometime between 1750 and 1950 A.D., depending on the particular criteria agreed upon. However, dramatic pre-18th century human influences on the global ecosystem also are clearly visible in the paleontological record as faunal changes associated with anthropogenically-driven dispersal events. On the global scale these are diachronous, spanning tens of thousands of years, and correspond with dispersal of *Homo sapiens* from Africa to Eurasia and Australia, and finally to the Americas. On continental scales, the dispersals and their results appear geologically rapid. For pre-Holocene time, events of similar magnitude and character are used to define biochronologic units known as the Land-Mammal Ages (LMAs), which are continent-specific. We therefore suggest the LMA concept offers a viable way to distinguish and highlight the important, step-wise episodes of human-induced ecological change that are otherwise hidden by a simple Pleistocene-Holocene-Anthropocene division. We illustrate this by presenting paleontological evidence that can define two post-Rancholabrean NALMAs. The older one, informally referred to as the "Santarosaean," would be defined by the earliest appearance of *Homo sapiens* in North America south of 55^{o}N, and would also define the end of the Rancholabrean (which currently has an ambiguous end-point). Lasting from ~14,000 years ago to ~1565 A.D., the "Santarosaean" can be divided into early and late phases, the former being characterized by co-existence of *Homo sapiens* and extinct Pleistocene megafauna, the latter by lack of both Pleistocene megafauna and non-native domestic mammals. The "Santarosaean" would end with the earliest appearance of domestic *Equus ferus caballus*, which would also define the beginning of the youngest NALMA, informally referred to as the "Saintaugustinean" and characterized by widespread occurrence of imported domestic species such as *Sus scrofa*, *Bos taurus, Ovis aries,* and *Capra hircus*. The LMA concept can be independently applied to characterize different sequences of change (both taxonomic and temporal) that lead up to the Anthropocene on other continents, although we do not do so here.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 8:00 am)

A NEW ORNITHISCHIAN DINOSAUR FROM THE VENEZUELAN ANDES
BARRETT, Paul M., The Natural History Museum, London, United Kingdom; BUTLER, Richard J., Ludwig Maximilian University, Munich, Germany; IRMIS, Randall B., Utah Museum of Natural History, Salt Lake City, UT, United States; SCHEYER, Torsten M., Paläontologisches Institut und Museum, Zurich, Switzerland; SÁNCHEZ-VILLAGRA, Marcelo R., Paläontologisches Institut und Museum, Zurich, Switzerland

Low paleolatitude dinosaur assemblages are relatively rare, especially in northern Gondwana, and localities in these areas have the potential to offer critical new biogeographic information as well as the opportunity of yielding new taxa. The La Quinta Formation crops out in the Venezuelan Andes and yields a significant, but so far briefly described, northern South American dinosaur assemblage. Determining the age of the La Quinta Formation has been problematic, however, with biostratigraphic correlations based on palynomorphs and plant macrofossils suggesting deposition of this unit sometime during the Late Triassic–Middle Jurassic. We report previously undescribed cranial and postcranial material from a bonebed within this unit that indicates the presence of a small, primitive ornithischian dinosaur. With the exception of rare shed theropod teeth and several possible theropod postcranial elements, all other material from this locality bears ornithischian synapomorphies or is otherwise consistent with attribution to a single taxon from this clade. Many elements are represented by multiple examples (e.g., scapulae, femora) and they display little variation, further supporting the hypothesis that only one ornithischian taxon is present. Consequently, this site represents the earliest-known monodominant ornithischian bonebed. We recognize this material as a new taxon that can be diagnosed on the basis of its unusual dental morphology, and features of the maxilla and astragalus. The taxon lacks cerapodan synapomorphies and possesses similarities to *Lesothosaurus* and heterodontosaurids, suggesting that it is a very basal ornithischian. The unspecialised anatomy of this new taxon provides some circumstantial support for a Late Triassic–Early Jurassic age for the La Quinta Formation. The bone histology of several specimens was also analysed, revealing well-vascularised, parallel-fibred bone tissue in all samples. Based on the size ranges of the specimens and the presence of lines of arrested growth, one individual was determined to be a juvenile, another a skeletally mature adult, and the remaining samples as belonging to still growing subadult animals. Through ontogeny the long bone samples showed that the overall longitudinal canal arrangement changes towards a reticular pattern dominated by laminar organization. True fibrolamellar bone was not present in any element.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

CHARACTERIZATION OF UNGULATE BUCCAL CUSP SHAPE USING OUTLINE-BASED GEOMETRIC MORPHOMETRICS AND ITS IMPLICATION FOR MESOWEAR ANALYSES
BARRÓN-ORTIZ, Christian R., University of Calgary, Calgary, AB, Canada; RANKIN, Brian D., University of Calgary, Calgary, AB, Canada; THEODOR, Jessica M., University of Calgary, Calgary, AB, Canada

The conventional mesowear method permits the reconstruction of ungulate diets based on the analysis of the buccal cusps of the second upper molars. The variables considered in the original application of the method included the degree of relief of the cusps, high or low, and cusp shape which can be scored as sharp, round, or blunt. Despite the successful application of the mesowear method to different ungulate taxa, scoring of the mesowear variables can be subjective, and in many instances intra- and inter-observer error can be a concern. Moreover, cusp apices are assigned to categories along a continuum and, thus, important information regarding cusp shape can be lost (e.g., slightly rounded cusps are not distinguished from more rounded cusps). In this study, we investigated the application of outline-based geometric morphometric methods to better characterize ungulate buccal cusp shape. A sample of 23 extant ungulate species (seven grazers, eight mixed-feeders, and eight browsers) was analyzed. This reference sample was then utilized to infer the diet of the latest Eocene (middle Chadronian) leptomerycid artiodactyls of the Calf Creek local fauna, Cypress Hills Formation, Saskatchewan, Canada (*Hendryomeryx esulcatus*, *"Leptomeryx" speciosus*, and *"Leptomeryx" mammifer)*. For each specimen, two landmarks, defining the extremes of the cusp, and a series of sliding-semilandmarks along the cusp outline were digitized. Average cusp shape for every species was calculated and relative warps and discriminant function analyses conducted. The first relative warp explains over 80 % of the variation and corresponds to change in cusp height, whereas the second relative warp describes change in cusp shape and accounts for over 10 % of the variation. Discriminant function analysis using the relative warp scores showed an overall correct classification of 89 % for the extant ungulates; in contrast, using the original mesowear variables, the overall correct classification of the same species was 79 %. The three leptomerycids were classified as browsers and a multivariate analysis of variance identified significant differences between *H. esulcatus* and *"L." speciosus*, with the former showing lower and rounder cusps. The refined mesowear analysis presented here documents a consistent, less subjective method to describe cusp shape. Further expansion of the extant ungulate dataset will provide finer dietary classifications.

Technical Session IV (Wednesday, October 17, 3:45 pm)

A CLADISTIC APPROACH TO UNDERSTANDING DINOSAUR EGG DIVERSITY AND THE EVOLUTION OF REPRODUCTIVE TRAITS WITHIN DINOSAURIA: PRELIMINARY RESULTS
BARTA, Daniel E., Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; JACKSON, Frankie D., Montana State University, Bozeman, MT, United States

Only a small percentage of fossil eggs contain identifiable embryonic remains. Consequently, knowledge of eggshell structure and reproductive strategies remains incomplete for many dinosaur clades. Most previous cladistic analyses of dinosaur eggs and eggshell focus on dinosaur egg types (ootaxa) with identified embryos with the goal of understanding the evolution of avian reproductive traits. In order to better assess the evolution of egg, eggshell, and reproductive attributes across all dinosaurs and to assess the apparent temporal and phylogenetic bias in dinosaur eggshell preservation, we undertook a comprehensive cladistic analysis of representatives of each major dinosaur oofamily. Using

two turtles as an outgroup, analysis produced a phylogeny with Megaloolithidae recovered as the basal-most dinosaur oofamily. Spheroolithidae and a polytomy of Dendroolithidae and Faveoloolithidae (with or without Dictyoolithidae, depending on the level of consensus examined) are recovered more inclusively within the dinosaur clade. Strong support exists in consensus trees for a clade of derived maniraptorans, including modern avians, within the dinosaur clade.

In this study, as in past efforts, cladistic analysis of eggshell remains complicated by a limited number of characters and extensive homoplasy between some ootaxa. For example, the polytomy of Faveoloolithidae through Dendroolithidae contains eggs variously assigned to sauropods (Faveoloolithidae), therizinosauroids (Dendroolithidae), and theropods (Dictyoolithidae) by previous authors. Homoplasy or the expression of shared ancestral dinosaurian eggshell features may account for the consistent recovery of this clade in consensus trees in this study. The grouping of hadrosaur eggshell (Spheroolithidae) with that of saurischians also suggests homoplasy or the expression of dinosaurian symplesiomorphies. Independent evolution of hard-shelled eggs within hadrosaurs could potentially explain the long absence of identified ornithischian eggshell in the Mesozoic fossil record, though taphonomic bias should temper this interpretation. The topology of the derived maniraptoran and extant avian eggshell clade broadly concurs with existing phylogenies based on skeletal data.

This study highlights possible convergences in egg and eggshell microstructural characters that complicate taxonomic assignments of ootaxa that remain unidentified on the basis of embryonic remains. The phylogeny presented here provides additional support for the initial evolution of some avian reproductive traits within derived maniraptorans, but demonstrates that relationships among ootaxa outside this clade remain difficult to resolve as they conflict with established phylogenies based on skeletal characters.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

SCAPHOLUNATUM, OR SCAPHOID AND LUNATUM. THAT IS THE QUESTION. THE CASE OF *HYAENODON*

BASTL, Katharina, Institut für Paläontologie, Vienna, Austria; NAGEL, Doris, Institut für Paläontologie, Vienna, Austria

The most obvious structural feature in the manus of Carnivora is the scapholunatum, which is not present in other Eocene/Oligocene predators (e.g. hyaenodontids): in those forms the carpals stay separate as scaphoid and lunatum. This unfused state is present in North American *Hyaenodon*. Interestingly, this observation was contradicted in the early literature with a description of a scapholunatum in European *Hyaenodon*. In order to address the question of whether this dramatic difference exists, the European skeletal material was reviewed. The study focused on a specimen from the late Eocene locality La Débruge (France) on which the statement was based. The morphology of the metapodials (broad, short and diverging), the terminal phalanx (not split) as well as the distal articulation facet of the scapholunatum (ursid-like) indicate that the specimen belongs to Carnivora and certainly not to *Hyaenodon*. Additionally, the carnivore *Cynodictis* is found in the same locality. Further material attributed to *Hyaenodon* and identified as scapholunatum could not be confirmed concerning their classification concerning the taxon and the element. Up to now, no carpus of a European *Hyaenodon* is known, but based on the distal radial facet, it should have articulated with a scaphoid and a lunatum as in North American taxa. Misidentifications lead to an enigmatic divergence that can now be refuted.

Technical Session XIII (Friday, October 19, 4:00 pm)

THE COLONIZATION OF AFRICA BY EARLY CENOZOIC ANTHROPOID PRIMATES: NEW DATA FROM THE EOCENE PONDAUNG FORMATION OF MYANMAR

BEARD, K. C., Carnegie Museum of Natural History, Pittsburgh, PA, United States; CHAIMANEE, Yaowalak, Universite de Poitiers, Poitiers, France; CHAVASSEAU, Olivier, Universite de Poitiers, Poitiers, France; LAZZARI, Vincent, Universite de Poitiers, Poitiers, France; JAEGER, Jean-Jacques, Universite de Poitiers, Poitiers, France

Reconstructing the origin and early evolutionary history of Anthropoidea is a current focus of primate paleontology. Although classical hypotheses have typically supported an African origin for the anthropoid clade, the more recent discovery of basal members of the anthropoid clade in China and Myanmar suggests that the group originated in Asia. The latter result agrees with the recorded distribution of Tarsiiformes, the sister group of Anthropoidea. Given the Oligocene-Recent history of African anthropoids, the colonization of Africa by early anthropoids hailing from Asia was a decisive event in primate evolution. However, the fossil record has previously failed to constrain the nature and timing of this pivotal event. Recent fieldwork in the late middle Eocene Pondaung Formation of Myanmar has yielded a new basal anthropoid that is remarkably similar to, yet dentally more primitive than, the roughly contemporaneous North African anthropoid *Afrotarsius*. Phylogenetic analysis suggests that the new Burmese taxon and *Afrotarsius* are sister taxa within a basal anthropoid clade that also includes *Eosimias*, *Bahinia* and *Phenacopithecus*. Current knowledge of phylogenetic relationships within this basal anthropoid clade and its distribution through space and time suggest that close relatives of *Afrotarsius* dispersed from Asia to Africa sometime during the middle Eocene, shortly before *Afrotarsius* first appears in the African fossil record. Crown anthropoids and their nearest fossil relatives do not appear to be specially related to *Afrotarsius*, suggesting that Africa was colonized by two or more Asian anthropoid clades during the latter part of the Eocene. A similar phylogenetic and biogeographic pattern appears to characterize early hystricognathous rodents, suggesting the possibility of a common, nonrandom mechanism of dispersal across Tethys at that time.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

CAN THE PALAEOECOLOGY OF REPTILE FOSSILS BE INFERRED FROM TAPHONOMY?

BEARDMORE, Susan R., University College Dublin, Dublin, Ireland; ORR, Patrick, University College Dublin, Dublin, Ireland; MANZOCCHI, Tom, University College Dublin, Dublin, Ireland; FURRER, Heinz, Paläontologisches Institut und Museum der Universität Zürich, Zurich, Switzerland

The palaeoecology of the Middle Triassic 'giraffe neck' protorosaur *Tanystropheus* is unresolved. It has been considered as either a terrestrial or aquatic taxon. Discussions centre on the biomechanical capabilities of the unusually long neck, short limbs and barrel-shaped body on land and in water but there has been little consideration of whether other sources of data could provide insight.

The possibility that the palaeoecology of *Tanystropheus*, and fossil vertebrates more generally, can be inferred from their taphonomy is investigated using a new method. In summary, the vertebrate skeleton is divided into nine anatomical units, each scored for two variables (articulation and completeness). Patterns exhibited by the data, coupled with various statistical analyses, allow the extent of disarticulation and loss of completeness to be quantified; this in turn can be related to processes in the taphonomic pathway in the interval between death and final burial.

The method was used to compare preservation of *Tanystropheus* from the Middle Triassic Besano Formation, with two coeval taxa, the life habits of which are considered resolved: the pachypleurosaurid *Serpianosaurus* (aquatic) and the protorosaur *Macrocnemus* (terrestrial). Two null hypotheses are tested: that the taphonomy of *Serpianosaurus* and *Macrocnemus* is different; the taphonomy of *Tanystropheus* is more similar to that of either *Serpianosaurus* or *Macrocnemus* implying the most likley ecological niche for *Tanystropheus*.

Serpianosaurus exhibits high completeness and moderate articulation. In contrast, *Macrocnemus* and *Tanystropheus* are characterized by high completeness but low articulation. The main cause of this variation was the initial decay that occurred during the extended period of floating experienced by the *Tanystropheus* and *Macrocnemus*, relative to *Serpianosaurus*; this resulted in greater disarticulation on impact at the sediment surface and an enhanced rate of disarticulation subsequently. The patterns of articulation and completeness suggest that *Serpianosaurus* alone lived in an open marine setting.

Technical Session XVI (Saturday, October 20, 8:15 am)

COMPARISONS OF LIGHT MICROSCOPY-BASED DENTAL MICROWEAR AND DENTAL MICROWEAR TEXTURE ANALYSIS: IMPLICATIONS FOR TESTING HYPOTHESES OF FEEDING ECOLOGY IN EXTINCT VERTEBRATES

BEATTY, Brian L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; MIHLBACHLER, Matthew C., New York College of Osteopathic Medicine, Old Westbury, NY, United States

Dental microwear is increasingly used to test hypotheses about feeding ecology, yet too little is understood about the causal nature of observed dental wear features (e.g. pits and scratches). Tooth wear is an accumulation of many small contact events on a three dimensional surface in which size, shape, hardness and fracture toughness of dental materials and introduced abrasives are all important. Such damage is constantly being overprinted and is subject to chemical erosion and differences in enamel microstructure. Awareness of these variables is important to determining how one might best visualize discrete contact events and light microscopy dental microwear (LDM) and dental microwear texture analysis (DMTA) "see" these variables in non-analogous ways.

LDM records data on discrete contact events that result in the formation of microwear features. Such features can be easily distinguished from wear due to chemical erosion and other aspects of occlusal relief caused by enamel microstructure, such as vertical Hunter-Schreger bands. Although DMTA is less prone to observer error due to the inconsistencies of microwear feature identification during LDM, DMTA doesn't recognize discrete microwear features and cannot yet distinguish microwear features from other effects, such as erosive wear and enamel microstructure effects. Although we anticipate these limitations may be surmountable in the future, care needs to be taken when employing DMTA to avoid these possible confounding variables.

To further compare the ability of LDM and DMTA in discriminating the feeding ecology of ungulates, we collected microwear data from the same tooth regions of the same fifteen specimens from four species with different feeding ecologies (*Equus, Alces, Giraffa,* and *Diceros*). DMTA analysis of the same teeth was done using a white light confocal microscope at the University of Arkansas, with variables of anisotropy, complexity, scale of maximum complexity, textural fill volume, and heterogeneity. When DMTA variables of anisotropy and complexity are compared to LDM variables pits and scratches, we find that LDM, although prone to higher rates of observer error, is more successful at discriminating animals of different feeding ecologies. More data are needed using both methods to better assess how useful they are in discriminating ungulate ecology and that of other vertebrate groups. Despite the data suggesting that LDM would more effectively discriminate ungulate diets, both methods measure the same surface in non-analogous ways, making a combination

of both methods more likely leading to robust results and more insightful interpretations of feeding ecology.

Technical Session V (Wednesday, October 17, 3:00 pm)

FIRST EVIDENCE OF REMINGTONOCETIDAE (MAMMALIA, CETACEA) OUTSIDE INDO-PAKISTAN: NEW GENUS FROM THE EARLY MIDDLE EOCENE OF EGYPT

BEBEJ, Ryan M., Calvin College, Grand Rapids, MI, United States; ZALMOUT, Iyad S., University of Michigan, Ann Arbor, MI, United States; ABED EL-AZIZ, Ahmed A., Egyptian Environmental Affairs Agency, Wadi Al-Hitan World Heritage Site, Fayum, Egypt; ANTAR, Mohammed Sameh M., Egyptian Environmental Affairs Agency, Wadi Al-Hitan World Heritage Site, Fayum, Egypt; GINGERICH, Philip D., University of Michigan, Ann Arbor, MI, United States

Remingtonocetids are semiaquatic archaeocete cetaceans known for their elongated narrow skulls, long necks, and robust pelves and hind limbs. The family currently includes five genera (*Attockicetus*, *Remingtonocetus*, *Dalanistes*, *Andrewsiphius*, and *Kutchicetus*), which are known principally from the middle-to-late Lutetian Domanda Formation of Pakistan and the late Lutetian Harudi Formation of India. Some specimens have been recovered from other formations; however, all previous occurrences have been restricted to the Lutetian of Indo-Pakistan. A new genus of remingtonocetid cetacean has been recovered from the late Lutetian Midawara Formation of Egypt. The specimen includes a left innominate with a complete ilium, ischium, and acetabulum; a nearly complete left femur; a four-vertebra sacrum; and partial lumbar and anterior caudal vertebrae. The long, broad ilium and near closure of the acetabular notch compare closely with the innominates of other remingtonocetids, though the ischium is much broader and flatter. The femur is generally similar in size and shape to known specimens of *Remingtonocetus*, but has a more vertically-oriented head and neck and a shaft with a more circular cross-section that lacks a conspicuous lateral keel. The sacrum is composed of four vertebrae, three of which are at least partially fused together as in other remingtonocetids, with very large dorsal sacral foramina. A well-preserved lumbar vertebra has curved zygapophyses, reniform epiphyses, and short transverse processes with only a modest degree of anterior or ventral inclination, comparing closely with lumbar vertebrae of *Remingtonocetus*. However, partial neural arches suggest that lumbar neural spines were inclined posteriorly rather than anteriorly. The new specimen increases the known taxonomic diversity of Remingtonocetidae, illustrates additional variation in the morphology and locomotor repertoire of the group, and provides the first evidence of the family in Africa.

Technical Session X (Friday, October 19, 8:30 am)

MORPHOLOGIC INDICATORS OF FOSSORIALITY AND THE EVOLUTION OF BURROWING IN DICYNODONTS (AMNIOTA: SYNAPSIDA)

BECK, Allison L., Augustana College, Rock Island, IL, United States; SCHECKEL, Jessica, Augustana College, Rock Island, IL, United States

Among the extinct ancestors of mammals, the Dicynodontia is a clade easily recognized by characteristic turtle-like beaks, toothless except for a pair of large tusks. Dicynodonts were an ecologically important group of herbivores with a distribution across the Permo-Triassic boundary. Evidence exists that some dicynodonts were burrowers; for example *Diictodon* has been found fossilized in burrows. Two highly specialized genera, *Cistcephalus* and *Kawingasaurus*, have skeletal morphologies very similar to that of modern moles, in that they have shortened but very robust humeri, with enlarged epicondyles and deltopectoral crests; thus they have been presumed to be fossorial, possibly even entirely subterranean. Despite the description of dicynodonts as generally fossorial by many workers, this assumption has yet to be rigorously tested. Here we test for the presence of morphological indicators of burrowing behavior in dicynodonts by using quantitatively identified osteological correlates of fossoriality in extant mammals, whose behavior is known. Understanding burrowing behavior in dicynodonts will give insight into the evolution of this unique group, as well as provide a model for examining the functional morphology of fossoriality in other vertebrate groups.

We collected linear measurements on the forelimb and hindlimb skeletons of 39 Permian to Triassic dicynodonts and 157 extant mammals spanning 15 orders. Extant mammals were binned into three categories: fossorial, subterranean or non-digging. Reduced major axis regression analyses indicate that fossorial taxa have more disparate hind- and forelimbs than nonfossorial taxa, and confirm that the humeral epicondyles and olecranon processes of fossorial taxa are relatively larger than those of non-diggers. Discriminant function analyses clearly distinguish between the three functional groups, demonstrating a morphologic continuum from the least to the most fossorial among extant taxa. The addition of dicynodonts to these analyses supports the prior notion that *Cistcephalus* and *Kawingasaurus* were at least fossorial, and *Cistecephalus* was likely subterranean. These analyses shed the most light on the behavior of the small to mid-sized dicynodonts, as the large Triassic forms fall well to the non-fossorial extreme of the limb shape space. Mapping inferred fossoriality into a phylogenetic context indicates that there was a single clade of specialized burrowing dicynodonts and that other burrowers, such as *Robertia*, were not closely related. Our results suggest that burrowing has evolved independently multiple times within dicynodonts. Understanding the distribution of burrowing in dicynodonts adds to our knowledge of the taxonomic and paleobiologic patterns of the critical end-Permian extinction.

Technical Session X (Friday, October 19, 12:00 pm)

A COMPREHENSIVE GENUS-LEVEL PHYLOGENY OF LIVING AND EXTINCT MARSUPIALS BASED ON CRANIODENTAL AND MOLECULAR DATA

BECK, Robin M., University of New South Wales, Sydney, Australia; VOSS, Robert S., Department of Mammalogy, American Museum of Natural History, New York, NY, United States; JANSA, Sharon A., Department of Ecology, Evolution, and Behavior, J.F. Bell Museum of Natural History, University of Minnesota, Saint Paul, MN, United States

Comprising approximately 6% of extant mammalian species, and with a rich fossil record, Marsupialia represents a diverse and successful mammalian clade. However, macroevolutionary studies of Marsupialia have been hampered by the absence of a well-resolved higher-level phylogeny that incorporates a wide sampling of living and fossil taxa. Here we present results of a comprehensive phylogenetic study of Marsupialia, based on a novel dataset comprising 180 craniodental characters (many of which are entirely new) and ~2kb of sequence data from two nuclear genes (IRBP and GHR). Our study includes representatives of every currently recognised Recent marsupial genus and also a broad sampling of fossil taxa, focusing on well-preserved plesiomorphic forms that are likely to be useful in resolving interordinal and deep intraordinal relationships by breaking up long branches, and using the stem-metatherians *Herpetotherium*, *Pucadelphys* and *Mayulestes* as outgroups. Collectively, this represents a >300% increase in taxon sampling over previous total evidence analyses of marsupial phylogeny. This project has led us to propose novel or revised interpretations of many aspects of marsupial craniodental morphology: for example, we conclude that the enlarged 'gliriform' lower incisor is plausibly homologous between paucituberculatans and diprotodontians, and that the labial cusps of the upper molars of most diprotodontians are stylar in origin. Maximum parsimony analysis of the morphological partition alone recovers monophyly of the currently recognised marsupial orders, but supraordinal relationships are weakly supported and some accepted clades (e.g. Australidelphia) are not recovered. However, analysis of the total evidence matrix results in a phylogeny that is highly congruent with recent molecular phylogenies at both the supraordinal and intraordinal levels, supporting monophyly of (*inter alia*) Australidelphia, Phalangerida, Australoplagiaulacoidea and Petauroidea. Novel results include placement of the fossil didelphimorphian *Sparassocynus* as a crown-group didelphid, placement of the fossil dasyuromorphian *Barinya* as a stem-thylacinid rather than stem-dasyurid, non-monophyly of Wynyardiidae, and support for *Ekaltadeta* as the 'basalmost' branch of Macropodoidea. However, the relationships of some marsupial taxa, such as the marsupial mole *Notoryctes* and the enigmatic fossil *Yalkaparidon*, remain uncertain. The position of microbiotherians within Australidelphia, which is crucial for understanding the biogeographical relationship between South American and Australian marsupials, and the location of the root were also not clearly resolved. Nevertheless, our study should provide a solid phylogenetic foundation for future macroevolutionary analyses of Marsupialia.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

TWO NEONATE MOSASAURS (SQUAMATA) FROM THE NIOBRARA FORMATION

BEHLKE, Adam D., Department of Geology and Geophysics, Yale University, New Haven, CT, United States; FIELD, Daniel J., Department of Geology and Geophysics, Yale University, New Haven, CT, United States

The Niobrara Formation of western Kansas represents one of the most famous mosasaur-bearing localities in the world. The relative abundance of mature mosasaurs compared to juveniles in the Niobrara Formation once led to the hypothesis that mosasaur birthing areas were located elsewhere. Although the discovery of numerous juvenile mosasaurs in the Niobrara Formation in the last several decades led to a revision of this hypothesis, neonate mosasaurs are still extremely rare. Here, we report the fragmentary cranial remains of two neonate mosasaurs from the Niobrara Formation, heretofore erroneously cataloged as avian fossils in the collections of the Yale Peabody Museum. One specimen is represented by an isolated partial left dentary, while the other consists of a partial left dentary, partial right palatine, and other cranial elements. Comparison with other neonate mosasaurs reveals that these specimens are amongst the smallest individuals ever found, and shed new light on western Kansas as a possible mosasaur birthing area.

Technical Session XIX (Saturday, October 20, 3:30 pm)

THE IMPACT OF MASS MORTALITY ON THE LAND SURFACE BONE ASSEMBLAGE OF AMBOSELI PARK, KENYA

BEHRENSMEYER, Anna K., Smithsonian Institution, Washington, DC, United States; WESTERN, David, African Conservation Center, Nairobi, Kenya; BADGLEY, Catherine, Museum of Paleontology, Ann Arbor, MI, United States; MILLER, Joshua H., Florida Museum of Natural History, Gainesville, FL, United States; ODOCK, Fredrick L., Kenya Wildlife Service, Kitale, Kenya

The partial collapse of the mammalian herbivore community in Amboseli National Park, Kenya, in 2009 provided an opportunity to compare catastrophic mortality with the attritional skeletal record previously documented in this ecosystem. Mass mortality occurred during a severe drought, when over 11,000 individuals (primarily grazers) died in a period of 8 months. Amboseli has large permanent springs and swamps, and herbivores died from starvation rather than thirst. Taphonomic surveys documented skeletal remains on 20 established transects. The number of drought deaths far exceeded the initial recycling capacity of local scavengers, mainly spotted hyena. In 2010, skeletons were relatively complete and scavenger impact was low, with characteristic patterns of damage to particular

skeletal parts. Drought-death carcasses occurred in all habitats and were concentrated near the swamps, but there were no piles of skeletons representing bonebed accumulations. Relatively few juveniles and many prime adults were recorded in the drought death bone sample, thus demographic profiles of affected species did not match the standard model for a standing crop (mass death) assemblage. Dentitions of the drought-affected species often had extreme wear in both adults and juveniles. Weathering-stage (WS) profiles of the bone assemblage show an increase in the number of individuals in WS 0-1 from the 2009 drought deaths. Grazing herbivores were somewhat more abundant in the least weathered portion of the overall surface assemblage. The time-averaged bone assemblage represents several decades of accumulation, and input from the 2009 carcass "pulse" increased the proportion of wildebeest but otherwise had minimal impact on relative abundances of the 15 most common herbivores. Unusual completeness of skeletons, low damage levels to individual bones, and extreme tooth wear were the clearest taphonomic indicators of the 2009 drought mortality. Whether or not this evidence would survive into the fossil record depends on the timing and nature of burial processes – rapid burial would preserve evidence for the mass mortality but these signals would decay with continued time-averaging.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MICROVERTEBRATE PALEOECOLOGY, WILDFIRES AND BIODIVERSITY OF COASTAL APPALACHIA IN THE CRETACEOUS (CENOMANIAN) WOODBINE FORMATION AT THE ARLINGTON ARCHOSAUR SITE, NORTH TEXAS

BENNETT, III, George E., Shenandoah Valley Discovery Museum, Winchester, VA, United States; MAIN, Derek J., University of Texas at Arlington, Arlington, TX, United States; NOTO, Christopher R., University of Wisconsin, Parkside, Kenosha, WI, United States; ANDERSON, B. K., University of Texas at Arlington, Arlington, TX, United States; VRANKEN, Nathan V., University of Texas at Arlington, Arlington, TX, United States

Mid-Cretaceous terrestrial vertebrate communities are poorly known in North America. The Arlington Archosaur Site (AAS) is a fossil site found in the mid-Cretaceous Woodbine Formation of North Texas that preserves a coastal community of macro- and microvertebrates. The Woodbine Formation (Cenomanian) was deposited on a coastal plain along the southwestern margin of Appalachia and the Interior Seaway. AAS field work initially focused on quarrying macrovertebrates, i.e. dinosaurs and crocodyliforms. Subsequent intensive surface collecting and screen washing have since revealed a diverse microvertebrate assemblage. Chondrichthyans include an indeterminant hybodont, the lamniform *Cretodus*, the ray *Pseudohypolophus*, and the sawfish *Onchopristis*. A new species of lungfish (*Ceratodus* n. sp.) has been recovered, as well as the ganoid scales of the semionotiform *Lepidotes*, the prearticular of the pycnodont cf. *Palaeobalistum*, and centra of an indeterminate amiiform. Teleost material includes a single tooth from a tetraodontiform (cf. *Stephanodus*) and numerous unidentified centra. Salamanders and frogs are represented by a handful of vertebrae, and a humerus and radioulna, respectively. The fresh water requirements of salamanders suggest an upstream source for these taxa. Shell fragments of turtles (cf. *Glyptops* and Trionychoidea indet.) are common and show crocodyliform feeding traces. Lizard vertebrae are small (<4 mm) and show typical conservative morphology. Shed crocodyliform teeth are common (n>100), representing multiple taxa and growth stages. Theropod teeth are rare, but indicate at least one small (Dromaeosauridae indet.) and one large (cf. *Acrocanthosaurus*) taxon. A single multituberculate lower fourth premolar may represent a new taxon. Stratigraphic data indicates an intermittently inundated delta plain that was beset by periodic wildfires. The AAS preserves a fossil rich peat from a marine-influenced wetland; a dinosaur bone bearing paleosol containing calcareous concretions and charcoal roots indicating seasonal dryness and wildfires; and a transgressive lag deposit. Each of the fossil beds is bound by charcoal bearing horizons including a charcoal conglomerate, a concretion bearing root horizon and a charcoal debris flow bed. The presence of charcoal beds intermingled with the fossil horizons suggests an ecosystem that endured periodic wildfires. Thus, the AAS allows one to explore the influence of the Intermediate Disturbance Hypothesis (IDH) on fossil biodiversity which may imply that coastal Woodbine ecosystems were adapted to and benefitted from seasonal wildfires.

Technical Session V (Wednesday, October 17, 2:15 pm)

A RE-EVALUATION OF *PLIOPHOCA ETRUSCA* (PINNIPEDIA: PHOCIDAE) FROM THE PLIOCENE OF ITALY: PHYLOGENETIC AND BIOGEOGRAPHIC IMPLICATIONS

BERTA, Annalisa, Department of Biology, San Diego State University, San Diego, CA, United States; KIENLE, Sarah, Department of Biology, San Diego State University, San Diego, CA, United States; SORBI, Silvia, Museo di Storia Naturale e Territorio, Universita di Pisa, Pisa, Italy; BIANNUCI, Giovanni, Dipartimento di Scienze della Terra, Universita di Pisa, Pisa, Italy

Monk seals (*Monachus* spp.) include the world's most endangered extant pinnipeds. The anatomy of monk seals is understudied and plays a major role in reconstructing their phylogeny. A close fossil relative *Pliophoca etrusca*, represented by a partial skeleton (holotype) from the Piacenzian (Pliocene) of central Italy, originally described in 1942 is thoroughly redescribed and comparisons made among more recently reported fossil monachines. In addition the taxonomy and phylogenetic relationships of extant and fossil monachines are re-evaluated. Cranial, dental and postcranial material from near the type locality and fragmentary mandibles from the Pliocene of eastern Spain are referred to *Pliophoca* aff. *etrusca*. Comparison of the type with referred material from the eastern North Atlantic (e.g. Lee Creek Mine) does not support referral of the latter to *Pliophoca* as recently suggested.

Using the largest novel dataset to date, including extant and fossil monachines and comprising 60 morphological characters, 16 nuclear genes, and 12 mitochondrial genes, we inferred the first combined analysis of morphological and molecular data for monachine phocids. Both parsimony and Bayesian approaches were employed. Results of combined analyses revealed: 1) *Pliophoca* is most closely related to *Monachus* spp. within a clade that includes *Monachus* + *Mirounga* + extant lobodontines, 2) *Acrophoca* (early Pliocene, Peru) and *Messiphoca* (late Miocene, Algeria) are successive sister taxa to this clade and 3) purported fossil monachines "*Callophoca*" and "*Pliophoca*" from Lee Creek more likely provide evidence of sexual dimorphism in the same taxon that is distantly related to *Pliophoca*. Based on our phylogenetic framework we confirm that the origin and dispersal of Pliocene monachines was centered in the Mediterranean with subsequent dispersal to the Caribbean and central North Pacific prior to mid-Pliocene closure of the Central American Seaway.

Technical Session IX (Friday, October 19, 8:00 am)

THE QUADRATOMAXILLARY LIGAMENT AND ITS IMPLICATIONS FOR THE EVOLUTION OF CRANIAL FENESTRATION IN REPTILES

BEVER, Gabriel S., New York College of Osteopathic Medicine, Old Westbury, NY, United States; LYSON, Tyler R., Yale University, New Haven, CT, United States; BHULLAR, Bhart-Anjan S., Harvard University, Cambridge, MA, United States

The characteristic absence of temporal fenestration in turtles has long influenced the hypothesis that the group originated outside the diapsid radiation that includes crown Lepidosauria and Archosauria. Recent phylogenetic analyses almost invariably reject this hypothesis, with the implication that the anapsid skull of turtles reflects a derived loss of fenestration rather than the conservation of the ancestral reptile condition. Though a closing of the temporal region at some point along the turtle stem is a requirement of current molecular-dominated matrices, the only direct anatomical evidence proffered to support such a transformation is an observation made in the 1920s that extant turtles express a quadratomaxillary ligament (QML). This structure is well known in crown squamates where it delineates the ventral margin of the lower temporal fenestra and is widely accepted as the unossified homolog of the diapsid lower temporal bar. Considering the historical importance placed on patterning of the amniote temporal region and the possibility of strengthening the consensus between paleontology, soft-tissue anatomy, and molecular-based phylogenetics, we investigated the implications of the QML by addressing two basic questions. 1) Is a homolog of the squamate QML present in turtles and if so, what is its distribution within the turtle crown? 2) Is it justified inferring that the presence of the QML reflects the structural ground plan of a diapsid skull?

Based on our dissection of a series of crown turtles, mammals, squamates, and archosaurs, we conclude that 1) the ancestral crown turtle did contain a QML, 2) the turtle QML is homologous to that of squamates and delineates the ventral margin of the cheek as a distinct thickening of the temporal fascia, and 3) a homologous QML is also present in crown archosaurs but apparently not in crown mammals. This distribution supports the QML as a unique feature of reptiles; however, narrowing its origin to Diapsida depends on its absence in extinct parareptiles, which may be unknowable. It is becoming increasingly probable that the ancestral parareptile had some form of temporal opening, which means that regardless of whether turtles originated within Diapsida or Parareptilia, their completed anapsid morphology likely is derived. We also critically reevaluated osteological characters of the temporal region with the goal of restricting assumptions of process. Preliminary results, not surprisingly, indicate high homoplasy. The most elevated levels were recovered when the origin of turtles was constrained to the lepidosaur stem as opposed to within Parareptilia or to the stem of Archosauria.

Technical Session XVI (Saturday, October 20, 10:45 am)

COMPLEX SOCIAL STRUCTURE IN PROBOSCIDEA FROM A REMARKABLE LATE MIOCENE TRACKWAY SITE IN THE UNITED ARAB EMIRATES

BIBI, Faysal, Museum für Naturkunde, Berlin, Germany; KRAATZ, Brian, Western University of Health Sciences, Pomona, CA, United States; CRAIG, Nathan, Independent Scholar, Balboa Island, CA, United States; BEECH, Mark, Historic Environment Department, Abu Dhabi Tourism & Culture Authority, Abu Dhabi, United Arab Emirates; HILL, Andrew, Yale University, New Haven, CT, United States

Evidence for social behavior, group size and structure in the fossil record is generally limited to rare and exceptional fossil finds. Living elephants are an example of a group that exhibits complex and well-studied social behavior. Despite a rich proboscidean fossil record going back to the early Eocene, evidence on the antiquity of characteristic elephant behavior has remained virtually unknown. We here present on the exceptional fossil trackway site of Mleisa 1, from the late Miocene Baynunah Formation (8–6 Ma) of the United Arab Emirates. Mleisa 1 preserves long trackways of a herd of proboscideans transected by that of a solitary individual. We used kite aerial photography to image the site and produce an orthographically-corrected photomosaic from which the trackways were mapped and measured.

Living elephant societies are sex-segregated and multi-tiered, centered around matriarchal family units and solitary or loosely associated adult males. The trackways at Mleisa 1 provide direct evidence that herding and probably sex-segregation were also present in late Miocene proboscideans. The tight grouping, sub-parallel alignment, and low incidence of intersection or overlap in the main group of trackways indicates these were made by a herd of individuals walking together. Site mapping indicates there were no less than 13

individuals in the herd, and stride length profiles and resulting body mass estimates reveal a diversity of sizes including at least one small juvenile individual. This is commensurate with the size of modern elephant family units, and represents a rare example of social group size determination in the fossil record. In comparison, stride lengths for the solitary trackway are the largest recorded at the site, indicating that they were most likely made by a solitary elephant bull.

Though phylogenetic inference already indicated that elephant-like behavior should exist in the latest Miocene (most recent common ancestor of *Loxodonta* and *Elephas*), this is the first and clearest indication of the fact to come from the fossil record.

Besides documenting modern-like proboscidean behavior in the late Miocene, Mleisa 1 preserves some of the longest continuous trackways known for fossil vertebrates anywhere, with that of the solitary individual traceable over a distance of 260m. The study of Mleisa 1 also demonstrates the efficacy of kite aerial photography for the scientific study of sites of large magnitude.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

LATE CRETACEOUS MARINE FISHES FROM THE UPPER GREENHORN LIMESTONE IN SOUTHEASTERN NEBRASKA, U.S.A.

BICE, Kelly N., DePaul University, Chicago, IL, United States; SHIMADA, Kenshu, DePaul University, Chicago, IL, United States; KIRKLAND, James I., Utah Geological Survey, Salt Lake City, UT, United States

The Greenhorn Limestone is an Upper Cretaceous rock formation deposited in the middle of an epicontinental sea in North America, the Western Interior Seaway. The upper half of the formation is represented by the Jetmore Chalk and Pfeifer Shale members, and they are together characterized by chalky shale beds interbedded by limestone layers rich in inoceramid bivalves. These shale and limestone beds mark the maximum transgressive phase of the Greenhorn Cyclothem during the early Turonian. Vertebrate remains are known to occur sporadically in these beds, but there is limited information about their taxonomic diversity.

The University of Nebraska State Museum, Lincoln, houses an assemblage of fossil marine fishes from the upper half of the Greenhorn Limestone in southern Jefferson County, Nebraska, USA. These fossils are the results of surface collecting from the Jetmore-Pfeifer interval. The ichthyofauna consists of at least ten taxa, including six chondrichthyans (*Ptychodus anonymus*, *P. occidentalis*, *P.* cf. *P. whipplei*, *Cardabiodon venator*, *Cretoxyrhina mantelli*, and *Squalicorax* cf. *S. falcatus*) and four osteichthyans (*Xiphactinus audax*, Plethodidae indet., *Enchodus gladiolus*, and *E. shumardi*). The fish assemblage is small with a likely collecting bias towards larger taxa, but the fauna is important because it provides a glimpse into the paleoecology of the Western Interior Seaway during its peak transgression. In particular, it is noteworthy that the taxa are remarkably diverse ecologically, comprising durophagous (*Ptychodus*), large predaceous (*Cardabiodon* and *Cretoxyrhina*), and medium-sized opportunistic (*Squalicorax*) sharks as well as small (*Enchodus*), medium-sized (plethodid), and large (*Xiphactinus*) bony fishes.

The deposition of the upper Greenhorn Limestone represents an important time frame in the history of the Western Interior Seaway, notably marking the rise and radiation of the geologically earliest mosasaurs in North America. The present study of the upper Greenhorn fish fauna suggests that the evolution of mosasaurs appears to have taken place in a stable fish community in the seaway. This is because practically all the fish taxa recognized also occur stratigraphically below (e.g., basal Lincoln Limestone) and above (e.g., Fairport Chalk and Niobrara Chalk) the geologic horizon.

Technical Session X (Friday, October 19, 9:00 am)

LOCOMOTOR LOADING OF THE FEMUR IN OPOSSUMS PROVIDES INSIGHT INTO THE EVOLUTION OF FEMORAL SHAPE IN SYNAPSIDS

BLOB, Richard W., Clemson University, Clemson, SC, United States; BUTCHER, Michael T., Youngstown State University, Youngstown, OH, United States; GOSNELL, W. C., Clemson University, Clemson, SC, United States; MAIE, Takashi, Clemson University, Clemson, SC, United States

The cross-sectional shape of the femur shows a distinctive pattern of change through the evolution of the synapsid lineage. Among basal "pelycosaur" grade lineages that have been interpreted to use sprawling limb posture, the midshaft of the femur is circular in cross-section. In contrast, among gorgonopsian and therocephalian taxa in which the limbs are interpreted to have shifted to an orientation beneath the body, femoral cross-sections are flattened anteroposteriorly (i.e., in the plane of knee flexion and extension). For taxa using primarily fore-aft (rather than sprawling) limb motion, this direction of asymmetry runs counter to biomechanical expectations. Studies of large, cursorial mammals have found bending loads to be greatest on the anterior and posterior surfaces of limb bones during forward running; however, anteroposterior flattening means that bone material and resistance to bending have been reduced, counterintuitively, in the direction expected to experience the highest loads. One explanation for these patterns is that models of limb bone loading derived from large, fully upright cursors (e.g., horses) may not be valid for smaller synapsid taxa in which the limbs may have been held beneath the body, but in a crouched, rather than upright, stance. We tested this possibility by measuring femoral loads in running Virginia opossums (*Didelphis virginiana*) using a combination of surgically implanted strain gauges and high-speed video synchronized with force platform recordings. As a marsupial with a generalized body plan, scansorial habits, and crouched limb posture, the opossum provides a more appropriate functional model than large cursorial taxa for the likely locomotor behavior of synapsids during the evolutionary transition away from sprawling locomotion. Our results from opossums contrast with previous data from large cursors. Both strain gauge and force platform experiments show consistent patterns of mediolateral femoral bending in opossums, despite the forward direction of travel. Force platform data also indicate that these patterns result from substantial contraction of hindlimb adductor muscles on the medial aspect of the femur, opposing a lateral torque induced by the ground reaction force. In the context of these loading data, the pattern of femoral shape change in therapsid taxa is no longer functionally surprising. If their hindlimb orientation was similar to that of opossums, then the greatest femoral bending in basal therapsids was also likely mediolateral. Thus, anteroposterior flattening would have distributed bone material to reinforce the mediolateral axis, improving resistance to bending in the primary direction of loading.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 8:45 am)

EARLY EOCENE MAMMALS FROM THE HOT TROPICS OF NORTHERN SOUTH AMERICA

BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; RINCON, Aldo F., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; HEAD, Jason J., Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE, United States; HERRERA, Fabiany, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Ancon, Panama

Recent estimates of mean-annual temperature (MAT) in the early Eocene tropics based on the TEX86 temperature proxy indicate temperatures of 31.5 ± 2.3 °C, approaching the MAT maxima of modern tropical forests and mammalian communities (about 35°C). Tropical temperatures during early Eocene hyperthermal events were likely much higher, suggesting the possibility of coincident widespread equatorial heat-death. Terrestrial Paleogene mammals from the northern tropics of South America have been largely unknown, limiting our ability to directly test this hypothesis. A notable exception is the primitive xenungulate *Etayoa bacatensis* from the Bogotá Formation, Colombia. While previous studies of preserved pollen had indicated a middle-late Paleocene age, possibly contemporary (or slightly older) than a pre-Itaboraian aged "*Carodnia* Zone," recently published U/Pb detrital zircon dates indicate an early Eocene (53.6 ± 1.1 Ma) age for the mammal-bearing level of the Bogotá Formation. Ongoing fieldwork in the type locality of *E. bacatensis* has already resulted in recovery of many additional vertebrate fossils including fish, amphibians, reptiles, and mammals. New mammals include an enigmatic small-bodied ungulate and multiple metatherians including several bunodont taxa referable to the Protodidelphidae. Although best known from late Paleocene-early Eocene of Brasil (Itaborái), protodidelphids have also been recovered from the late early Eocene of central and western Patagonia, Argentina, and it has been suggested that their widespread occurrence corresponds to the presence of extensive tropical environments throughout South America. Presence of medium-sized herbivorous ungulates, a diversity of frugivorous/omnivorous marsupials, arboreal boiid snakes and iguanian lizards, and fossil leaves just before the Early Eocene Climatic Optimum and close to the Eocene Thermal Maximum 2 (about 53.7 Ma) in tropical South America indicates that diverse tropical ecosystems survived at temperatures approaching their MAT maxima in the past.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A MULTI-PROXY REAPPRAISAL OF DIET AND MICROHABITAT IN CHADRONIAN AND ORELLAN UNGULATES FROM NEBRASKA BASED ON STABLE ISOTOPES, MESOWEAR AND HYPSODONTY INDEX

BOARDMAN, Grant S., University of Nebraska, Lincoln, NE, United States; SECORD, Ross, University of Nebraska, Lincoln, NE, United States

We infer diet and microhabitat for 12 ungulate taxa from Chadronian (latest Eocene) and Orellan (earliest Oligocene) age deposits of the White River Group in Nebraska. This period of time is especially interesting because it samples an interval of climate change associated with the onset of Antarctic glaciation (Oi-1). We use carbon isotopes in mammalian tooth enamel ($\delta^{13}C_E$) to infer ancient habitats based on $\delta^{13}C$ values in modern vegetation, corrected for changes in atmospheric composition and physiological enrichment from diet to enamel. Oxygen isotopes in enamel ($\delta^{18}O_E$) can be used to recognize semi-aquatic species. Mesowear data and hypsodonty index (HI) are used to interpret diet. Mesowear measures total dietary abrasion in ungulate dentition by assessing cusp shape and relief. We categorize "lifetime" diet by comparing the mesowear of fossil taxa to those of modern taxa of known diet via principle component and cluster analyses. Lastly we compare HI, which is strongly correlated with diet, with mesowear results to test consistency between proxies.

We studied 11 ungulate taxa from the Chadronian, and 7 from the Orellan, with a total of 6 range-through taxa: *Subhyracodon* (rhinocerotid), *Hyracodon* (hyracodontid), *Mesohippus* (equid), *Archaeotherium* (entelodont), *Agriochoerus* (agriochoerid), and *Merycoidodon* (merycoidodontid). Hypsodonty index indicates that all taxa were brachydont, and thus probably browsers, but mesowear suggests that *Subhyracodon*, *Trigonias* (also a rhinocerotid), *Eotylopus* (an oromerycid), *Aepinacodon* (an anthracothere), and Orellan *Merycoidodon* were probably mixed-feeders. High mean carbon values (~-8‰) and mesowear suggest that *Mesohippus* and *Agriochoerus* were browsers in open microhabitats

(woody scrubland). On the low end of the carbon range, the bronthothere *Megacerops* (-10.9‰) and the tapir *Colodon* (-12.2‰) lived in closed microhabitats (riparian woodland) and were browsers. *Archaeotherium*, an omnivore, inhabited both woodland and scrubland based on average carbon values (~-9.0‰). Other taxa were browsers (including the peccary *Perchoerus*) or mixed-feeders inhabiting woodland and scrubland. Anatomical evidence suggests that *Aepinacodon* was a semi-aquatic species, but oxygen values were near the faunal average and not consistent with the low values expected for a semi-aquatic species. Habitat preference and diet in range-through taxa remained stable, suggesting little habitat change through this interval of global climate change.

Romer Prize Session (Thursday, October 18, 8:15 am)

FOSSILS, GENES AND THE EVOLUTION OF THE VERTEBRAL COLUMN IN ARCHOSAURS

BOEHMER, Christine, Ludwig-Maximilians-Universität, Munich, Germany

The integration of fossils, morphology and genes in order to understand the evolution of life has gained in importance over the past two decades. In the majority of cases, this approach only allows the use of processes of individual development to indirectly interpret phenotypic change during evolution. Here, the direct correlation between genetic expression and morphological variation is analyzed for the first time. In vertebrates, the functions of *Hox* genes include the specification of vertebral shape. It has been proposed that a unique or highly distinctive axial *Hox* code (a combination of *Hox* genes) expressed in each somite specifies differing vertebral morphologies. This idea was tested here, and results applied to fossil taxa. First, the *Hox* code for the formation of the presacral vertebral column in recent archosaurs was established. The available genetic information was expanded via whole-mount *in situ* hybridization experiments on embryos of nile crocodile. Next, the direct linkage between changes in *Hox* gene expression and the morphology of presacral vertebrae was tested in chicken, alligator and crocodile. A correlation was identified between the degree of shape change between successive vertebrae (assessed qualitatively and also quantitatively via landmark analysis) and the number of active *Hox* genes in the corresponding axial region, and was supported by statistical tests based on the morphometric results. Because morphological similarity is therefore directly causally related to *Hox* gene expression, it was possible to use axial shape variation in recent archosaurs with varying vertebral count as a proxy for *Hox* gene expression. Finally, these results were applied to fossil species. *Hox* gene patterns in extinct archosaurs, including sauropodomorphs, were established on the basis of quantifiable changes in morphology. Analysis of the shape of the cervical vertebrae in extinct and extant archosaurs revealed a pattern of 3 subunits within the neck in crocodilians. This pattern changed to one of 4 subunits in basal saurischians, and 5 morphological subgroups are recognized in groups with longer necks such as sauropod dinosaurs and birds. The observed variation in morphological subregions of the neck in dinosaurs and birds results from specific expansions of *Hox* gene activity. These results show that morphological disparity within the vertebral column can be used to reconstruct underlying genetic information. The analyses thus not only provide new insights into the evolution of axial patterning in archosaurs, but represent an important case study of the direct application of principles of evolutionary developmental biology in paleontology.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE YUKAGIR BISON: A COMPLETE FROZEN MUMMY OF THE EXTINCT *BISON PRISCUS* FROM YAKUTIA, RUSSIA

BOESKOROV, Gennady, Diamond and Precious Metals Geology Institute, Siberian Branch of the Russian Academy of Sciences, Yakutsk, Russian Federation; POTAPOVA, Olga, Mammoth Site of Hot Springs, SD., Inc., Hot Springs, SD, United States; PROTOPOPOV, Albert, Dept. of Mammoth Faunal Studies, Sakha (Yakutia) Republic Academy of Sciences, Yakutsk, Russian Federation; KOLESOV, Stanislav, Dept. of Mammoth Fauna Studies, Sakha (Yakutia) Republic Academy of Sciences, Yakutsk, Russian Federation; TIKHONOV, Alexey, Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russian Federation

The Yukagir bison is the most complete frozen and partially mummified carcass of extinct *Bison priscus* found so far. Until now, only isolated body parts or partial bodies of adult steppe bison, such as Mylakhchin mummy, Fairbanks Creek mummy head, Dome Creek mummy, Pearl Creek partial mummy, and Blue Babe mummy from Alaska, were found. Quick burial of the Yukagir bison, and permafrost conditions facilitated preservation of all body parts, from internal organs to the head with intact fleshy snout, ears, horns, and tail, complete extremities, and undamaged hide with patches of remaining dark-brown and black fur. The mummy was found in the Pleistocene deposits of the lowlands between the Yana and Indigirka Rivers, within the Paleontological Reserve “Yana Mammoths” in Yakutia (Sakha) Republic, Russia. The exact location is the shore of Chukchalakh Lake (72º17´30? N 140º54´05? E). The discovery was made by Yukagir community members in August 2011. Preliminary analyses of the mummy’s head and comparisons with recent *Bison bison* skulls showed that this was a young, relatively small-sized animal. Judging by the condition of frontal teeth, and taking into account teeth eruption stages in the modern Plains Bison, *Bison bison*, the specimen was at least 4 years old, and possibly older (4.5 years). The cause of the bison death is being investigated. An exploratory cut in the belly for sampling stomach and intestines contents revealed that the animal didn’t die of starvation: the guts were full of plant material. Neither had it died from predators, as it was lacking any visible damage of hide, opened wounds, scratches, tears or cut marks on the skin. Moreover, the mummy was found lying on its belly with legs bent and tucked under it, which is similar to the body position observed in modern ungulates that died naturally. None of the external body tissues contained vivianite. Preliminary microbiological studies confirmed that the exterior mummy tissues did not contain any traces of dangerous infectious viruses and bacteria, such as anthrax (*Bacillus anthracis*) or foot-and-mouth disease (*Aphtae epizooticae*). The samples for microflora taken from interior parts of the body are being analyzed for pathogens. The ongoing studies of the Yukagir bison are AMS dating; carbon and oxygen isotopes analyses, X-ray computed tomography (CT scan), and DNA analysis, designed to inflict minimal body damage to the unique specimen

Technical Session XIX (Saturday, October 20, 3:45 pm)

TAPHOFACIES ANALYSIS OF THE NEOGENE PURISIMA FORMATION IN NORTHERN CALIFORNIA INDICATES STRONG DEPOSITIONAL CONTROL ON MARINE VERTEBRATE PRESERVATION IN SHALLOW MARINE DEPOSITS

BOESSENECKER, Robert W., Department of Geology, University of Otago, Dunedin, New Zealand; SCHMITT, James G., Department of Earth Sciences, Montana State University, Bozeman, MT, United States

The taphonomy of vertebrate skeletal remains in the marine realm is poorly understood, with a majority of previous studies having focused on single skeletons, lagerstatten, or bonebed genesis. Few studies have attempted to document environmental gradients in preservation, and as such it has been difficult to establish a concrete taphonomic model for vertebrates in the shallow marine realm. The Neogene Purisima Formation of central California, a richly fossiliferous unit representing depositional settings from nearshore to offshore, offers a unique opportunity to examine preservational trends across these settings. Lithofacies analysis was conducted in order to place vertebrate fossils within a proper sedimentologic (energy, substrate type, water depth) context. This study examined over 1000 vertebrate fossils of elasmobranchs, osteichthyes, aves, pinnipeds, odontocetes, mysticetes, sirenians, and land mammals, and included taphonomic data regarding abrasion, fragmentation, phosphatization, articulation, polish, and biogenic bone modification. Differential preservation of these taxa was compared within multiple individual lithofacies, and preservation of each taxon was compared across lithofacies to document the influence of environmental gradients on preservation. Differing taphonomic processes resulted in varying rates of abrasion, fragmentation, phosphatization, and polish between taxa, indicating strong preservational bias within the Purisima Formation. Varying levels of abrasion, fragmentation, phosphatization, and articulation were found to be strongly correlated with physical processes of sediment transport and sedimentation rate, as well as element morphology and histology. These varying characteristics were used to delineate four taphofacies that correspond to inner, middle, and outer shelf settings, and bonebeds which cut across all taphofacies. Application of sequence stratigraphic methods shows strong similarity between taphofacies and sequence stratigraphic models. Bonebeds mark major discontinuities (sequence boundaries, transgressive surfaces of erosion, marine flooding surfaces), while packages of rock between these discontinuities consistently exhibit onshore-offshore changes in taphofacies, closely corresponding to onshore/offshore changes in lithofacies and inferred depositional setting. The strong physical control on marine vertebrate preservation and preservational bias within the Purisima Formation has implications for paleoecologic and paleobiologic studies of marine vertebrates. Differential preservation encountered during this study casts doubt on the viability of paleoecologic studies utilizing raw relative abundance data for marine vertebrates.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE FIRST HISTOLOGICAL DESCRIPTION OF THORACOSAURUS NEOCESARIENSIS: CRETACEOUS/PALEOGENE HORNERSTOWN FORMATION OF NEW JERSEY

BOLES, Zachary, Drexel University, Philadelphia, PA, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

Thoracosaurus neocesariensis is one of five crocodyliforms known from the Late Cretaceous/Paleogene greensands of New Jersey. The new specimen was recovered from the Main Fossiliferous Layer (MFL) at the base of the Hornerstown Formation, exposed at the Inversand glauconite mine in NJ. The specimen, represented by a nearly complete left mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and a dorsal osteoderm to examine the histology and preservation of bone microstructure. This is the first histological study of *T. neocesariensis* and the first of any specimen from Inversand.

Microstructure in both bones is well-preserved with osteocyte lacunae and canaliculi clearly visible. In the femur, endosteal bone deposition has resulted in the formation of compacted coarse cancellous bone. The cortex is composed of the typical crocodylian lamellar-zonal bone with several zones and annuli present. Sharpey’s fibers are present along the ventral side of the femur indicating a muscle attachment site. The outermost 50-250µm of the cortex is diagenetically altered with most of the microstructure no longer preserved. Similar alteration is seen in the osteoderm. We hypothesize that this is the result of diagenetic interactions between the bone and the glauconite-rich environment. The osteoderm is composed of zonal bone with a fibrolamellar cancellous core. Growth markers are present but do not extend around the entire circumference of the bone. Rather, they terminate at the dorsal margin or where they intersect other areas of zonal bone. Approximately 13 growth lines run the length of the osteoderm, however other areas of zonal bone have fewer or

many more growth lines (>20 lines). These markers likely represent the expansion of the osteoderm and the development of the ridges along the dorsal surface.

Annuli and lines of arrested growth (LAGs) are deposited annually in some extant animals allowing for an estimation of minimum ontogenetic age. Between 10-13 LAGs are preserved in the femur that can be traced around the entire cross-section, indicating a minimum age of 10 years. Some modern crocodilians (e.g. *Alligator mississippiensis* and *Crocodylus niloticus*) reach sexual maturity between the ages of 10-20 years while adult size is not reached until later. Thus, this specimen was likely at or near sexual maturity but far from fully-grown.

Technical Session VI (Thursday, October 18, 2:15 pm)

WHAT LIES BENEATH: SUB-ARTICULAR LONG BONE SHAPE SCALING IN EUTHERIAN MAMMALS AND SAURISCHIAN DINOSAURS SUGGESTS DIFFERENT LOCOMOTOR ADAPATIONS

BONNAN, Matthew F., Richard Stockton College of New Jersey, Galloway, NJ, United States; WILHITE, Dewey R., School of Veterinary Medicine, Auburn University, Auburn, AL, United States; MASTERS, Simon L., Intermountain Paleo-Consulting, Salt Lake City, UT, United States; YATES, Adam M., Museum of Central Australia, Araluen Cultural Precinct, Alice Springs, Australia; GARDNER, Christine K., Western Illinois University, Macomb, IL, United States

Both eutherian mammals and saurischian dinosaurs (Aves inclusive) evolved lineages of giant terrestrial herbivores. However, previous morphometric analyses have not revealed significant differences in long bone dimensions and shape between giant mammals and saurischian dinosaurs, suggesting that both lineages had dynamically similar gaits and postures. However, the shape of the sub-articular bone and calcified cartilage deep to the articular cartilage is seldom considered. The humeri and femora of all mammals have a well-formed, bony epiphysis capped by a thin layer of articular cartilage loaded a distance away from the metaphysis. In contrast, archosaurs, including saurischians, have thick, cartilaginous epiphyses loaded over a broad region near the metaphysis. With increasing size, different patterns of shape change in the sub-articular surface are predicted if epiphyseal loading regimes between eutherian mammals and saurischian dinosaurs were not dynamically similar. Therefore, we tested the hypothesis that the sub-articular shape of eutherian mammal and saurischian dinosaur humeri and femora scale differently with increasing size using geometric morphometrics. Our sample included taxa from sprawling outgroups (monotremes for eutherian mammals, alligators for saurischian dinosaurs) to ensure we were detecting postural and loading differences. Our results indicate that the sub-articular surfaces of the humerus and femur in mammals narrow significantly with increasing size, whereas these same regions expand tremendously in saurischian dinosaurs. In fact, approximately 30-40% of the total shape change in saurischian dinosaurs and alligators were related to size, compared to only 5-14% of size-related shape changes in eutherian mammals and monotremes. Furthermore, with increasing size the deltopectoral crest became laterally-oriented in mammals but medially-deflected in saurischian dinosaurs, suggesting that forelimb locomotion in particular was not dynamically similar between giant mammals and sauropods. Our results suggest that there were significant differences in how mammal and saurischian dinosaur epiphyses were loaded. We suggest that distinct joints with narrow articular regions and thin articular cartilage may be necessary in giant mammals to ensure appropriate safety factors. In contrast, the thick, cartilaginous epiphyses of saurischian dinosaurs may instead have selected for the evolution of greatly expanded articular joints. Overall, our results suggest profound differences in how mammal and saurischian long bones adapt to increasing size, and demand further exploration of long bone scaling beyond their overall size and shape.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ECOMORPHOLOGICAL VARIATION OF THE DISTAL PHALANX IN THE CERVIDAE: DO CAPTIVE MODERN ANALOGUES SKEW RESULTS?

BORMET, Allison K., Indiana University, Bloomington, IN, United States; LAWING, A. M., Indiana University, Bloomington, IN, United States

Ungulate locomotor morphology indicates habitat type and substrate use and has been used extensively to predict paleohabitat. Many studies used extant captive specimens to determine the relationship between morphology, habitat, and substrate. We explore factors contributing to morphological variation in the shape of the plantar surface of the third phalanx within different biotic levels, including within an individual, within a species, and within captive and wild caught specimens. We also determine the amount of explained variance due to habitat type and substrate use. Forelimbs and hindlimbs in quadrupeds likely bear weight differently and have different biomechanical interactions with the ground. Because of this, there is a chance that the third phalanx (PH3), which is in direct contact between the animal and the substrate it traverses, may be morphologically variable within an individual or between species. This potential variation in wild populations could be altered when an animal is placed into captivity, and whose man-made habitats consist of cement or other hard materials the animal would not naturally interact with. Cervids were analyzed in this study because they populate a wide range of habitats, are commonly kept in zoos and have visually similar PH3 morphology among hooves. Four cervid species were analyzed to explore morphological variation using geometric morphometrics. Within each species we sampled one wild caught and one captive individual. Thirty semi-landmarks around the plantar surface of the third phalanx were Procrustes superimposed and subjected to a principal components analysis. PC1 explained 53.5% of the total variance and represents the morphological trajectory of a straight PH3 to an angled PH3. After rank ordering the factors, the amount of explained variance is highest for substrate (2.91%). PC2 explained 20% of the total variance and represents the trajectory of a thin, tapered PH3 to blocky, robust PH3 morphology. Rank ordering the factors by explained variance of PC2 shows that habitat explains the most variance (2.12%). Although the amount of explained variance calculated with ANOVA for each factor explained little of the total variance (>3% each) in this exploratory study, the small sample size causes the analysis to have little power to detect differences within and between factors. With a larger sample size, greater variation in the sample among factors will be detectable. Early results show no variation exists between forelimb and hindlimb PH3 in an individual and cervid PH3 morphology is best explained by substrate and habitat interaction with phylogeny following closely behind. In addition, studies interested in PH3 ecomorphology may use captive animals within their sample.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

VIRTUAL BRAIN ENDOCASTS SHED NEW LIGHT ON THE EARLY EVOLUTION OF MODERN BIRDS (NEORNITHES)

BOURDON, Estelle, The Natural History Museum, London, United Kingdom; MILNER, Angela C., The Natural History Museum, London, United Kingdom; WALSH, Stig A., National Museums Scotland, Edinburgh, United Kingdom

Recent studies of the brain anatomy of Palaeogene birds using high resolution X-ray computed tomography (CT) have provided an important source of phylogenetic information for avian systematics. Although the basalmost divergences of modern birds (Neornithes) are well supported by both molecular and morphological studies, the phylogenetic placement of many Cenozoic avian groups remains controversial. We used CT slice data to obtain virtual brain endocasts for a broad selection of extinct and extant avian species. The sample consists of 50 living species encompassing all major neornithine clades, plus several key Cenozoic taxa including *Lithornis* (Lithornithidae), *Dasornis* (Pelagornithidae), *Prophaethon* (Prophaethontidae), *Halcyornis* (Halcyornithidae), *Septentrogon* (Trogonidae) and *Patagornis* (Phorusrhacidae). Outgroup comparison is made with non-avian theropod dinosaurs and non-neornithine birds such as *Archaeopteryx* and *Enaliornis*. Anatomical characters used for phylogenetic analysis include: (1) position/shape of different brain regions; (2) form/path of cranial nerves, blood vessels and sinuses; (3) size of various brain regions relative to overall brain size. We aim to (1) provide a clearer picture of the evolution of various brain regions from the origin of birds to the present, and (2) shed new light on the early diversification of modern birds. This will enable testing of the hypothesis that telencephalic expansion conferred modern birds with an advantage over more basal avian clades at the end of the Cretaceous.

Technical Session VI (Thursday, October 18, 1:45 pm)

DORSAL OR ROSTRAL NOSTRILS? TESTING FLESHY NOSTRIL POSITION AND AIRFLOW IN SAUROPODS USING COMPUTATIONAL FLUID DYNAMICS

BOURKE, Jason M., Ohio University, Athens, OH, United States; PORTER, William R., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

The enlarged and caudally retracted bony nasal opening in sauropods has led to conflicting ideas regarding nostril placement. As a soft-tissue structure with few direct bony associations, the fleshy nostril has proven problematic for sauropod life restorations and, more importantly, for understanding sauropod nasal physiology. Early work based on presumed aquatic lifestyles placed the nostrils high on the head. More recent interpretations—based on the anatomy of sauropods and extant outgroups—have argued for a nostril position farther down the snout. We test these varying nostril positions using computer simulations of fluid dynamics. Conservative hypotheses of nasal capsule morphology in the macronarian *Camarasaurus* and the diplodocoid *Diplodocus* were generated based on osteological correlates for soft-tissue boundaries using the software Avizo, Maya, and Mudbox. Fleshy nostril and choana placement were manipulated iteratively to test the range of hypotheses proposed. These models were subjected to a computational fluid dynamic analysis using Fluent, simulating a single breath during resting respiration. Fleshy nostril position greatly affected air movement throughout the nasal capsule. Modeling dorsally placed nostrils in *Camarasaurus* resulted in a direct route to the throat, leaving unrealistically stagnant airfields in both the rostral end of the nasal capsule and the caudodorsally placed olfactory chamber. Rostral placement of the fleshy nostril, however, resulted in an airflow pattern more consistent with that seen in our studies of extant sauropsids, including a separation of the airfield into two streams, a relatively fast-moving air stream directed to the oropharynx, along with a slower moving olfactory stream. Further manipulation of the airway was performed to better reflect airflow patterns seen in extant archosaurs. This anatomical arrangement would have enhanced airflow into the olfactory chamber, which is consistent with olfactory bulb size in *Camarasaurus*. The more complicated bony airway of *Diplodocus* was more informative of general nasal capsule shape. The caudally retracted bony nasal opening, coupled with the rostrally shifted choana, produced a sinuous airway even when the fleshy nostril was modeled in its traditional dorsal position, but, again, leaving the rostral portion of the nasal capsule as an unrealistic cul-de-sac. A more rostrally positioned fleshy nostril resulted not only in an airway more consistent with our extant findings, but also a very long S-shaped airway. Both taxa exhibit intimate associations of nasal vasculature with the nasal capsule, particularly in the rostral region that was so sensitive to modeled nostril position, suggesting considerable potential for heat-exchange in these sauropods.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

ASSESSING SPECIES DIVERSITY AND INTRASPECIFIC VARIABILITY IN SHIELD-TAILED TORTOISES (TESTUDINIDAE, *HESPEROTESTUDO*) SPANNING THE EARLY CLARENDONIAN THROUGH LATE RANCHOLABREAN OF FLORIDA

BOURQUE, Jason R., Florida Museum of Natural History, Gainesville, FL, United States; HULBERT Jr., Richard C., Florida Museum of Natural History, Gainesville, FL, United States; WOOD, Aaron R., Florida Museum of Natural History, Gainesville, FL, United States

An extinct clade of small (adult carapace length 15–26 cm) land tortoises persisted in Florida from at least the middle–late Miocene to the end of the Pleistocene, a duration of 11–12 million years. Three species have been formally named from the southeastern United States: *Hesperotestudo alleni* (late Miocene); *Hesperotestudo mlynarskii* (middle Pleistocene); and *Hesperotestudo incisa* (late Pleistocene). Members of this clade possess a round to ovate tail shield (supracaudal buckler) comprised of osteoderms that articulates with the caudal vertebrae, a unique feature among testudinids. An extensive sample of both previously and recently collected *Hesperotestudo* fossils from the middle to late Miocene, early Pliocene, and early through late Pleistocene of Florida fill in major temporal gaps in the fossil record. These fossils have increased the available material needed to attempt quantitatively and qualitatively analyzing evolutionary patterns within this clade. Specimens largely comprise isolated shell bones, but include two partial shells from the late Hemphillian Swift Mine, and one complete and two partial shells (as well as six whole and partial tail bucklers) from the Blancan Inglis 1C locality. Three-dimensional (3D) geometric morphometric analyses of isolated nuchals, pygals, epiplastra, and xiphiplastra were conducted using a surface laser-scanner to locate semi-landmarks in a xyz-grid system encompassing the full 3D surface of each element. Principal components analyses were then used to find clusters in morphospace. The combined results from the analyses were used to delimit and better define species. Preliminary results suggest that two morphologically distinct lineages within this clade inhabited Florida from the Miocene through Pleistocene: the *H. alleni* group (early Clarendonian–late Hemphillian), and the *H. incisa* group (late Blancan–late Rancholabrean). A third lineage with affinities to the *H. turgida* group may also be represented in the late Hemphillian Bone Valley Formation. Significant increases and decreases in body size and shell thickness occur within the *H. incisa* group throughout the Pleistocene, probably caused by phenotypic response to repetitive climate change during glacial and interglacial cycles.

Technical Session V (Wednesday, October 17, 1:45 pm)

A RELATIONSHIP BETWEEN CERVICAL VERTEBRAL MORPHOLOGY AND TERRESTRIAL AND AQUATIC HABITATION

BOYD, Alec A., UC Davis, Davis, CA, United States

Terrestrial vertebrates have reinvaded the aquatic realm numerous times since they first colonized land in the Devonian period. Each reinvasion has followed a unique evolutionary pathway making the classification of an extinct taxon as being aquatic or terrestrial based purely on morphology very difficult. This problem is compounded by the fragmental and usually incomplete nature of fossil vertebrate remains. Observation and comparison of vertebrae of extant aquatic and terrestrial vertebrates suggest that aquatic creatures have a more “simple” vertebral shape. This correlation of form and environment is most likely due to the lessened effects of gravity in the aquatic realm. I believe this difference will be magnified in the cervical vertebra as they serve to support the weight of the head. To test this hypothesis a suite of linear character measurements were recorded for the cervical vertebra of numerous reptiles and mammals representing aquatic, terrestrial and amphibious lifestyles. Principle component analyses showed that aquatic mammals separated clearly from amphibious and terrestrial mammals on the second principle component axis, but amphibious specimens showed no clear separation from terrestrial organisms. Similar results were obtained from the analysis of the reptilian taxa; however, the separation was not nearly as clear as it was for the mammalian taxa. The results of a discriminant analysis of the mammalian and reptilian data further supports the trends observed in the principle component analyses. The discriminant analysis also shows that the characters and structures that best separate these environmental groups are associated primarily with ligaments that aid in structural support of the axial skeleton and serve to bear the weight of the head. The classification scheme based on these measurements will provide a useful tool for the classification and understanding of extinct organisms based on limited skeletal remains.

Technical Session XV (Saturday, October 20, 8:45 am)

ADDRESSING THE ‘HYPSILOPHODONTID’ PROBLEM IN ANALYSES OF BASAL ORNITHISCHIAN RELATIONSHIPS: NEW TAXA, NEW DATA, NEW HYPOTHESIS

BOYD, Clint A., South Dakota School of Mines and Technology, Rapid City, SD, United States

The illusion of systematic stability within Ornithischia has slowly eroded over the past decade, first via the dissolution of the “Hypsilophodontidae” and latter by the removal of heterodontosaurids from within Ornithopoda to near the base of Ornithischia. Most recently, some phylogenetic analyses of basal ornithischian relationships recovered some former ‘hypsilophodontids’ as non-cerapodan basal neornithischians, further restricting the taxonomic contents of Ornithopoda. Additionally, the interrelationships of many other ‘hypsilophodontid’ taxa were incompletely resolved in these analyses and in many cases their placement within Cerapoda was uncertain. Thus, the unresolved systematic relationships of ‘hypsilophodontid’ taxa remain one of the largest impediments to clarifying basal ornithischian relationships and understanding the evolution of major ornithischian subclades. Prior analyses of this clade were hampered by the fact that the hypodigm material of many ‘hypsilophodontid’ taxa is highly fragmentary, obscuring crucial character data. The recent discovery of several new ‘hypsilophodontid’ taxa and the referral of more complete specimens to known taxa provide important new data pertinent to addressing this issue. This study supplements these recent advances with additional data regarding the anatomy of ‘hypsilophodontid’ taxa from the latest Cretaceous of North America gleaned from a thorough restudy of published specimens and examination of several recently discovered specimens referable to both previously described and newly recognized ‘hypsilophodontid’ taxa. These new data were compiled into a dataset designed to assess basal ornithischian relationships that included 59 ornithischian terminal taxa (all species exemplars), including 27 ‘hypsilophodontid’ taxa. The recovered strict consensus topology is the most highly resolved phylogenetic hypothesis of basal ornithischian relationships yet proposed and agrees with other recent hypotheses in recovering heterodontosaurids near the base of Ornithischia. Most taxa previously referred to as ‘hypsilophodontids’ are recovered as non-cerapodan basal neornithischians, and a new clade is recovered as the sister taxon to Cerapoda that contains many ‘hypsilophodontid’ taxa. This dataset was also analyzed using Bayesian methods to determine, via comparison of Bayes factors, whether there is support for partitioning the dataset by anatomical subregions (e.g., cranial versus postcranial) or if a single partition model is preferred. The results of this latter analysis provide a quantitative means of assessing the traditional assumption that cranial characters are more important for resolving ornithischian relationships than postcranial characters.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE JAW ONTOGENY OF *DUNKLEOSTEUS TERRELLI* (PLACODERMI: ARTHRODIRA) SUGGESTS AN ACTIVE PREDATORY HABIT THROUGHOUT GROWTH

BOYLE, James T., State University of New York at Buffalo, Buffalo, NY, United States; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; SNIVELY, Eric, Ohio University, Athens, OH, United States; HLAVIN, William J., Bass Energy, Inc., Fairlawn, OH, United States;

, Cleveland Museum of Natural History, Cleveland, OH, United States

One of the driving forces of evolution is competition for resources between individuals. Competition for food is likely to be more intense among members of a single species that share an ecological niche. Ontogenetic niche shifts within some taxa (e.g. Copper Sharks) allow for resources to be partitioned between age and/or size stages, often with notable differences in jaw shape or size at the various growth stages. This phenomenon presumably has a deep historical record, although it is difficult to verify in fossil species. The Upper Devonian (Famennian) apex predator, *Dunkleosteus terrelli*, would presumably have been vulnerable to predation at smaller growth stages, and an inferior competitor to adults. To test if *D. terrelli* may have gone through ontogenetic niche shifts we examined a growth series of inferognathals (lower jaws) to test if there were significant changes in size or shape throughout ontogeny. One notable morphological feature (denticles) was examined and seven linear dimensions of more than 60 *D. terrelli* inferognathals were measured. The inferognathal typically bear two shearing cusps on the anterior portion and occasionally a row of denticles posterior to these cusps. Although the area containing the posterior denticles is poorly preserved on most specimens, denticles of the same proportional size and shape were noted on both very small and very large specimens suggesting that they do not vary ontogenetically (assuming no sexual dimorphism). The linear dimensions were analyzed for non-linear trends that would suggest shifts in function. Results indicate that the overall shape of the inferognathals was isometric throughout growth, and that the smallest known juveniles (total inferognathal length = 48mm, estimated total skull length = 125mm) of *Dunkleosteus* were active predators, just like many modern shark taxa. Subtle allometric growth between the functional length and blade length results in an increased concentration of force at the anterior cusp tip as the animal grew, allowing them to hunt larger placoderms with thicker dermal plates (indeed bite-marked skull plates suggest opportunistic cannibalism). However, lower mandible stress in juvenile *Dunkleosteus* suggests a proportionally stronger jaw despite slightly inferion mechanical advantage. Morphometric results suggest that the jaws of *Dunkleosteus* functioned similarly throughout life, and that only the size of their prey changed as they grew larger. An inference of niche shifts during ontogeny based on mandible shape changes is not supported.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

COMPARATIVE TAPHONOMY OF CERATOPSID BONEBEDS: IMPLICATIONS OF NEW DATA FROM SOUTHERN LARAMIDIA

BRANDAU, Deanna L., Natural History Museum of Utah and Dept. Geology and Geophsyics, University of Utah, Salt Lake City, UT, United States; IRMIS, Randall B., Natural History Museum of Utah and Dept. Geology and Geophsyics, University of Utah, Salt Lake City, UT, United States

Ceratopsid (horned dinosaur) fossils are well-known for preservation in multi-individual assemblages, but this is an oversimplification. Chasmosaurine ceratopsid bonebeds are rare; most specimens are found as isolated individuals. The few known chasmosaurine bonebeds are predominantly juvenile remains and number 2–3 individuals, except for *Agujaceratops* (up to 10 individuals). These bonebeds typically comprise disarticulated elements preserved in low energy, finer-grained floodplain/overbank deposits with low levels of taphonomic

modification. In contrast, centrosaurine bonebeds are predominantly attributed to mass mortality events (flooding) encompassing dozens to hundreds of individuals from all size classes. These monodominant disarticulated bonebeds are more often associated with high energy, thick paleochannel deposits and are thought to be hydraulically reworked from overbank deposits, displaying higher amounts taphonomic modification. However, most of these data are from northern Laramidia (e.g., Montana and Alberta).

Our sedimentologic and taphonomic study of two new chasmosaurine bonebeds from the middle Campanian Kaiparowits Formation in southern Utah provides insight into ceratopsid taphonomic patterns and paleoenvironmental associations. These Kaiparowits Formation sites are similar to other chasmosaurine bonebeds in being rare compared to isolated chasmosaurine specimens, comprising 2–3 individuals, exhibit low taphonomic modification, and little hydraulic reworking. One Kaiparowits bonebed was deposited as disarticulated skeletal remains in a channel, whereas the other includes articulated skeletons in a crevasse splay setting.

Because all ceratopsid bonebeds exhibit broadly similar depositional, paleoclimatic, tectonic, and basin settings, an alternate explanation is necessary for the rarity of chasmosaurine bonebeds. Although the Kaiparowits Formation has high sedimentation rates (39-42 cm/ka), chasmosaurine bonebeds are still rare in northern Laramidian formations where sedimentation rates are much lower (4-12.5 cm/ka), which suggests this does not solely explain the difference in preservation. Because chasmosaurine bonebeds are typically found in overbank deposits, and the Kaiparowits Formation has a higher ratio of overbank-hosted deposits to paleochannels, one would expect chasmosaurine bonebeds to be more common in the Kaiparowits Formation, but this is not the case. Therefore, differences between chasmosaurine and centrosaurine bonebeds appear to be better attributed to behavior or ecology, where chasmosaurines were solitary or lived in small groups, but centrosaurines congregated in larger social groups at least occasionally.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PROBOSCIDEAN DIVERSITY FROM THE PLIO-PLEISTOCENE OF HIDALGO, CENTRAL MEXICO

BRAVO-CUEVAS, Victor M., Museo de Paleontología, Universidad Autónoma del Estado de Hidalgo, Pachuca, Hidalgo, Mexico; CABRAL-PERDOMO, Miguel A., Museo de Paleontología, Universidad Autónoma del Estado de Hidalgo, Pachuca, Hidalgo, Mexico

In central Mexico, Hidalgo is a state with an important record of terrestrial mammals that inhabited the region in a time range from Pliocene to Pleistocene (*ca.* 5 Ma to 10 ka). One of most representative groups is the proboscideans. The known diversity of this group includes three families and four genera. Elephantidae is represented by the genus *Mammuthus*, Gomphotheriidae by the genera *Rynchotherium* and *Cuvieronius*, and Mammutidae by the genus *Mammut*. The taxonomic identity at species level of *Rynchotherium* and *Cuvieronius* is unresolved at this time; however, we are certain of the presence of *Mammuthus columbii* and *Mammut americanum*. The fossil material has been recovered from 13 localities unevenly distributed in northeastern and southern regions of Hidalgo. The sample consists of tusks, skulls, mandibles, numerous isolated teeth, and several postcranial elements. The record testifies that Hidalgo is a state with a high diversity of proboscideans in Mexico, given that around 75% of the mammoths and mastodonts known from North America during the last third of late Cenozoic, have been found there.

Preparators' Session (Thursday, October 18, 11:45 am)

STATE-OF-THE-ART DIGITAL DATA COLLECTION OF PALEONTOLOGICAL RESOURCES: COMPARING METHODS OF CAPTURE AND QUANTIFYING RESULTS OF 3D POINT CLOUD DATA

BREITHAUPT, Brent H., DOI-Bureau of Land Management, Cheyenne, WY, United States; MATTHEWS, Neffra A., DOI-Bureau of Land Management, Denver, CO, United States; NOBLE, Tommy A., DOI-Bureau of Land Management, Denver, CO, United States

During the last decade there has been a marked increase in the use of 3D data capture for the purpose of documentation, evaluation, and preservation of paleontological resources. Subjects can vary from an isolated tooth to an entire bonebed or from a single fossil footprint to an entire tracksite. The most notable methods for capturing 3D data of paleontological subjects are LIDAR and photogrammetry. Photogrammetric point cloud data (PPCD) contain both the exterior physical dimensionality of a subject and a high quality image texture registered precisely for each data point (x,y,z r,g,b file). Excellent results can be achieved from photogrammetry when the software solves for a robust camera calibration and when overlapping photographs are taken with proper geometry. Resulting PPCD can easily achieve submillimeter precision and be used to produce accurate rapid prototypes. Because of the computational power of the new generation of photogrammetric software, hundreds of photographs can be processed at once and stitched together allowing for the documentation of subjects "in the round." Advances to software and cameras allow this technique to be used on paleontological specimens of all shapes and sizes in the field, lab, and collections. Relatively low-cost and even free online services allow curators, collections managers and preparators to document material in their collections for research, management, and preparation purposes. Three-dimensional image datasets provide a permanent digital record of paleontological resources and is a non-destructive method to obtain 3D data assessment and can support the creation of a worldwide 3D digital data archive. These data can also lead to better science–based management decisions, which require that state-of-the-art methodologies be used in the documentation of paleontological resources in accordance with current paleontological legislation (PRPA). In addition, open source software is available for manipulating, scaling, and comparing point cloud data. This not only makes it affordable to use and compare 3D data obtained from various sources, but also makes it possible to conduct scientific evaluation of paleontological subjects. Several studies have been conducted comparing LIDAR and photogrammetry methods. Recent comparisons demonstrate that photogrammetric point clouds can be generated at a level that meets (or exceeds) the instrument specifications for the LIDAR unit used in the comparison. Once a PPCD is generated, analytical tools support direct 3D comparison of anatomical features, such as individual skull bones or tracks within a trackway. Virtually every paleontologist has the basic equipment (i.e., scale bar and camera) necessary to successfully create paleontologically useful PPCD.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

DENTAL HISTOLOGY AND TOOTH IMPLANTATION IN EARLY PERMIAN NON-MAMMALIAN SYNAPSIDS

BRINK, Kirstin S., University of Toronto Mississauga, Mississauga, ON, Canada; LEBLANC, Aaron R., University of Toronto Mississauga, Mississauga, ON, Canada; SANDER, P. Martin, University of Bonn, Bonn, Germany; REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada

The tooth implantation of non-mammalian synapsids has been previously described as protothecodont or subthedocont, based on the macroscopic observation that the tooth root is implanted in a shallow socket and separated from neighboring teeth by bone or other connective tissues. However, the mode of tooth implantation in non-mammalian synapsids is poorly known, because the teeth and tooth attachment tissues of these lineages have never been described histologically in any detail. Here, we describe for the first time the tooth attachment of marginal and palatal teeth of sphenacodontids and the marginal dentition of a mycterosaurine varanopid using histological methods. Dentary and maxillary teeth of *Sphenacodon*, *Dimetrodon natalis*, *Dimetrodon grandis*, and an undescribed varanopid from Oklahoma as well as the teeth of the pterygoid flange and the palatal surface of the pterygoid of *Dimetrodon limbatus* were examined in longitudinal and transverse sections. We observed that the labial walls of the tooth bearing elements are higher than the lingual walls in all four taxa, creating a superficially pleurodont implantation, but all marginal teeth are implanted in true sockets lined with vascularized alveolar bone. The teeth are ankylosed to the alveolar bone of the socket through a layer of acellular cementum. The pterygoid teeth of *Dimetrodon* are also connected to alveolar bone by a layer of acellular cementum. Interestingly, these non-mammalian synapsids exhibit plicidentine (infolding of the dentine at the tooth root), a first for Synapsida. The dentine infoldings in *Sphenacodon* and *Dimetrodon* have a four-lobed shape below the level of the jaw line, which becomes convoluted closer to the base of the root. By comparison, plicidentine in the varanopid does not possess the four lobes present in sphenacodontids and is instead highly convoluted throughout the root of the tooth. We hypothesize that plicidentine in these non-mammalian synapsids played a role in increasing the surface area of attachment for cementum and alveolar bone at the base of the tooth root. The results of this analysis suggest that development of palatal and marginal dentitions in non-mammalian synapsids is regulated by similar mechanisms regardless of the tooth position in the skull. The occurrence of plicidentine, cementum, and alveolar bone in Early Permian synapsids suggests that the presence of these tissues is plesiomorphic for Synapsida.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 9:00 am)

SOUTHERN NORTHERN CROCODILES: *BOREALOSUCHUS* FROM THE CAMPANIAN OF ALABAMA AND THE EARLY BIOGEOGRAPHIC HISTORY OF CROCODYLIANS IN NORTH AMERICA

BROCHU, Christopher A., University of Iowa, Iowa City, IA, United States; DENTON, Robert K., GeoConcepts Engineering, Inc., Ashburn, VA, United States; GRANDSTAFF, Barbara S., University of Pennsylvania, Philadelphia, PA, United States; PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States; SCHEIN, Jason P., New Jersey State Museum, Trenton, NJ, United States

The eusuchian *Borealosuchus* is endemic to North America and preserves critical evidence for the phylogenetic relationships and historical biogeography of the earliest crocodylians. It is best known from deposits of Maastrichtian through middle Eocene age in the Western Interior, but the lineage has also been found along the Atlantic Coastal Plain, including a new species based on craniomandibular and postcranial remains from the Campanian Eutaw Formation and Mooreville Chalk of Alabama. It is the oldest known species of *Borealosuchus*, and like *B. threeensis* from the latest Maastrichtian-earliest Paleocene of New Jersey, it has virtually no external mandibular fenestra and bipartite ventral osteoderms. These are features shared with late Paleocene-Eocene *B. wilsoni* from western North America. Unlike either *B. wilsoni* or *B. threeensis*, the new form retains a robust splenial symphysis. The lacrimal is unusually long, suggesting the derived rostral sutural condition found in western *Borealosuchus*. Eastern Late Cretaceous *Borealosuchus* are more closely related to species from the late Paleocene and Eocene than they are to Maastrichtian-early Paleocene western members of the clade, suggesting a substantial unsampled history for the group. Most other eastern crocodyliforms belong to groups found in western North America, and the only close relationships between eastern North American and Eurasian or African crocodyliforms is limited to coastal groups (e.g. thoracosaurs, dyrosaurids). Whether this pattern reflects dispersal or vicariance driven by the rising and falling Western Interior Seaway, and the number and timing of such events, is unclear. The absence of an external mandibular fenestra in the new species, as well as in early putative gavialoids and several

outgroups to Crocodylia, raises questions about the homology of the structure in extant crocodylians; and lability of *Borealosuchus* relative to other basal crocodylian clades in our results reveals sensitivity of crocodylian phylogenetic analyses to outgroup sampling.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

SKULL SHAPE VARIATION IN LEPIDOSAURS: THE INFLUENCE OF ECOLOGY AND PHYLOGENY

BROCKLEHURST, Neil, Museum für Naturkunde, Leibniz-Institut für Evolutions und Biodiversitätsforschung, Berlin, Germany

Studies on various vertebrate groups have unsurprisingly shown a link between cranial morphology and diet. Studies focused on lizards, however, have produced conflicting results, with some showing little correlation between diet and skull and tooth morphology, and others finding variation in snout shape between carnivorous and herbivorous groups. This investigation focused not only on lizards but also on Rhynchocephalia, both extant and extinct. Measurements were made on the cranium in ventral view, with landmarks positioned around the tooth row and adductor chamber to represent their shape. These landmarks were analysed using the geometric morphometric software Morphologika to examine how skull shape differs between species. Three significant principal components were identified by Morphologika. As Principal Component 1 (PC1) increases in value, the distance between the tooth rows increases, and the distance between the tooth rows and the adductor chambers decreases. As the value of PC2 increases, the tooth row shortens, and the adductor chamber increases in size. PC3 relates to the position of the quadrates relative to each other. As the value increases, the quadrates move closer together. Results show that species within the same clades tend to have similar cranial shapes, but within each clade morphology varies according to dietary specialisation. Predatory squamates such as Varanidae and Teiidae usually have longer, narrower tooth rows and widely spaced quadrates whereas herbivores like the Iguanidae and the rhynchocephalian *Priosphenodon* have relatively larger adductor chambers, positioned closer to the tooth row. Long, narrow tooth rows (reflecting elongate rostra) are also a feature of aquatic lepidosaurs. Acrodont iguanians and Rhynchocephalia show a similar tooth-row outline, suggesting they occupied similar niches, a factor that may have contributed to the decline of the Rhynchocephalia towards the end of the Mesozoic.

Technical Session IV (Wednesday, October 17, 4:00 pm)

EVIDENCE FOR TAPHONOMIC SIZE BIAS IN A MODEL MESOZOIC TERRESTRIAL ALLUVIAL-PARALIC SYSTEM

BROWN, Caleb M., University of Toronto, Toronto, ON, Canada; EVANS, David C., University of Toronto/Royal Ontario Museum, Toronto, ON, Canada; CAMPIONE, Nicolás E., University of Toronto, Toronto, ON, Canada; O'BRIEN, Lorna J., University of Toronto, Toronto, ON, Canada; EBERTH, David A., Royal Tyrrell Museum , Drumheller, AB, Canada

The body-size distribution of dinosaurs reveals a prominent negative skew (towards large body size), a pattern opposite to modern terrestrial faunas. Here, we test if this pattern is a biological feature of dinosaur faunas or the result of taphonomic processes. We use the Dinosaur Park Formation (DPF: Campanian, Alberta) as a model to examine the relationship of body-size (estimated body mass) with taphonomic/sampling proxies, such as taxon completeness, taphonomic mode, and year of discovery/description, to test the hypothesis that the distribution of body-size in dinosaurs is biased by preservation potential. We find a direct correlation between taxon size and known skeletal completeness ($r=0.90$, $p<0.001$). In particular, there is a clear dichotomy in which taxa <60 kg are significantly less complete (mean completeness = ~8%) than those ≥60 kg (~78%). There is also a strong association of body-size and taphonomic mode, with small taxa known largely from isolated and occasionally associated remains, and large taxa known mainly from articulated skeletons. All correlations are consistent both within and between taxonomic groups (e.g., Dinosauria, Ornithischia, Theropoda, Ornithopoda, etc.). A significant correlation is also noted between taxon body mass and both its date of discovery and description, with taxa <60 kg taking an average of ~60 and ~75 years to discover and describe, respectively, compared to ~30 and ~36 years for taxa ≥60 kg. The rates of both accumulative discovery and description for large taxa are best described by a logarithmic curve nearing an asymptote, while small taxa show either a linear or power law increase through time. This suggests our current knowledge of the large-bodied dinosaur assemblage is representative of the true biological fauna with few discoveries likely to be made in the future, while the diversity and abundance of small taxa are greatly underestimated, with more discoveries to be made. Our results indicate that the interpretation of the paleoecology of the DPF requires recognition of this taphonomic bias, which greatly reduces its compositional fidelity for small-bodied forms. Given that (1) the sedimentary deposits and fossil assemblages of the DPF represent one of the best studied examples of a Mesozoic alluvial-paralic (terrestrial) 'paleoecosystem,' and (2) similar patterns have been suggested (but not documented) for other Mesozoic terrestrial ecosystems in the Western Interior of North America, we suggest this pattern of taphonomic size bias may typify vertebrate fossil assemblages in Mesozoic systems. If so, such biases must be considered before patterns of diversity in dinosaur communities through time can be accurately reconstructed, or used to compare and interpret Mesozoic paleoecosystems.

Preparators' Session (Thursday, October 18, 10:45 am)

TECHNIQUES AND MATERIALS FOR MICROFOSSIL PREPARATION: MAXIMIZING SUCCESS AND MINIMIZING STRESS

BROWN, Gregory W., University of Nebraska State Museum, Lincoln, NE, United States

Microfossil preparation is probably the most difficult and stressful job a preparator can undertake. Although successful microfossil preparation requires considerable skill, dexterity and patience, no level of these attributes can overcome the powerful influences of using poor equipment, techniques and materials. On this scale, even minor errors in judgment or execution can result in disastrous loss of data. By optimizing our tools, techniques and materials we can maximize successful outcomes. Proper tools include a stereo microscope with zoom capability and quality optics, a variety of light sources, a stable work-holding stage or jig (a ball-mount), precision preparation tools that provide maximum control (carbide) and minimum damage (polished points of various shapes, insect needles, porcupine quills), hand/arm support that provides optimum positioning and support, and ergonomic seating. Useful materials include various reaction and solution adhesives, specimen supports (polyethylene glycol, cyclododecane) and temporary positioning aids (waxes, plastiline). Techniques include using light of various wavelengths or color temperatures to help differentiate between matrix and bone, enhancing visual perception by preparing through and within water-droplets and using capillary action to apply adhesives, among others. Technique is the most difficult category to describe precisely because, as is true in all other aspects of preparation, each situation encountered will demand a new or significantly modified technique. Work station setup that provides a stable base or mount for the microscope and work stage, a method of minimizing the possibility of fragment-loss, arrangement of tools and maintaining work area cleanliness all contribute to the quality of microfossil preparation and may be the difference between a job well-done and a specimen essentially lost to science.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:15 am)

ON THE UTILITY OF LIKELIHOOD MODELS FOR PHYLOGENETIC RECONSTRUCTION FROM DISCRETE MORPHOLOGICAL CHARACTERS

BROWN, Joseph W., University of Idaho, Moscow, ID, United States; SLATER, Graham J., UCLA, Los Angeles, CA, United States

After a relatively slow reception a decade ago, morphological likelihood (Mk) models are emerging as a popular alternative to parsimony for phylogenetic reconstruction from discrete morphological characters. The reason for this recent uptake in use is that Mk offers several promising features, chief among which are: 1) the ability to apply likelihood methods to paleontological data (including branch length estimation), and 2) the ability to incorporate molecular and morphological data into a single joint model-based phylogenetic analysis. Despite these promising features, Mk is based on two very strict assumptions: 1) that all character state transitions occur at the same rate, and 2) that the equilibrium frequencies of all character states are equal. These assumptions are clearly wrong, but it is not clear whether these are 'importantly wrong' (i.e., they bias inference). Here we use simulation methods to investigate how model assumption violations impact phylogenetic reconstruction accuracy. Failing to accommodate differences in character state frequencies misleads phylogenetic reconstruction, frequently returning incorrect but highly-supported trees. Violation of the equal transition rate assumption likewise misleads phylogenetic reconstruction, the degree of which depends on the extent of model violation. Results are presented exploring a range of simulation conditions, as well as for an empirical study of archosaurs.

Preparators' Session (Thursday, October 18, 12:00 pm)

VERTEBRATE PALEONTOLOGICAL PREPARATION CORE COMPETENCIES AND TRAINING CURRICULUM: RESULTS FROM THE 2012 AUSTIN WORKSHOP

BROWN, Matthew A., The University of Texas at Austin, Austin, TX, United States; DAVIDSON, Amy, American Museum of Natural History, New York, NY, United States; FOX, Marilyn, Yale Peabody Museum, New Haven, CT, United States; JABO, Steven J., Smithsonian National Museum of Natural History, Washington, DC, United States; SMITH, Matt, Petrified Forest National Park, Petrified Forest, AZ, United States

A number of organizations responsible for the care of fossils call for preparation by individuals with specialized training (e.g., Society of Vertebrate Paleontology, National Park Service). At present, there is no consensus as to what constitutes a trained or qualified preparator. A writing workshop at The University of Texas at Austin (UT) Vertebrate Paleontology Laboratory was organized to address this gap between policy and practice. The goal of the workshop was originally to produce preparation standards documents and a curriculum for training and evaluating preparators. In practice, such a project exceeded the time constraints imposed by the one week available to the authors, thus the aim was shifted to defining the trained preparator and creating a model syllabus for teaching basic paleontology laboratory practices. Through this workshop, a team of five preparators drafted a competencies document encompassing the fundamental knowledge, skills, and abilities that typify capable fossil preparation and conservation. Fourteen competencies were identified and elaborated upon, covering areas such as: Critical Thinking, Understanding of Conservation Principles and Ethics, Understanding and Aptitude in the Use of Preparation Tools and Techniques, and Understanding and Use of Adhesives. The competencies were subsequently used to create a model syllabus for an introductory course in fossil preparation. The course is designed to provide students with an overview of the methods commonly

encountered in paleontology laboratories, including preparation, conservation, molding, and casting, exposure to a range of tools and techniques, as well as an introduction to the relevant literature. The syllabus can be easily modified and adopted by other institutions and ensures that students are grounded in the basics of good preparation. The syllabus was also designed to be scalable, any element of it (e.g. molding) can be individually expanded to constitute a short workshop or fill an entire semester. This framework can then function as a broader curriculum for formal or informal training in paleontological preparation. Discussions during the workshop highlighted the need for continuing work toward training programs and standards in preparation. These competencies will provide a foundation for this continuing discussion of standards and best practices in vertebrate paleontological preparation. The core competencies and syllabus may eventually be useful as a basis for certification of vertebrate fossil preparators, as well as provide guidance for hiring officials when writing job descriptions or evaluating applicants for preparation positions.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 10:15 am)

THEROPOD DINOSAURS FROM THE LATE CRETACEOUS OF EASTERN NORTH AMERICA: ANATOMY, SYSTEMATICS, BIOGEOGRAPHY AND NEW INFORMATION FROM HISTORIC SPECIMENS

BRUSATTE, Stephen L., American Museum of Natural History, New York, NY, United States; CHOINIERE, Jonah N., American Museum of Natural History, New York, NY, United States; BENSON, Roger B., University College London, London, United Kingdom; CARR, Thomas D., Carthage College, Kenosha, WI, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States

During the latest Cretaceous (Campanian-Maastrichtian), when North America was bisected by the Western Interior Seaway, a diverse fauna of carnivorous theropod dinosaurs ranged across the western half of the continent (Laramidia). Some of these taxa, such as *Tyrannosaurus* and *Dromaeosaurus*, are among the most familiar dinosaurian carnivores of the Mesozoic. Considerably less is known about the theropods that lived in eastern North America (Appalachia) at this time. Their sparse fossil record has frustrated scientists since the first discoveries of theropods in New Jersey and surrounding states by Cope, Leidy, and colleagues in the mid-late 1800s. Over the past decade, new fossil discoveries and reinterpretations of historic specimens, studied in the context of an ever-growing phylogenetic understanding of theropods, have shed new light on Appalachian theropod faunas. Reasonably complete and diagnostic specimens are rare, but the inventory of Appalachian Late Cretaceous theropods in major museum collections includes specimens of at least three diagnosable taxa: two tyrannosauroids (*Appalachiosaurus montgomeriensis*, *Dryptosaurus aquilunguis*) and an ornithomimosaur ("*Ornithomimus*" *antiquus*), as well as additional tyrannosauroid and ornithomimosaur material that cannot be tied to the holotypes of these three taxa based on shared derived characters. *A. montgomeriensis*, from the mid Campanian Demopolis Formation of Alabama, and *D. aquilunguis*, from the Maastrichtian New Egypt Formation of New Jersey, are both known from holotypes that preserve several cranial and postcranial bones. A recent phylogeny of Tyrannosauroidea shows that both *A. montgomeriensis* and *D. aquilunguis* are "intermediate" tyrannosauroids, nested between basal taxa such as *Guanlong* and *Dilong* and the derived, large-bodied Tyrannosauridae, the clade consisting of *Albertosaurus*, *Tyrannosaurus*, and kin that were apex predators in western North America and Asia during the latest Cretaceous. Therefore, the eastern North American taxa are considerably more basal than their western contemporaries, suggesting that Late Cretaceous Appalachia may have been a refugium for relictual species. The long-mysterious "*O.*" *antiquus* is represented by two specimens from the Maastrichtian of New Jersey originally described by Leidy. It can be referred to Ornithomimosauria based on the gracile, arctometatarsalian pes that lacks a deep notch proximally on metatarsal II, and is diagnosed as a distinct taxon by an autapomorphic bulbous medial condyle on the tibia. Phylogenetic analysis suggests that it is a relatively derived ornithomimosaur, closely related to *Ornithomimus* and *Gallimimus*. There is no evidence that "*O.*" *antiquus* was a primitive taxon ancestral to Laramidian ornithomimosaurs, as has been argued.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

SOMITE - LATERAL PLATE INTERACTION AS A DEVELOPMENTAL CONTROL ON EVOLUTION OF TETRAPOD AXIAL MORPHOLOGY

BUCHHOLTZ, Emily A., Wellesley College, Wellesley, MA, United States

Morphology is understood as the product of natural selection acting on variants generated randomly by the developmental process. If the generation of variation is not random, any bias may limit the possible morphologies that natural selection can elicit. Here amniote axial morphology is examined to ask if the distribution of its variation reflects the existence of bias imposed by the early embryonic interaction of somitic (SM) and lateral plate mesoderm (LPM) cell populations. In tetrapods, premyocytes at isolated anterioposterior somite levels (hypoglossal, limb, diaphragm, and cloacal locations) delaminate from the dermomyotome, migrate along routes established by chemical signaling, and then invade and muscularize structures of lateral plate origin. Major transitions in vertebrate axial patterning occur at these same locations. For example, the axial cervicodorsal and dorsocaudal transitions occur at axial locations where somitic cells migrate into the lateral plate limbs. Multiple lines of evidence also suggest that both internal differentiation within the cervical region and the thoracolumbar transition of mammals are tied to the migration of cells from the cervical somites to the lateral plate diaphragm. This study asks whether SM-LPM interaction is also associated with limitations in the meristic variation of the column. Using a database of vertebral anatomy in living and fossil tetrapods assembled from museum collections and from the literature, it concludes that greater SM-LPM interaction is associated with both column subdivision and progressive restriction in meristic flexibility, with mammals being the clade with greatest SM-LPM interaction, regionalization of the column, and meristic constraint. The hypothesis of a causal tie is supported by examples of evolutionary loss of SM-LPM interaction that are associated with reappearance of meristic flexibility. This is most vividly demonstrated by terrestrial taxa that have undergone limb loss during re-invasion of marine habitats. These results emphasize the important role that developmental mechanisms may play in influencing and limiting macroevolutionary trends.

Technical Session I (Wednesday, October 17, 9:30 am)

EVOLUTION OF THE FORELIMB MUSCULATURE IN TYRANNOSAUROIDEA (DINOSAURIA: THEROPODA)

BURCH, Sara H., Stony Brook University, Stony Brook, NY, United States

The highly reduced forelimbs of tyrannosaurid theropods have sparked many hypotheses about their function. Although the musculature and its function in the charismatic taxon *Tyrannosaurus* has been studied, the myology of other tyrannosauroids has largely been ignored. This study provides the first look at the forelimb musculature across the entire clade and examines what the major morphological shifts reveal about the evolution of reduced forelimb function. Osteological correlates of muscle attachment were identified on pectoral girdle and forelimb material in 11 tyrannosauroid and several outgroup taxa. Morphological features were coded as characters and optimized onto a recent tyrannosauroid phylogeny to trace character transformations. Most major shifts in the forelimb musculature occur at the base of Tyrannosauridae, though a few appear earlier among tyrannosauroids. The scapula and humerus show an enlargement of the available area for attachment of deltoideus musculature in tyrannosaurids, which is primarily responsible for humeral abduction as well as some protraction and retraction. Expansion of the internal tuberosity is retained in most tyrannosauroids except for *Tyrannosaurus* and *Raptorex*; reduction in these taxa results in less insertion area and shorter lever arms for much of the adductor musculature of the humerus. Supinator became primarily a flexor of the forearm early in the tyrannosauroid lineage as shown by the excursion of its origin proximal to the ectepicondyle and a shift of its insertion from the lateral to the anterior surface of the radius. Inability to pronate or supinate may also be indicated by scars for the interosseus membrane on the radius in some tyrannosaurids. The distal migration of the triceps brachii insertion from the tip of the olecranon also characterizes tyrannosauroids, extending the lever arm without requiring expansion of the olecranon process. In the manus, reduction of the medial tubercle on metacarpal I in tyrannosaurids results in a shorter lever arm for extensor carpi radialis brevis, which is responsible in part for abduction of digit I. Accompanying this reduction, however, is development of a medial tubercle on the proximal ventral surface of I-1 near the abductor digiti I insertion, indicating a shift of major abduction responsibility to the intrinsic manual musculature. These and other myological characters of tyrannosauroid forelimbs show a mosaic pattern of reduction and enlargement with retention of robust musculature for some functional units (e.g., flexors, extensors) even as others (e.g., adductors) have become diminished. Substantial differences in the morphology of even closely related taxa suggest that a single functional hypothesis does not apply to all reduced forelimbs.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

USING GIS SLOPE AND ASPECT DATA AS PREDICTORS OF SURFACE FOSSIL ABUNDANCE IN THE UINTA BASIN, UTAH

BURK, Daniel A., Intermountain Paleo-Consulting, Draper, UT, United States

A variety of factors contribute to slope degree and aspect in a primarily erosional modern environment such as that found in the Uinta B (Wagonhound) Member of the Uinta Formation in Uintah Co., Utah, USA. These factors include but are not limited to: the freeze-thaw cycle, vegetation, insolation, presence of water, and regolith development. These factors combine to determine the types of slopes and aspects upon which fossils will be found at the surface. Data regarding fossils found in a sample PLSS section was collected through paleontological reconnaissance surveys. Slope and aspect data were obtained from a 5m resolution DEM. Using a GIS, slope angle and aspect data were combined with fossil data and analyzed. Slopes were classified into two nominal categories: low angle (angles between 0° and 10°) and high angle (angles > 10°). Aspects were classified into two nominal categories: southern (aspects between 90° and 270°) and northern (all other aspects). These categories were combined to create four nominal categories for all fossils: North Low, North High, South Low, and South High. Assuming a random, unbiased distribution of fossils in the subsurface, χ^2 analysis showed that, with 99.5% confidence, fossils are not distributed equally on all surface types. Fossils were 81.3% to 87.1% more likely to be found on surfaces in the South Low category than on any other single surface category. Surfaces with southern aspects tend to have less available water allowing them to support less vegetation and contributing to more poorly developed regolith. Regolith is more developed on northern facing surfaces and can obscure or destroy existing fossils. Additionally, surfaces with higher angle slopes have less available surface area with which to expose fossils. Therefore, the combination of low angle slopes and southern aspects allows for fossils to be found on the ground surface more readily. Other factors possibly influencing discovery of fossils not considered in this study include rock type, depositional environment, degree of weathering, time of day or year and local weather conditions during which reconnaissance surveys were conducted, and attitude and skill of surveyors.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

PLESIOSAURS HAD A TASTE FOR BIRDS

BURNHAM, David A., University of Kansas Biodiversity Institute, Lawrence, KS, United States; MARTIN, Larry D., University of Kansas Biodiversity Institute, Lawrence, KS, United States; ROTHSCHILD, Bruce M., University of Kansas Biodiversity Institute, Lawrence, KS, United States

Presence of unhealed bite marks or stomach contents suggests the possibility of predation, but could also represent scavenging. Healed bite marks witness failed predation and potentially allow identification of both prey and predator. Avian predator-prey interactions are difficult to document because of the fragility of the avian skeleton. Partially digested hesperornithiform bones have previously been reported in stomach contents of the mosasaur *Tylosaurus* and enantiornithine bird bones, in the abdominal cavities of an ichthyosaur and the dromaeosaur, *Microraptor*. We present evidence that the Late Cretaceous ornithurine, *Hesperornis*, was a prey item for plesiosaurs, in a manner analogous to the relationship between contemporary penguins and killer whales. Conical depressions were macroscopically and radiologically examined on the left leg of a *Hesperornis* (YPMPU 17208) and compared to the tooth character and spacing of dentition in mosasaurs and plesiosaurs. The tibiotarsus had a series of rounded 4.4 mm depressions at 11.9 mm intervals, with inwardly pressed bone fragments. The size and separation of the depressions matched that of a small polycotylid plesiosaur. Radiologic examination of the distal tibiotarsus revealed an irregular moth-eaten radiolucent area, documenting osteomyelitis complicating the bite trauma.

The *Hesperornis* appears to have been attacked by a polycotylid plesiosaur that was unable to maintain its grip and the *Hesperornis* was able to escape. While there is evidence of plesiosaur predation on fish and cephalopods, there is limited evidence that they targeted tetrapods. To examples of plesiosaur predation, a pliosaur and an embryonic ichthyosaur, is now added *Hesperornis*.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

QUANTITATIVE ANALYSES OF CRANIAL CHARACTERS IN *PANOPLOSAURUS* AND *EDMONTONIA* (ANKYLOSAURIA: NODOSAURIDAE) AND THEIR TAXONOMIC IMPLICATIONS FOR THE CLADE

BURNS, Michael E., University of Alberta, Edmonton, AB, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

The clade *Edmontonia+Panoplosaurus* is widely accepted as the most highly-derived group of nodosaurid ankylosaurs. Despite representation by adequate cranial, postcranial and osteodermal material, the taxonomic assignment of some specimens remains equivocal. Four new skulls referable to this clade were collected from Dinosaur Provincial Park in 1998 and can be used to quantitatively reassess cranial characters with measurement data and binary morphological characters. PCA and neighbour joining analyses on raw measurement data suggests possible affinities between *Panoplosaurus* and one of these 1998 specimens.

Statistical analyses of some characters suggest division into "*Panoplosaurus*" and "*Edmontonia*" specimen groups. Normalized for skull length, the "*Edmontonia*" group exhibits larger width to length ratios. *Panoplosaurus* also has armor encroachment over the anterior rim of the lateral temporal fenestra that is not observed in "*Edmontonia*" specimens. Most bivariate plots show that many characters traditionally used to distinguish *Panoplosaurus* fall within the range of variation of specimens referred to *Edmontonia*. This is complicated by the fact the holotype skull of *Panoplosaurus* is significantly shorter than all other skulls referable to *Edmontonia+Panoplosaurus*.

The addition of new characters into a character-taxon matrix allows a specimen-specific parsimony evaluation of those characters. An initial heuristic search (10000 replicates, tree bisection reconnection algorithm) of 7 ingroup and 3 outgroup OTUs and 54 characters (16 parsimony-informative) returned 17 most parsimonious trees (length 29 steps, consistency index 0.93, and retention index 0.92). A 50% majority rule consensus returns the holotype of *P. mirus* as the most deeply nested specimen and the holotype of *E. rugosidens* as most basal. This means that either the remainder of the specimens examined represent *P. mirus*, or that *Edmontonia* may be paraphyletic.

Completion of this project hinges on inclusion of all available skull specimens referable to this clade, including the holotype of *E. longiceps*, and incorporating all available data (including results of morphometric analyses) into a more global analysis before taxonomic decisions can be made. It is clear, though, that the inclusion of more anatomical data demonstrates that the relationships amongst specimens referred to this clade are more complex than previously intimated. The addition of more material and data may help to clarify possible taxonomic groupings among all relevant specimens.

Technical Session VII (Thursday, October 18, 2:30 pm)

EXPLORING AND EVALUATING THE IMPACT OF ANATOMICAL PARTITIONS ON MORPHOLOGY-BASED PHYLOGENETIC ANALYSES

BURROUGHS, Robert W., The University of Texas at Austin, Austin, TX, United States

Paleontologists must use, of necessity, limited data to reconstruct the relationships of extinct taxa represented by fossils. An implicit assumption that underlies many paleontological systematic studies is that characters from anatomical sub-regions (i.e., the cranium, appendicular, or axial post-cranial skeleton) each provide similar or congruent phylogenetic signal independent of one another. I tested this assumption through examination of a dataset of extant Emydid turtles divided into two anatomical partitions (cranial and shell). I conducted a series of tests to evaluate how those partitions affect resulting phylogenetic estimations. Traditional parsimony approaches were used to evaluate congruence between partitions when they are independently analyzed, including the partition-homogeneity test. In addition to parsimony, congruence was evaluated using Bayesian partition analyses, Bayes factor calculations, and topological congruence between reconstruction methods. The results of these tests indicate that the phylogenetic hypotheses generated by each partition independently are not fully congruent regardless of reconstruction method, and that a loss of resolution is generally found when using only cranial characters; shell characters often yield increased resolution by comparison. Compared to other reconstruction methods (e.g., Bayesian or maximum likelihood) parsimony has increased topological resolution, regardless of the partition used. The partition-homogeneity test was inconclusive, with partitions appearing to be no more, or less, congruent than incongruent with one another. Bayes factors indicated that partitioning the data into two anatomical partitions is appropriate and statistically preferred. Bayesian partition analyses showed that tree topology was improved when each partition is allowed to inform tree topology independently. This indicates that each partition is appropriate within the dataset and that each partition is potentially evolving at a different rate. If the partitions exhibit rate heterogeneity then selection of characters for evaluating older (stem) versus younger (crown) taxa is greatly impacted. The independence of characters within a given partition must also be critically evaluated. These data indicate that exploration of a dataset is critical to understanding how character partitions may be informing tree topology and may produce biased results, and give insight into the selection of characters and character partitions for turtle systematics, providing a methodological framework for addressing complex systematic questions employing modern methods.

Technical Session IX (Friday, October 19, 9:15 am)

SYSTEMATIC AND ANATOMICAL RE-EVALUATION OF BASAL PHYTOSAURS FROM THE LATE TRIASSIC OF CENTRAL EUROPE, WITH IMPLICATIONS FOR LATE TRIASSIC BIOSTRATIGRAPHY

BUTLER, Richard J., Ludwig Maximilian University of Munich, Munich, Germany; STOCKER, Michelle R., The University of Texas at Austin, Austin, TX, United States; RAUHUT, Oliver W., Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; LAUTENSCHLAGER, Stephan, University of Bristol, Bristol, United Kingdom; BRONOWICZ, Robert, University of Warsaw, Warsaw, Poland

Phytosaurs are a diverse and morphologically distinctive clade of superficially crocodile-like archosauriforms that had a near global distribution during the Late Triassic. Because their remains are among the most abundant vertebrate remains recovered in many Late Triassic terrestrial formations, phytosaurs are used extensively in long-range biostratigraphic correlations. The stratigraphically oldest and most basal known phytosaurs include an array of nominal species from the early Late Triassic of North America, central Europe, Morocco, and India that have been synonymized within the genus *Paleorhinus*, and subsequently used to define a global "*Paleorhinus* biochron". However, recent phylogenetic work suggested that the North American species previously referred to *Paleorhinus* are paraphyletic. Here, we reassess the systematics and anatomy of putative *Paleorhinus* specimens from Germany and Austria. Two well-preserved basal phytosaur skulls from the Blasensandstein (Carnian) of Bavaria form the holotypes of *Francosuchus angustifrons* and *Ebrachosuchus neukami*, both of which were synonymized with *Paleorhinus* by previous workers. We demonstrate that *Francosuchus angustifrons* shares unique synapomorphies with *Paleorhinus bransoni* from the Late Triassic of Texas and Wyoming, and thus refer the species to *Paleorhinus*. By contrast, the longirostrine *Ebrachosuchus* is highly distinctive in morphology, and a new cladistic analysis of Phytosauria demonstrates that it represents a valid taxon that is more closely related to Phytosauridae than to *Paleorhinus*. CT scan data allows virtual reconstruction of the crocodylian-like endocranial anatomy as well as examination of the cranial sinuses, including a remarkable and extensive pneumatic paranasal sinus, providing new insights into basal phytosaur paleobiology. Our work provides the first autapomorphy-based support for a monophyletic but restricted *Paleorhinus* (supported by a nodal row on the jugal, and low paired ridges on the squamosal) and confirms that previous broader conceptions of *Paleorhinus* are likely to be paraphyletic. A putative specimen of *Paleorhinus* ("*Francosuchus*" *trauthi*) from marginal marine beds in the Late Triassic of Austria has previously been used to correlate the "*Paleorhinus* biochron" to marine stages. We demonstrate on the basis of micro-CT data that "*Francosuchus*" *trauthi* differs in numerous and substantial features from basal phytosaurs, and instead likely represents a non-phytosaurian saurian clade. Therefore, precise correlation of Late Triassic terrestrial units bearing *Paleorhinus* to the global marine timescale cannot continue using that taxon.

Technical Session IV (Wednesday, October 17, 2:45 pm)

CONTINUOUS CHARACTER STATES AND THEIR IMPACT ON THE PHYLOGENY OF THE PTEROSAURIA

BUTTON, David J., University of Bristol, Bristol, United Kingdom; UNWIN, David M., University of Leicester, Leicester, United Kingdom; PURNELL, Mark A., University of Leicester, Leicester, United Kingdom

The use of continuous characters in phylogenetic analysis is controversial, primarily because there is no consensual method for coding them into discrete states, which can result in conflict owing to inconsistencies in delimitation of states between different analyses. Such problems may be especially marked in vertebrate paleontology as analyses of fossil vertebrates often include a relatively high proportion of continuous characters. The pterosaurs are a notable example of such a group, with recent analyses containing 20-25% continuous characters. Difficulties with state delimitation may hence be contributing to the current lack of consensus in pterosaur phylogeny. To test this possibility two recent contrasting analyses of pterosaurs were reanalysed employing an additive treatment using TNT. This approach is capable of handling continuous character data directly, avoiding the need to delimit discrete states. Experimentation with inclusion and exclusion of continuous characters showed that whilst they do convey some phylogenetic signal, many such characters, and the majority of character states, are flawed. Critically, however, varying the treatment of continuous characters failed to detect any significant role for them in the conflict between pterosaur phylogenies which, in this case, appears to be related to fundamental differences in general character selection and coding, with certain problematic taxa (such as *Germanodactylus*) coded differently for identical characters between matrices. Additionally, a basalmost position of the Anurognathidae and, more tentatively, paraphyly of the Ctenochasmatoidea are supported. Some theoretical and practical issues with continuous characters, especially for groups with small sample sizes as is typical for fossil vertebrates, prevent their use from being generally recommended. However, as they do show some phylogenetic signal, they cannot be omitted outright. Rather than ruling out entire classes of data based on presumed weaknesses it would seem more prudent to critically evaluate all characters on the grounds of the hypotheses of homology they present. In the case of pterosaurs it is clear that movement toward a consensus regarding their phylogenetic relationships will require a transparent and thorough reappraisal of character selection and coding.

Technical Session XV (Saturday, October 20, 11:45 am)

USING TRAIT-BASED ANALYSES TO UNDERSTAND CERATOPSIAN COMMUNITIES IN LARAMIDIA DURING THE LATE CRETACEOUS

BYKOWSKI, Richard J., Indiana University, Bloomington, IN, United States

Traditional approaches to studying communities have focused on comparisons between pairs of species to ascertain how they manage to coexist. However, these methods are not wholly appropriate for studying extinct non-analogue communities. Applying trait-based methods is more appropriate to quantify how communities form and they are ideal for paleontology where discrete traits are our primary data. Shared traits that are independent of phylogeny could be indicative of community-adapted features while unique traits could be indicative of niche partitioning or character displacement. In these analyses, traits that are shared among taxa and traits unique to a single taxon are both informative. The diversity of horned dinosaurs in Laramidia during the Late Cretaceous provides an excellent opportunity to apply these methods intraspecifically to see how multiple large-bodied organisms managed to coexist with reduced potential habitat spaces. A comprehensive phylogeny of 208 discrete characters for North American horned dinosaurs was compiled from published matrices including 27 taxa from the Campanian and Maastrichtian and these were subjected to a Principal Coordinates Analysis to describe morphological disparity. In addition, a genus-level dataset of 265 fossil occurrences was downloaded from the Paleobiology Database to estimate alpha-level diversity and calculate niche preference. Niche preference was tabulated from a rank-index for four environments along a gradient from coastal-marine to upland-montane based on occurrence formation. The niche index illustrates statistically significant differences between chasmosaurines and centrosaurines ($p=0.03$) but not between either of these and the basal ceratopsians ($p>0.05$). The index showed chasmosaurines more often occurring closer to coastal environments than centrosaurines. Shifts in morphological disparity also show statistically significant differences between all three groups ($p<0.05$) with changes in disparity significantly positively correlated between centrosaurine disparity and centrosaurine diversity ($p<0.01$, $r=0.96$) but not basal ceratopsian disparity and diversity ($p=0.06$, $r=-0.61$). However, it was found that changes in disparity were significantly ($p<0.01$) negatively correlated between disparity in chasmosaurines ($r=-0.78$) and basal ceratopsians ($r=-0.86$). From these results, it appears that community composition was driven by taxonomic turnover. In this case, the surviving taxa were more inter- and intraspecifically different suggesting that very disparate morphologies were key to survival in Laramidia.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ONTOGENETIC STATE OF A JUVENILE POLYCOTYLID PLESIOSAUR (SAUROPTERYGIA: PLESIOSAURIA) AND ITS IMPLICATIONS FOR PLESIOSAUR GROWTH AND REPRODUCTION

BYRD, Christina J., Marshall University, Huntington, WV, United States

Ontogenetic variation within plesiosaurs of the family Polycotylidae, short-necked marine reptiles from the Cretaceous period, can be useful in understanding allometric differences among genera of these animal. It may also be used to shed light on the mammal-like life history and reproductive nature of plesiosaurs. In this study, we analyze a plesiosaur specimen from the University of Nebraska State Museum (UNSM 55810), a post-natal juvenile polycotylid plesiosaur from the Pierre Shale (99-65 Ma) of Nebraska. It is a partial skeleton possessing a partial skull, both the pectoral and pelvic girdles, the left humerus, both femura and an assortment of phalanges. Previous qualitative research using UNSM 55810 was conducted with other plesiosaurs, but no formal description has been produced. UNSM 55810 is probably referable to the polycotylid genus *Dolichorhynchops* based on several cranial characteristics. In order to understand the ontogenetic changes in morphology of polycotylids, metric data was collected from UNSM 55810 and compared among related plesiosaurs to address allometric variation. The pectoral and pelvic girdles exhibit a significant amount of allometric growth along the anterior and posterior edges. The scapulae exhibit extreme positive allometric growth along the ventral ramus, which extends anteromedially, and the dorsal process, which extends posterolaterally. The coracoids grow longer and wider posteriorly, forming a symphysis at the midline. The pubes grow the most conservatively, with only slight allometric growth anteriorly. The ishia demonstrate the greatest amount of allometric growth extending greatly in length posteriorly. The clavicles grow larger in size while maintaining their morphology during ontogeny. This relative morphological conservatism may be linked to the dermal origin of the clavicle as opposed to the endochondral ossification of the other girdle elements. In addition, the lack of ossification along the edges of the girdle elements of the juvenile suggests that cartilage may have been present, which could provide support to the girdles at the time of birth prior to complete ossification, particularly at the glenoid and acetabulum. The overall morphology of the juvenile girdle elements tend to resemble the morphology of more basal sauropterygians such as nothosaurs, pistosaurs, and basal plesiosaurs. Understanding morphological variation during polycotylid ontogeny will provide information for better identification of subadult specimens, as well as give insight to the evolutionary and developmental changes that occurred during plesiosaur evolution.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 8:30 am)

FOUR NEW PELOMEDUSOIDES TURTLES FROM THE MIDDLE-LATE PALEOCENE OF COLOMBIA: THE FIRST CENOZOIC GIANT FRESHWATER TURTLE AND AN UNUSUALLY CIRCULAR TURTLE SHELL

CADENA, Edwin, North Carolina State University, Raleigh, NC, United States; KSEPKA, Daniel T., North Carolina State University, Raleigh, NC, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

Four new taxa of Pelomedusoides are reported here from the Middle-Late Paleocene, Cerrejón Formation, Guajira Peninsula, Colombia. Two species correspond to new genera of Podocnemididae and Bothremydidae, and the other two are attributed as Pelomedusoides incertae sedis.

The new podocnemidid genus is based on a nearly complete skull that differs from all other podocnemidids by: (1) a prefrontal–postorbital contact that excludes the frontals from the orbital margin, (2) a reduced basisphenoid with very short medial incursion between the pterygoids, and (3) a posteriorly wide snout which becomes abruptly narrow anteriorly, particularly at the premaxillary region. Phylogenetic analyses place this new podocnemidid inside the clade Erymnochelyinae, and outside the crown Podocnemididae when morphological and molecular data is combined. With a total skull length of 22 cm, this specimen constitutes the first giant representative of Cenozoic podocnemidids.

Bothremydids are shown to be part of the Paleocene South American tropical herpetofauna by new material referable to Bothremydidae. A new genus is based on cranial material and dozens of shells, differing from all other bothremydids by: (1) pectoral scales shorter than humeral scale, (2) abdominal and femoral scales at midline of the plastron, (3) small and very shallow medial notch at the anterior margin of the nuchal, (4) vertebral 1 much wider than the others, (5) axillary scar oriented greater than 60º with respect to the posterior margin of costal 1, and (6) short, wide, and rounded prezygapophyses on the first thoracic vertebrae. Based on phylogenetic analysis this new taxon is closed related to the *Foxemys* group. The new bothremydid also exhibits the most circular carapace yet observed among Pelomedusoides, which we hypothesize could have deterred predators, particularly large snakes as *Titanoboa*, by making the turtle more difficult to ingest.

A third new taxon is based on a single large shell (170 cm) resembling *Stupendemys* in many carapace and carapace-plastron proportions and refered to Pelomedusoides incertae sedis. A fourth new taxon, is represented by specimens that are relatively small compared to all other pelomedusoides from Cerrejón (<35 cm along the midline of carapace). Theor shells lack a cervical scale and show the earliest evidence for a complete absence of the neural series in Pelomedusoides. Cerrejón fossil turtles show that the earliest tropical rain forests of South America after the K-Pg event are linked to the emergence of turtle diversity, large body size, and body plans innovations, with implications for the assembly of extant South American turtle faunas.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ON THE CRISTA CIRCUMFENESTRALIS OF SNAKES: COMPARATIVE ANATOMY, SIMILARITY, FUNCTION AND THE FOSSIL SNAKES *DINILYSIA* AND *NAJASH*

CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada; PALCI, Alessandro, University of Alberta, Edmonton, AB, Canada

Despite more than two centuries of discussion, the origin and evolution of snakes remains a much debated, and highly controversial problem. The principal barrier to achieving reasoned consensus on snake phylogeny resides in the inaccurate language of squamate comparative anatomy as applied to snakes and in contrast to lizards. Anatomical nomenclature underpins empirical statements that are used as transformed metadata statements as characters and states; these statements are then tested via congruence to hypothesize synapomorphies that support sistergroup relationships and thus the constitution of clades. A characteristic anatomical feature of snakes, not observed in lizards, is the crista circumfenestralis (CCF), a system of bony crests that surrounds the fenestra ovalis and the lateral aperture of the recessus scalae tympani, the latter of which are common to both snakes and lizards. Because the characteristics of the CCF are poorly defined in extant snakes, this morphology is problematic in the phylogenetically important Upper Cretaceous fossil snakes *Dinilysia patagonica* and *Najash rionegrina.* In order to effectively qualify the morpho-concept of the CCF, we use the test of topology to clarify the anatomical features for empirical assessment of the presence/absence of the CCF. We conclude that the appearance of a CCF is preceded by the enclosure of the ventral margin of the juxtastapedial recess by flanges of the otoccipital (crista tuberalis and crista interfenestralis) that extend forward to contact the posterior margin of the prootic. According to this homology criterion neither *Dinilysia patagonica* nor *Najash rionegrina* possess a CCF. Metadata statements and character state assignments asserting the presence of the CCF in *Dinilysia* and *Najash* are rejected with respect to the quality of comparative anatomical observation leading to such metadata and state assignments.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

COMPARATIVE TAPHONOMY OF ARIKAREEAN DEPOSITS OF OREGON AND MONTANA

CALEDE, Jonathan J., University of Washington, Department of Biology, Seattle, WA, United States

The rich and geographically widespread mammalian fossil record of the Arikareean (30-18.8 Ma) displays the transition from the archaic Eocene fauna to the already modern one of the Miocene. This major faunal change overlaps with critical changes in the environment (spread of grasslands) and global climate (late Oligocene warming, Oligo-Miocene glaciation). This interval in mammalian evolution has been extensively studied with a focus on two stratigraphically and paleontologically critical fossil-bearing rock sequences: the John Day Formation (Oregon) and the Arikaree Group (Nebraska, Wyoming). Another sequence in the Rocky Mountains preserves an Arikareean fauna: the Cabbage Patch Beds of western Montana. These three sequences all range from the earliest part of the Arikareean leading up to and across the Oligo-Miocene boundary.

Collections dating back to the 19th century and ongoing fieldwork have added and are adding thousands of fossils allowing a quantitative analysis of the changes in paleoecology in this critical interval of mammalian evolution. However, validating any potential ecological signal requires the consideration of the potential differences in taphonomy across these fossil bearing sequences.

I present results of an analysis combining a specimen-based assessment of taphonomy on a site-by-site basis with a comparison of the body size structures across these localities. This preliminary work focused on the well known John Day Formation fauna (Turtle Cove and Kimberly members) as well as the lesser known Cabbage Patch fauna where large mammals are rare. The analysis includes over 1500 specimens from nine different localities. Preliminary results show that differences in the maximum, average, and median body size of the fossil mammal fauna recovered at a locality are linked to the degree of weathering, abrasion, and breakage of the bones of the assemblage. Despite differences in taphonomic characteristics across localities, the minimum body size captured in the assemblages did not differ, most likely as a consequence of intense screenwashing. Assemblages dominated by small mammals where weathering was highest, abrasion was lowest, and bones were more complete also exhibit the highest proportion of juvenile specimens and include the most robust elements (teeth, skulls, scapulae). Voorhies diagrams and multiple regressions suggest that the differences in body size between the mammalian communities of the Cabbage Patch Beds and John Day Formation may be a consequence of significantly different taphonomic settings. Further research adding field data will help document the relative importance of taphonomy and ecology in the observed signal.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

FIRST RECORD OF THE SYNECHODONTIFORM SHARK *SPHENODUS* (NEOSELACHII, ORTHACODONTIDAE) FROM THE DANIAN OF NORTH AMERICA

CALLAHAN, Wayne R., New Jersey State Museum, Trenton, NJ, United States; SCHEIN, Jason P., New Jersey State Museum, Trenton, NJ, United States; SCHROETER, Elena R., Drexel University, Philadelphia, PA, United States; PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

The synechodontiform shark *Sphenodus* is here reported from the Hornerstown Formation (Danian) of Gloucester County, New Jersey. A well-preserved, upper-right lateral tooth was recovered in June of 2011, from the Inversand Company glauconite quarry, during a joint field expedition between the New Jersey State Museum, Drexel University, and the Delaware Valley Paleontological Society. The complete tooth (NJSM 23223) displays the following characteristics: (1) a typical, tearing-type crown that is lingually inclined and moderately sigmoidal in lateral view; (2) acute cutting edges, flanked by blade-like enameloid ridges that extend as heels along the upper surfaces of the root and bear numerous vertical folds; (3) a highly vascularized (pseudopolyaulacorhize) root which is sub-oval in basal outline and has a flattened, slightly concave base.

The genus *Sphenodus* has a temporal range that extends from Early Jurassic into the early Paleogene. The only other confirmed report of the genus in North America is of specimens referred to *Sphenodus* sp. from the Upper Cretaceous of Hornby Island, British Columbia, Canada. The Paleogene record is limited to a single species, *Sphenodus lundgreni*, a large shark known from the Danian of Scandinavia, the United Kingdom, Russia, and Kazakhstan. Additional specimens of *S.* cf. *lundgreni* have been reported from Greenland and New Zealand. Based on size, tooth morphology and age, we assign NJSM 23223 to *Sphenodus lundgreni*. This is the first record of this taxon from the Americas and the lowest latitudinal occurrence in the Northern Hemisphere. Since the roots of synechodontiform sharks are seldom preserved, it is possible that isolated tooth crowns of *S. lundgreni* have been recovered in other North American Danian localities, but mis-identified as lamnid teeth, which they closely resemble. We encourage scrutiny of Danian chondrichthyan tooth collections from Atlantic and Gulf Coastal Plain localities for other possible occurrences of this rare taxon.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW DATA ON THE CENOMANIAN VERTEBRATE SITE OF NAZARÉ (WEST CENTRAL PORTUGAL)

CALLAPEZ, Pedro, Universidade de Coimbra, Coimbra, Portugal; BARROSO-BARCENILLA, Fernando, Universidad de Alcalá de Henares, Universidad Complutense de Madrid, Alcalá de Henares, Madrid, Spain; CAMBRA-MOO, Óscar, Universidad Autónoma de Madrid, Madrid, Spain; PÉREZ-GARCÍA, Adán, Universidad Autónoma de Madrid, Madrid, Spain; TORICES, Angélica, University of Alberta, Edmonton, Canada

The Cenomanian vertebrate site of Nazaré is located in a coastal cliff of West Central Portugal, and is comprised of large exposures of Upper Cretaceous marginal-marine carbonates and continental siliciclastics. The study of this vertebrate site, internationally known from the presence of the only dyrosaurid from Europe (attribution exclusively based on a mandibular symphysis), has been recently resumed to compile a detailed survey of its faunal assemblage, biostratigraphy, and paleoecology. This new study reveals the presence of several important Lower and Middle Cenomanian fossiliferous levels, in which numerous vertebrate macroremains (shallow aquatic fauna; fishes, turtles and crocodilians) appear well preserved and partially articulated. Fish remains are abundant and mainly composed by scattered scales, teeth and skull fragments, though an almost complete specimen has been also found. Specifically, isolated teeth from Pycnodontiformes have been identified. They are crushing teeth with a smooth surface and subcircular or elongated crowns in oclussal view, very similar to teeth belonging to the genus *Coelodus*. Other discovered teeth, both isolated and implanted in fragments of a dentary, are elongated and inclined distally, with a mesial flexure. They also have a distal carina with a slightly wavy pattern, and a mesial carina that has a better defined cutting edge. Lingual longitudinal folds are present in the base of the crown. These teeth are remarkably similar to those classified as *Enchodus*. The specimen that is nearly complete has characteristics that allow us to identify it as a primitive teleost cf. Elopomorpha. Turtle remains may correspond to Pan-Cryptodira and, probably, Pan-Pleurodira. Both are likely aquatic forms, which may have lived in transitional or marine environments. New crocodylomorph material has also been discovered, but it cannot be assigned to Dyrosauridae. All this material sheds new light on the little known record of European Cenomanian vertebrates. The particular location of Nazaré, close to the transition from Tethys to the Temperate domain, will be also useful to explain possible faunal changes and migrations influenced by sea-level changes and regional paleogeography.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW RECONSTRUCTION OF THE PARIETALMORPHOLOGY OF PACHYRHINOSAURUS CANADENSIS, A CENTROSAURINE CERATOPSID FROM THE CAMPANIAN OF ALBERTA

CAMPBELL, James A., Carleton University, Ottawa, ON, Canada; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada; LANGSTON, Wann, University of Texas, Austin, TX, United States

The centrosaurine ceratopsid, *Pachyrhinosaurus,* is known from multiple, disarticulated elements derived primarily from bone bed assemblages. Described species include *P. lakustai* from the Wapiti Formation, AB (~72-73 MA); *P. canadensis* from the Scabby Butte and St. Mary River Formation, AB (~71 MA), and *P. perotorum* from the Prince Creek Formation, Alaska (~69 MA). Adult members of the clade exhibit extreme *pachyostosis* of the nasal and postorbital ornamentation, which causes the facial portions of the skulls to be typically preserved as massive, fused units. The parietals are comparatively thin and fragile. While none are known from complete specimens, the morphology of the parietal and its associated ornamentation, which is often critical to distinguishing closely related centrosaurs, can be reliably inferred for most taxa. However, the parietal ornamentation of *P. canadensis* is poorly understood, with the only significant material being two partial rami, CMN 9602 and CMN 10644, and a partial P3 spike, CMN 8863, described from the Scabby Butte bone bed. The initial identification of these elements was tentative due to their fragmentary nature and their dissimilarity to ceratopsian parietal material known at the time. Comparison to multiple *P. lakustai* parietals from the Grande Prairie bone bed now allows for the first formal description of the parietal of *P. canadensis*. Although it closely resembles *P. lakustai*, it is unknown if *P. canadensis* possessed dorsally-projecting processes on the midline ramus. Based on CMN 9602, *P. canadensis*: lacks P1 processes; has short, wide-based, posteromedially directed P2 processes on caudal margin; has wide-based, elongate, caudolaterally projecting P3 spikes that curve gently laterally; and low, well-fused, elongate, imbricated epiparietals at loci 4-6 (P7 is broken off). The caudal margin of the midline ramus of CMN 9602 adjacent to the P2 surface has a large, sinus-like, pathological opening; similar pathologies are common on *P. lakustai* skulls. CMN 10644 is a partial left lateral parietal ramus that may represent the counterpart to CMN 9602. It preserves at least four, low epiparietals (P4-P7) and the thickened contact surface for the squamosal; an additional epimarginal would have straddled the parietal-squamosal contact. CMN 8863 is a massive, isolated, partial left P3 spike. Its size (basal dimensions ~ 110 x 80 mm) is what would be expected from an adult-sized *P. canadensis* skull, which are notable for being up to 50% larger than that of other putative adult-sized *Pachyrhinosaurus* taxa. This suggests that CMN 9602 and CMN 10644 represent much smaller and/or younger specimens despite their adult bone texture and well-fused epiparietals.

Technical Session VIII (Thursday, October 18, 2:45 pm)

NEW LATE MIOCENE NORTH AMERICAN ARTIODACTYL FROM THE AMAZON BASIN: IMPLICATIONS FOR INTERCHANGE DYNAMICS

CAMPBELL, Kenneth E., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; PROTHERO, Donald R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; BEATTY, Brian L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; FRAILEY, Carl D., Johnson County Community College, Overland Park, KS, United States

A new genus and species of palaeomerycid artiodactyl from the upper Miocene Acre Conglomerate of the Amazon Basin (older than 9.01 Ma, based on Ar/Ar dating) found in the channel of the Acre River between Bolivia and Brazil documents the first known occurrence of this Northern Hemisphere group in South America. Characters of the nearly complete dentary place the new taxon amongst the earliest dromomerycines, closest to *Barbouromeryx trigonocorneus,* which lived in North America during the early to middle Miocene, 20-16 mya. However, it is a new genus and species that is distinguished from all other dromomerycines by its relatively wide lower molars and large labial stylids. Along with the previous documentation of gomphotheres, peccaries, and tapirs from the Acre Conglomerate or older beds, the presence of an early-middle Miocene dromomerycine artiodactyl in South America is further evidence that the first pulse of the Great American Faunal Interchange occurred in the early late Miocene, not the Plio-Pleistocene as traditionally portrayed.

Romer Prize Session (Thursday, October 18, 8:30 am)

A UNIVERSAL LIMB SCALING RELATIONSHIP FOR ESTIMATING BODY MASS IN EXTINCT TERRESTRIAL TETRAPODS

CAMPIONE, Nicolás E., University of Toronto, Toronto, ON, Canada

Body size is intimately related to the ecology and physiology of an organism. Accurate body mass estimates are therefore vital for inferring a wide range of paleobiological attributes (including growth rates, metabolism, and energetics) and investigating large-scale evolutionary and ecological patterns in the history of life. Scaling relationships between limb measurements and body mass of extant birds and mammals are commonly used to predict body mass in extinct members of these crown clades, but their suitability for predicting mass in more distantly related stem taxa (e.g., non-avian dinosaurs and non-mammalian synapsids) is frequently criticized based on the observation that 1) limb scaling patterns in some extant clades can significantly deviate from each others (e.g., Ungulata vs. Carnivora), 2) scaling patterns may be affected by differences in gaits and/or limb postures, and 3) outliers may have a disproportionately large effect on scaling coefficients, especially at large body size. This study directly tests if these criticisms affect the relationship between body mass and various stylopodial limb measurements in terrestrial quadrupedal tetrapods. Stylopodial length and minimum shaft circumference were taken from 200 mammal and 47 non-avian reptile species, all of which were derived from skeletons with individual live weights. Scaling patterns between different clades of mammals, and between mammals and reptiles were examined using bivariate line fitting techniques (Standardized Major Axis) and phylogenetic independent contrasts. The analyses confirm significant differences between select groups in some proportional properties, but, remarkably, the relationship between stylopodial circumference and body mass, in particular the combined humeral and femoral circumference, is highly conserved in extant terrestrial quadrupedal tetrapods, despite disparate limb postures, gaits, and phylogenetic histories. As a result, this study conclusively rejects the main criticisms of a universal scaling equation for estimating body mass in terrestrial quadrupedal tetrapods. This approach also allows the incorporation of percent prediction errors (PPE) into mass estimates, and demonstrates that combined circumference (PPE=25%) is a more accurate estimator of body mass than all other metrics tested here, including the commonly used femur length (PPE=70%). As a result, this method will also enable testing of other mass estimation methodologies, such as volumetric models. This study provides a much-needed, robust, phylogenetically corrected framework for accurate and consistent estimation of body mass in extinct terrestrial quadrupeds, which is important for a wide range of paleobiological studies and meta-analyses of body size evolution.

Education and Outreach Poster Session (Poster displayed October 17 – 20)

THE JANE COLLABORATIVE: PALEONTOLOGY IN THE PUBLIC SQUARE

CARLSON, Elizabeth C., Burpee Museum of Natural History, Rockford, IL, United States; RAWLINGS, Sheila, Burpee Museum of Natural History, Rockford, IL, United States; WILLIAMS, Scott A., Burpee Museum of Natural History, Rockford, IL, United States

Burpee Museum of Natural History of Rockford, Illinois completed a two year grant, called “The Jane Collaborative,” which served 64 mostly rural libraries in northern Illinois and southern Wisconsin. This project brought science to the small town public square by featuring the museum’s exceptional juvenile *Tyrannosaurus rex,* named “Jane.” One-fifth of the American population is rural, with limited access to science centers. There is evidence that trickle-down dissemination of scientific information to rural America is not effective. First, only slightly more than half of Americans read a newspaper daily. The number of daily print newspapers has also declined over the last twenty years. One study found that only 70% of these papers publish science articles, with 10% or fewer articles including actual terms and or quasi-scientific explanations. Second, there is a decline of science education in public schools. To combat these deficiencies, “The Jane Collaborative” created a unique learning environment and serves as a model for libraries and museum partnerships, utilizing a high profile specimen to create awareness of both library and museum resources and to introduce science into the community. Prior to “The Jane Collaborative,” only 45% of these libraries had sponsored scientific programming mostly computer classes. Additionally, only 50% of the participating library staff read a daily newspaper. To address these shortcomings, Burpee provided two training programs at the museum for library staff, and a series of four outreach paleontology programs at each libary. These outreach programs used dinosaurs to pique the attention of the public. These programs were essentially a traveling museum providing opportunities to introduce fossils to the public. In addition, adults accompanying their children to the programs asked the museum educators a variety of science related questions. Thus, these programs provided scientific experiences. Libraries also received up-to-date paleontology books, videos, games, a summer reading program, and a bus trip to Burpee. After participating in “The Jane Collaborative,” library staff increased their comfort level in assisting patrons with questions about science and about dinosaurs in particular. Two-thirds of the participants believed their collaborative experiences will help them develop future programs. They rated public reaction to Burpee’s outreach programs very positively. The partnership of Burpee Museum and the libraries engaged the public and allowed them to be a part of current scientific discoveries.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

BEGINNINGS OF NEOGENE FISH DIVERSITY IN WESTERN NORTH AMERICA: THE 15 MA SUCKER CREEK FORMATION, IDAHO AND OREGON

CARPENTER, Nathan E., College of Idaho, Caldwell, ID, United States; SMITH, Gerald R., University of Michigan, Ann Arbor, MI, United States

The Barstovian Sucker Creek Formation has the earliest known “diverse” freshwater fish community in the Neogene of North America, following the widespread Oligocene extinction of fishes. Like most other early to middle Miocene western U.S. fishes, these are usually found with leaf impressions. The Succor Creek flora, from 50 X 10 km Sucker Creek valley along the southern Oregon-Idaho border, is exceptionally well-known, with over 100 species, including lowland oaks, maple, beach, elm, hickory, walnut, chestnut, sycamore, bald cyprus, sequoias, and others, and associated upland pine, spruce, and fir. Over 50 species of mammals, including soricids, equids, rhinos, antilocaprids, camels, ursids, sciurids, murids, geomyids, heteromyids, and bats, occupied the forests and surrounding areas. We have identified seven kinds of fishes in indurated volcaniclastic silt deposits among thousands of leaf specimens in the Museum of Natural History at the College of Idaho. In order of abundance the fish are: two genera of sunfishes, two genera of minnows, one muskellunge, one sucker, and one catfish. The sparse fish fauna suggests lowland basins enclosed by barriers to dispersal, with low immigration rates. Extensive planar siltstone with two associated arkosic sandstone bodies, and abundance of sunfish (*Archoplites* and *Plioplarchus*) and small minnows (*Lavinia* and a new genus) suggest a shallow flooded

forest. Small fish bones are often in sorted, partially digested, apparently disgorged masses, about 30mm in diameter, indicating lack of current and modest depth. Large predatory fishes are rare, but isolated bones of 70 cm muskellunge (*Esox*) and 30 cm Pikeminnows (*Ptychocheilus*) have been found with mammals in fluvial environments, peripheral to the leaf-bearing siltstone.

Technical Session I (Wednesday, October 17, 9:15 am)

ONTOGENY AND PHYLOGENY OF CEPHALIC ORNAMENTATION IN TYRANNOSAUROIDEA (DINOSAURIA, COELUROSAURIA)

CARR, Thomas D., Carthage College, Kenosha, WI, United States

Cephalic ornamentation is seen in all derived tyrannosauroids. A robust sample size and growth series are known for most taxa, providing the opportunity to assess larger scale patterns in this potentially important adaptation for the clade. Cephalic horns in tyrannosauroids have a conserved pattern that includes cornual processes that extend from the lacrimal, jugal, and postorbital. Also, the dorsal surface of the nasals is coarse. Ornamentation is taken to an extreme in *Alioramus altai*, where a series of stout horns extend from the nasals, and a fourth set from the lateral surface of the jugal.

In this study the ontogenetic development of cephalic ornamentation in each species of derived tyrannosauroid (*Bistahieversor* + Tyrannosauridae) was compared in a phylogenetic context. Growth series were reconstructed, where possible, by parsimony analysis of discrete characters. There are four principal findings:

(1) The growth pattern of ornamentation is conserved, where the ventral jugal horn grows first, the lacrimal process develops second, and the postorbital horn appears last. In each species, the lacrimal and postorbital horns enlarge with growth. This iterative pattern of development indicates it was an important adaptation that functioned to identify relative maturity among conspecifics. As indicated by *Alioramus altai*, major additions to ornamentation in part involved de novo structures in different regions of the skull.

(2) The ontogeny of horns is broadly congruent with tyrannosauroid phylogeny, where the cornual process of the jugal is seen in the basal taxon *Dilong*, the beginnings of the lacrimal process is then seen in *Appalachiosaurus*, and the postorbital process appears last in *Bistahieversor*.

(3) Phylogenetic variation is also seen in the ontogeny of ornamentation. For example, in juveniles of tyrannosaurids, except *Tyrannosaurus*, the lacrimal horn has up to three apices that are lost in adults, where only one apex is retained. In *Tyrannosaurus* adults, the apex is obliterated by inflation.

(4) Variation in the pattern of ornamentation is diagnostic at the level of species. For example, the dorsal part of the postorbital horn is vertically oriented in *Albertosaurus sarcophagus*, in contrast to the horizontal condition that is seen in other species. Also, in *Tyrannosaurus rex* an osteoderm caps the caudal surface of the lacrimal, and another extends between the lacrimal and postorbital that covers the cornual process of the postorbital.

These species differences indicate their importance to conspecifics in identifying each other. Consistent with this is the observation that ornamentation is most different between sympatric taxa, such as *Albertosaurus libratus* and *Daspletosaurus torosus* in Laramidia, and *Alioramus altai* and *T. bataar* in Asia.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A JUVENILE *HYPOSAURUS ROGERSII* SKULL FROM THE HORNERSTOWN FORMATION OF NEW JERSEY

CARTER, Aja M., Drexel University, Philadelphia, PA, United States; BOLES, Zachary, Drexel University, Philadelphia, PA, United States; SCHROETER, Elena R., Drexel University, Philadelphia, PA, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

Recent excavation in the Hornerstown Formation of Mantua Township, Gloucester County, New Jersey, has yielded a plethora of marine vertebrates, including a partial skull consisting of a complete braincase, associated fragments, and two teeth. We assigned the material to *Hyposaurus rogersii* based on the following characteristics: 1) braincase exhibits a flat ventral margin of the magnum foramen, resulting in a shunted occipital condyle that is very short; 2) the quadrate curves ventrally relative to the dorsal margin of the brain case; 3) tuberosities are present on both sides of the dorsal-most lateral line on the supraoccipital; and 4) a flattened parietal-frontal complex. The combination of these characteristics are diagnostic of *Hyposaurus*. The lack of fused skull joints, indicates this specimen to be a juvenile *H. rogersii*. This material represents an individual of intermediate size, relative to three previously reported specimens, and provides insight into osteological changes in the skull of *H. rogersii* through ontogeny.

Technical Session VIII (Thursday, October 18, 3:30 pm)

PATTERNS AS PRETTY AS CAN BE: THE RANGE AND EXTENT OF THE VALLESIAN CRISIS (LATE MIOCENE) IN THE VALLÈS-PENEDÈS BASIN (CATALONIA, SPAIN)

CASANOVAS-VILAR, Isaac, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; VAN DEN HOEK OSTENDE, Lars W., Netherlands Centre for Biodiversity, Leiden, Netherlands; FURIÓ, Marc, Institut Català de Paleontologia Miquel Crusafont, Cerdanyola del Vallès, Spain; MADERN, Anneke, Netherlands Centre for Biodiversity, Leiden, Netherlands

In analyses of patterns and trends in past diversity, undesirable biases associated with the fossil record must be taken into account. Sampling of the record is uneven, with variation in both the temporal spacing of the fossil-bearing sites and their quality of preservation. Often the richest or better sampled sites (or time intervals) show a greater diversity than less well known ones simply because many more rare taxa are recovered. Therefore, a single peak in the quality of the record would exaggerate the recorded diversity as well as origination and extinction rates. Robust diversity estimates must assess such biases either by excluding those taxa know from just one single site or time interval which is supposed to be better sampled, or by taking into account the sample size recovered in each locality and the probability of sampling a particular taxon in subsequent localities. Here we analyze the effects of the quality of the small mammal record in our understanding of the Vallesian Crisis, an important turnover event said to have affected European mammal faunas by the beginning of the late Miocene. The Vallesian Crisis was initially recognized as a local event that implied the extinction of certain rodent and artiodactyl genera coinciding with the early/late Vallesian boundary (at 9.7 Ma). Subsequent studies increased the range and extent of this event to encompass all Europe and involved a great number of mammal taxa. Here we focus on the Vallesian rodent and insectivore record of the Vallès-Penedès basin (Catalonia, Spain), where the crisis was first recognized. We show that the quality of the record before the crisis is comparatively much better than afterwards so diversity appears inflated and extinction rates are overemphasized. Accordingly, we used the probability of sampling a given taxon as well as rarefaction to calculate new diversity measures independent of sample size. These measures virtually eliminate the Vallesian Crisis, showing that diversity somehow decreased during the earliest late Vallesian and soon recovered afterwards. This is because several rare taxa, customarily said to have disappeared during the crisis, are in fact present. Amongst the rodents and insectivores these taxa include genera that are generally rare and show a discontinuous record during the early Vallesian. These presumed specialists are thought to have inhabited humid forested environments such as flying squirrels, beavers, or certain dormice, most of them recorded only when the sample size is large enough. Some of them are *in de facto* present in a few late Vallesian sites, thus supporting our interpretation. Alternatively, these genera may have been associated with very specific habitats that, for unknown reasons, are not sampled during the late Vallesian. Our results cast serious doubts on the very existence of the Vallesian Crisis suggesting that rather than an abrupt event, a series of extinctions occurred during a longer time span. While it has not been evaluated whether the same pattern will be observed in large mammals or faunas in other areas, previous approaches have generally omitted the bias introduced by the quality of the record and, as shown here, they may importantly affect diversity calculations.

Technical Session II (Wednesday, October 17, 12:00 pm)

DIVERSITY, ABUNDANCE AND TURNOVER IN THE ANTARCTIC MARINE FAUNA DURING THE EOCENE IN RESPONSE TO CLIMATE CHANGE

CASE, Judd A., Eastern Washington University, Cheney, WA, United States

The La Meseta Formation crops out on the northern end of Seymour Island, northeastern Antarctic Peninsula and its deposits have been dated by $^{87}Sr/^{86}Sr$ ratios to range from 54.2 Ma to 34.2 Ma, thus encompassing nearly the entire Eocene. The La Meseta Formation spans nearly an 18 million year (myr) time frame and exhibits an 8°C drop in ocean temperature from 11°C to 3°C. The La Meseta Fm is divided in seven stratigraphic units (Telm 1-7); in units Telm 3-5, spanning from 54.2 Ma to 45.2 Ma, the diversity index of neoselachian sharks is very high (H= 1.814), nearly equaling the shark diversity values (H= 1.920) in the modern tropics today, with high levels of abundance as well. Penguin diversity is high (H= 1.619), with low levels of abundance (10% of marine vertebrate fauna), while cetacean diversity (1 species) and abundance are low. In units Telm 6 and 7 (41.0 Ma to 34.2 Ma), a significant portion of the 8°C temperature drop occurs and significant changes in vertebrate diversity are seen. Sharks are now extremely rare in the two upper units, penguin diversity remains high but abundances dramatically increase (90% of marine vertebrate fauna). The cetacean fauna shows only a slight increase in diversity, however cetacean abundance shows a substantial increase. The drop in ocean temperature and the changes in marine vertebrate diversity and abundance seem to coincide with a deep water opening of the Drake Passage around 41 Ma.

Technical Session X (Friday, October 19, 8:15 am)

A NEW TATARIAN DICYNODONT FROM MOZAMBIQUE

CASTANHINHA, Rui, Instituto Gulbenkian de Ciência and Museu da Lourinhã, Lisboa, Portugal; ARAÚJO, Ricardo, Southern Methodist University and Museu da Lourinhã, Dallas, TX, United States; COSTA JÚNIOR, Luís, Museu Nacional de Geologia, Maputo, Mozambique; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; MARTINS, Rui, Instituto Tecnológico e Nuclear and Museu da Lourinhã, Lisboa, Portugal

A nearly complete three-dimensionally preserved skull and mandible, with a series of 19 articulated dorsal, sacral and tail vertebrae, ribs, ilia, partial pubis and femur (ML1620) was collected from the Late Permian Karoo sediments, Metangula Graben, northern Mozambique (Niassa Province), Cádzi Formation. The specimen can be distinguished by the following four autapomorphies: radiating pattern of vascular foramina plus grooves and ridges on dorsal surface of the frontals, weak longitudinal ridge on the dorsal surface of the preparietal, shoe-shaped profile of the articular surface of the quadrate in posterior view and

a waterdrop-shaped interpterygoid vacuity. Micro-CT visualization of the internal cranial bones combined with a phylogenetic analysis demonstrate a set of characters shared with Eumantelliidae (namely, the interparietals contribute to the intertemporal skull roof and lateral dentary shelf present and well developed) and Emydopoidea (namely, palatal surface of premaxilla with groove-like depressions that have straight sides and a rounded anterior end). However, the absence of both caniniform depression and keel-like extension of the palatal rim posterior to the caniniform process plus symphyseal region of lower jaw with an upturned margin that is raised above the level of the dorsal surface of the jaw rami with a scooped-out depression on its posterior surface is distinct from Emydopoidea. Moreover, the possession of 6 maxillary tooth positions and 11 dentary teeth is also distinct from emydopoids, none of which possess non-caniniform teeth. On the other hand, the presence of the lateral palatal foramen at the level of the anterior, expanded palatal exposure of the palatines is distinct from Eumantelliidae.

This specimen was collect as a result of an annual expedition that started in July 2009. Since then, important fossil sites have been discovered. The sediments are Tatarian in age which is equivalent to the Beaufort Group, possibly correlatable to the *Cistecephalus* Assemblage Zone from South Africa. Mozambique offers a new window of unstudied sites suggesting that a complete faunal list from the East African Late Permian is still far from being accomplished.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE FIRST RECORD OF AN APATEMYID FROM OREGON: *SINCLAIRELLA DAKOTENSIS* FROM THE TURTLE COVE MEMBER OF THE JOHN DAY FORMATION

CAVIN, Jennifer L., John Day Fossil Beds National Monument, Kimberly, OR, United States; SAMUELS, Joshua X., John Day Fossil Beds National Monument, Kimberly, OR, United States

Sinclairella dakotensis is a rare and unusual species belonging to the family Apatemyidae, a group of archaic insectivorous mammals of uncertain phylogenetic affinities. Here we report a new occurrence of *S. dakotensis* from the Arikareean aged Turtle Cove Member of the John Day Formation, Oregon. Two isolated teeth, a lower first incisor and an upper second molar, were found at two separate sites. Both were located in Unit C of the Turtle Cove Member in the Blue Basin area of John Day Fossil Beds National Monument. Because of the well-studied stratigraphy with persistent, traceable ash layers found in the Turtle Cove Member of the John Day Formation, these finds can be dated to between 29.75 and 28.8 Ma. The distinctively enlarged lower incisor, and morphology and measurements of the M2 were consistent with published descriptions of *S. dakotensis* from the Great Plains region. *S. dakotensis* has previously been found in Chadronian to early Arikareean aged deposits from South Dakota, North Dakota, Colorado, Nebraska, and Saskatchewan. This find represents the first occurrence of the taxon west of the Rocky Mountains and possibly the youngest dated occurrence to date. Due to the hypertrophied, procumbent incisors and elongate digits on the manus, apatemyids are thought to have been ecologically similar to extant "wood-pecking" mammals like the aye-aye. The presence of *Sinclairella* and other forest adapted species in the lower part of the Turtle Cove Member is consistent with interpretation of the early Oligocene in Oregon as being dominated by woodland environments.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

REVISION OF A MIOCENE *CARASSIUS*-LIKE CYPRINID *LUCYPRINUS* (TELEOSTEI, PISCES) FROM EAST CHINA AND ITS BEARING ON FRESHWATER FAUNAL EXCHANGE BETWEEN EUROPE AND ASIA

CHANG, Mee-Mann, IVPP, Beijing, China; CHEN, Gengjiao, Natural History Museum of Guangxi Zhuang Autonomous Region, Nanning, China; LIU, Huanzhang, Institute of Hydrobiology, Wuhan, China

Fossil cyprinids from the late early Miocene of Shanwang diatomite quarry, Shandong, East China were first studied by Young and Tchang, who referred some to the genus *Barbus* as two new species, *B. linchüensis* and *B. scotti* without designating holotypes and giving diagnoses. All specimens were later lost. Zhou restudied this fauna, and moved *B. linchüensis* and *B. scotti* from the genus *Barbus,* because of both their dorsal and anal fins contain a robust spine with serrations, to a new genus *Lucyprinus.* She established two additional new genera, *Platycyprinus* and *Qicyprinus*, and referred all three newly named genera to the subfamily Cyprininae.

Here we base our revision on the specimens studied by Zhou as well as newly collected specimens. Different proportions alone were used by Zhou as criteria for the new taxa. Our results indicate that all specimens assigned by Zhou to the Cyprininae are nearly identical in characters, except for their body proportions. Many specimens studied by Zhou are visibly, and some severely, deformed, either shortened or lengthened, by taphonomic processes. Even the specimen used as the neotype of *Lucyprinus linchüensis* has the anterior part of its vertebral column bent and the dorsal and anal rays spread apart from each other. Consequently, the measurements taken from these specimens and the ratios thus calculated are invalid. We consider only *Lucyprinus* a valid genus with a monotypic species, *L. linchüensis*.

Its skull roof bones and cheek bones are rather corrugate, with ridges and tubercles, especially in larger specimens, more similar to those in *Carassius* than in *Cyprinus*. The pronounced auricular angle of the opercle also seems very much like that in *Carassius* than in *Cyprinus*. Though numerous pharyngeal teeth were revealed during the preparation, not a single pharyngeal bone has been found. Only in one specimen did we find two rows of pharyngeal teeth in the posteroventral part of the opercle, four in each row. The posterior two teeth from these rows have broad, rostrocaudally compressed crowns and narrow neck. The number, rows, and shape of the pharyngeal teeth are similar to those of *Carassius*. Compared with living *Cyprinus* and *Carassius*, its dorsal fin is comparatively short and slightly backwardly situated. Similar fossils, i.e., several species of *Palaeocarassius*, have been found from Europe and Middle Asia from the early Miocene onward. The *Carassius*-like forms from Europe and Asia are more similar to each other than to their Recent kin. This implies that there must have been faunal exchanges between the two regions after disappearance of the Turgai Strait, and subsequent divergent evolution of the *Carassius*-like forms in each region.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE ANATOMY AND PHYLOGENETIC PLACEMENT OF THE CRETACEOUS STEM TURTLE *NAOMICHELYS SPECIOSA*

CHAPMAN, Sandra D., Natural History Museum, London, United Kingdom; STERLI, Juliana, CONCET-Museo Egidio Feruglio, Trelew, Argentina; LYSON, Tyler R., Yale University, New Haven, CT, United States; JOYCE, Walter G., University of Tubingen, Tubingen, Germany

Naomichelys speciosa is a highly unusual turtle from the Cretaceous of North America. The type specimen consists of an isolated entoplastron that was discovered in Aptian/Albian sediments in Montana more than 100 years ago and that was diagnosed as a new species of turtle by its unusual surface sculpturing consisting of raised tubercles. A small number of additional fragments have since extended the temporal range to the Campanian and the spatial range to Alberta, Maryland, Oklahoma, Texas, Utah, and Wyoming, but these specimens add little to help understanding the anatomy or phylogenetic position of this enigmatic taxon. The unique surface sculpture of the shell, however, was recognized relatively recently as being the same as that found in European turtles of the clade Solemydidae and *N. speciosa* is now generally recognized as a representative of that clade.

Field crews of the Field Museum of Natural History discovered an unusually well-preserved, near complete skeleton of *Naomichelys speciosa* in the Aptian/Albian Trinity Sands of Texas in the 1950s, but the specimen was never described in any detail, likely because the braincase is only partially preserved. A phylogenetic analysis places *N. speciosa* as sister to the solemydid taxa *Helochelydra nopcsai* from the Early Cretaceous of England and *Solemys vermiculata* from the Late Cretaceous of Spain based on the complete lack of an ossified processus interfenestralis, formation of a secondary pair of "basioccipital tubercles" by the pterygoids, and based on the presence of V-shaped anterior peripherals, a supernumerary entoplastral scute, and the unique surface ornamentation. Among others, the presence of a secondary intertubercular fossa, extension of the upper temporal roofing posterior to the level of the basioccipital condyle, and primitive cervical vertebrae with a biconvex fourth cervical place *N. speciosa* within the clade Meiolaniformes. Meiolaniformes is therefore known to have had a near global distribution in the Cretaceous, a pattern best explained by vicariance. The presence of large nasals, confluent external nares, a single vomer, eleven peripherals, five wide vertebrals, large mesoplastra, five pedal claws, and the absence of lacrimals, supratemporals, temporal emarginations, palatal teeth, and supramarginals support placement of *N. speciosa* just outside of crown Testudines. The presence of limb osteoderms and short digits support the hypothesis that *N. speciosa* was a terrestrial turtle.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MEASURING THE PENGUIN HUMERUS: THE IMPACT OF INTRASPECIFIC VARIATION ON QUANTITATIVE CHARACTERS

CHAVEZ-HOFFMEISTER, Martin F., School of Earth Sciences, University of Bristol, Bristol, United Kingdom

Isolated skeletal elements are often used as type specimens in vertebrate paleontology. In the case of fossil penguins, the humerus has been one of the most widely used elements, but its reliability for taxonomic treatment has only been recently studied. It has been suggested that angular measures are useful for discrimination of taxa at different levels; however these results have been based on the use of average values for the studied species. This study aimed to evaluate the impact of intraspecific variability on our ability to use metric characters for taxonomic treatment. Through the expansion of published sets of linear and angular measurements, the distributions of data for four species of extant penguins are analysed through the construction of modified logarithmic differences diagrams. This modification consists of the use of box plots instead of linear graphics to show the distribution of data in each measure analyzed. The results show that: 1) the use of average values for the evaluation of measures is inadequate; 2) the proportions between measures vary for each individual; 3) each measure has different ranges of variation; and 4) the angular measurements have wide ranges of variation. Comparing the three species of the genus *Pygoscelis* to each other, only four of the 12 measures evaluated are reliable for all three species and none of the measures allows their discrimination. This exemplifies the difficulties of using of isolated elements for taxonomic purposes and the importance of considering intraspecific variability of each character to identify which of them can be useful for taxonomy.

Technical Session XIV (Saturday, October 20, 8:15 am)

AN EARLY SPADEFOOT TOAD (ANURA: PELOBATIDAE) FROM THE LATE PALEOCENE - EARLY EOCENE OF TSAGAN KHUSHUU, MONGOLIA, AND ITS IMPLICATION FOR THE PHYLOGENY AND BIOGEOGRAPHY OF THE PELOBATIDAE

CHEN, Jianye, American Museum of Natural History, New York, NY, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States

Here we report a new spadefoot toad (Anura: Pelobatidae) from Tsagan Khushuu, Mongolia, based on a nearly complete skeleton. The age of the frog is Paleocene-Eocene, slightly older than the earliest *Eopelobates* from Europe. Skeletal features uniting this fossil with living spadefoot toads include the presence of metatarsal spade, procoelous centra, absence of ribs, dilated sacral diapophysis and monocondylar sacrum-urostyle articulation. Notably it documents the earliest record of spadefoot toads that have a bony spade in foot adapted for burrowing. Two phylogenetic analyses are performed to determine the relationships of the new fossil, one among archaeobatrachians (29 taxa/65 characters) and one within the Pelobatoidea (17 taxa/37 characters). The results show that the new taxon represents the most basal member of the Pelobatidae. Interestingly, it also suggests that, within the Pelobatidae, neither Asian fossil taxa nor the two extant North American genera (*Spea* and *Scaphiopus*) are monophyletic. Therefore, we conducted an empirical biogeographic analysis. A Bayesian MCMC process with a widespread root is performed based on the Pelobatoidea phylogeny. Excluding very fragmentary records from the Mesozoic, the results indicate that spadefoot toads are likely to have an East Asian origin, with dispersal to North America during the Early Eocene, a succeeding dispersal from North America to Europe right after, and a dispersal from North America back to East Asia sometime between Early Eocene and Early Oligocene.

Technical Session X (Friday, October 19, 11:15 am)

LOCOMOTOR INFERENCE OF FOSSIL MAMMALS BASED ON QUANTITATIVE MORPHOMETRIC ANALYSIS OF THE POSTCRANIAL SKELETON OF SMALL-BODIED EXTANT TAXA

CHEN, Meng, University of Washington, Seattle, WA, United States

Recent studies of fossil mammal skeletons from the Jehol Group of western Liaoning, China, which is known for its well-preserved Mesozoic vertebrate fossils, have revealed a much greater diversity of locomotor adaptations of Mesozoic mammals than previously known. These Mesozoic taxa provide a unique opportunity to study their paleoecology. Instead of the traditional perception that Mesozoic mammals were generalized terrestrial animals excluded by the dinosaurs from more specialized ecological niches, these discoveries indicate that mammals of the Jehol Group likely occupied a breadth of ecological niches, possibly approaching the ecological diversity of extant mammals.

To develop a method to quantify the range of locomotor morphotypes among Mesozoic mammals, I conducted a morphometric analysis of the entire postcranial skeleton of 51 small-bodied extant mammals of 13 orders, including Afrosoricida, Carnivora, Cingulata, Didelphimorphia, Dasyuromorphia, Diprotodontia, Erinaceomorpha, Monotremata, Peramelemorphia, Primates, Rodentia, Scandentia, and Soricomorpha. Eight locomotor categories were used: arboreal, gliding, scansorial, terrestrial, fossorial, semi-fossorial, semi-aquatic, and saltatorial. Twenty-four osteological indices were derived from 54 linear measurements of the entire postcranial skeleton in contrast to the indices of individual elements applied in previous studies. Linear Discriminant Analysis of those indices shows statistically significant differences among the diverse locomotor categories. In the plots of Linear Discriminant Analysis, fossorial and saltatorial mammals have particularly distinctive postcranial skeletons, whereas arboreal, scansorial, and terrestrial mammals show some overlap suggesting that similar morphological features may respond to different locomotor adaptations. Two fossil representatives, *Yanoconodon* and *Fruitafossor,* are shown by Principle Component Analysis to plot among generalized terrestrial and specialized fossorial mammals, respectively. This preliminary study suggests that this quantitative morphometric analysis of the entire postcranial skeleton supports the conclusions drawn from previous qualitative studies of individual features of limb skeletons. Moreover, this method helps identify the critical indices derived from the entire postcranial skeleton for distinguishing locomotor categories and with just several simple measurements estimates the locomotor adaptation of fossil mammals more accurately and effectively than previous qualitative methods.

Technical Session XVI (Saturday, October 20, 11:00 am)

ISOTOPE ANALYSES SUPPORT USE OF CT SCANS FOR IDENTIFYING ANNUAL INCREMENTS IN SNOWMASS MASTODON MANDIBULAR TUSKS

CHERNEY, Michael D., University of Michigan, Ann Arbor, MI, United States; FISHER, Daniel C., University of Michigan, Ann Arbor, MI, United States; ROUNTREY, Adam N., University of Western Australia, Perth, Australia; CALAMARI, Zachary T., University of Michigan, Ann Arbor, MI, United States

At an altitude of almost 3km in the Colorado Rockies, the Snowmass site gives a rare look at a high-elevation ecosystem from the late Pleistocene of North America. Recent studies have shown that the roughly 4000 *Mammut americanum* bones recovered from the site include tusks of about 35 individuals ranging from calves to senescent adults. The assemblage may represent the combination of many independent single-death events, but it has also been proposed that seismically induced liquefaction of sediments on the shoreline might have trapped entire groups of mastodons. We aim to evaluate the nature of the assemblage by analyzing tusks to compare the timing of death for many individuals. Mastodon tusks grew throughout life and are marked by annual, fortnightly, and daily growth increments that enable fairly precise season-of-death determinations. Furthermore, many studies have shown consistent seasonal patterns in the stable isotope composition of tusk dentin. Multi-year comparisons will be used to determine if animals that died in the same season actually died simultaneously, in the same year.

Mastodon mandibular tusks are numerous at the site and convenient for censusing, but their annual growth increments are often obscure. However, X-ray computed tomographic (CT) scans of mandibular tusks reveal cyclic features in dentin density that appear to correspond to annual growth increments. Previously reported oxygen isotope ($\delta^{18}O$) data from one tusk support this interpretation of the CT data. Additional serial isotope analyses combined with increment thickness profiles now further reinforce this interpretation. The $\delta^{18}O$ and nitrogen isotope ($\delta^{15}N$) series from the Snowmass tusks consistently show elevated values during periods of slowed growth, shown in previous work to correspond to late winter. Periodic peaks in $\delta^{15}N$ probably result from winter nutritional stress. However, the simultaneous highs in $\delta^{18}O$ are contrary to expectations for mid-latitude temperate regions, where meteoric water $\delta^{18}O$ tends to display higher values in summer and lower values in winter. Explaining this 'inverted' $\delta^{18}O$ signal in Snowmass mastodon tusks requires invoking either a seasonal pattern of water source variation shared by individuals at the site or a mechanism for enrichment of $\delta^{18}O$ in the local water source during the winter months. Enrichment in $\delta^{18}O$ of snow pack due to sublimation during the cold, dry, high-altitude winters may explain the anomalous oxygen values. Isotopic patterns from Snowmass mastodon tusks are consistent among individuals, present a first look at seasonal variation in a high-altitude population of mastodons, and support the interpretation of annual increments in CT data.

Technical Session XIII (Friday, October 19, 2:15 pm)

TARSAL MORPHOLOGY OF THE OLDEST PLESIADAPIFORM *PURGATORIUS* INDICATES ARBOREALITY IN THE EARLIEST PRIMATES

CHESTER, Stephen G., Yale University, New Haven, CT, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; CLEMENS, William A., University of California Museum of Paleontology, Berkeley, CA, United States

The origin of primates has long been thought to relate in part to arboreality, yet direct fossil evidence of positional behaviors of the earliest primates has been lacking as these taxa are only represented by fragmentary dentitions. Though plesiadapiforms (stem primates) are generally considered to have been arboreal based on partial skeletons from the late Paleocene and early Eocene, it is unclear whether this substrate preference evolved independently or was characteristic of the first primates in the early Paleocene. The Garbani Channel fauna localities in Garfield County, northeastern Montana, are thought to represent the late Puercan (Pu3; ~65MYA) and have yielded hundreds of dental specimens of *Purgatorius*, the oldest and most primitive plesiadapiform known. Several isolated astragali and calcanea were recovered from four Garbani Channel localities and are referred to *Purgatorius* based on size, abundance, and diagnostic similarities to dentally associated tarsals of euarchontans in general, and plesiadapiforms specifically. In the astragalus, these similarities include a dorsoventrally deep fibular facet relative to the medial tibial facet, a medial edge of the trochlea that extends onto the neck, and a helical sustentacular facet clearly confluent with the navicular facet. Within plesiadapiforms, these astragali are most similar to those of micromomyids in having a body with a relatively high medial ridge and a large flexor fibularis groove. Several similarly sized calcanea are also diagnostically similar to those of other plesiadapiforms in having an ectal facet fairly aligned with the long axis of the calcaneum, a prominent sustentaculum with a helical sustentacular facet that extends distally onto the body, a large peroneal tuberosity, a round and concave cuboid facet, a distinct plantar pit, and lacking a fibular facet. These characteristics indicate a mobile ankle that would allow pedal inversion in order to adjust to an uneven substrate, typical of euarchontan mammals. While results from recent phylogenetic analyses failed to support primate or placental affinities of *Purgatorius*, this new tarsal evidence strongly suggests that *Purgatorius* is a plesiadapiform that lies near the ancestry of all primates within Euarchonta. These specimens are the first to demonstrate that the earliest known plesiadapiforms possessed postcranial modifications for arboreality compared to other mammals in the earliest Paleocene, and these specializations likely played a key role in the evolutionary success of the earliest primate radiation.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A TAXONOMIC REVISION OF THE SAPEORNITHIDAE (AVES: PYGOSTYLIA) FROM LIAONING PROVINCE, CHINA

CHIAPPE, Luis M., Dinosaur Institute-Natural History Museum of Los Angeles County, Los Angeles, CA, United States; POMEROY, Diana L., Dinosaur Institute-Natural History Museum of Los Angeles County; California State Univ-Long Beach, Los Angeles, CA, United States

The fossil localities of the lower Cretaceous Jiufotang and Yixian formations in Liaoning Province (China) have yielded a number of well-preserved sapeornithid specimens. Sapeornithids are larger than contemporaneous Mesozoic birds and are characterized by having extremely long wings with a reduced digit III, broad, non-columnar coracoids, and a short pygostyle. To date, these birds are known by less than twelve published specimens, including the holotypes of four named species—*Sapeornis chaoyangensis*, *Sapeornis*

angustis, *Didactylornis jii*, and *Shenshiornis primita*—whose validity has yet to be critically assessed. We present the results of a qualitative and quantitative analysis of twelve specimens, including the aforementioned holotypes. We obtained regression models of the limb proportions of these specimens and examined the characters used to diagnose the four previously named species. The regression models reveal that the compared limb elements show a strong correlation, with all specimens, including the holotypes, fitting the regression lines. Our examination of the four species diagnoses reveals that these contain characters influenced by taphonomic biases and/or differences in ontogeny. In some instances, our observations were also unable to confirm the characters specified in these diagnoses. Our results indicate that the perceived morphological differences among previously named sapeornithids are better interpreted as taphonomic artifacts, ontogenetic differences, or mistaken observations. The regression models indicate that the observed differences in size are better interpreted as ontogenetic variation within a single growth series. Based on these observations, we argue that *Sapeornis angustis*, *Didactylornis jii*, and *Shenshiornis primita* are junior synonyms of *Sapeornis chaoyangensis*.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MORPHOMETRICS OF RATITE FEMORA AND IMPLICATIONS FOR SEXUAL DIMORPHISM IN DINOSAURS

CHIBA, Kentaro, Natural History Sciences, Hokkaido University, Sapporo, Hokkaido, Japan; BRINK, Kirstin S., University of Toronto Mississauga, Mississauga, ON, Canada; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; SUZUKI, Daisuke, Sapporo Medical University, Sapporo, Hokkaido, Japan

Sexual dimorphism in non-avian dinosaurs has traditionally been studied based on cranial material, especially in taxa with ornamental display structures (e.g., ceratopsians and hadrosaurids). However, with the exception of a rigorous morphometric study of *Kentrosaurus*, few studies have focused on assessing sexual dimorphism in the postcranial skeleton. This may be due to the fact that sexual dimorphism based on size and morphology in the skeletons of extant analogues, such as *Alligator mississipiensis*, is poorly known. Here, we test for sexual dimorphism in the femur of the ratites (*Struthio camelus* and *Dromaius novaehollandiae*), which are basal members of modern birds. As these ratites show a sexual size dimorphism, they are ideal to test whether morphological sexual dimorphism independent of size can be detected in the skeleton.

We performed a principal components analysis (PCA) on geometric morphometric data of the femur of males and females at a variety of growth stages. The bones were analyzed from photographs in proximal, distal, anterior, and posterior view, using landmarks and semilandmarks. In the ostriches, three distinct groups are detected: juveniles, adult females, and adult males. The adult groups are separated from the juvenile group by the morphology of the proximal end of the femur and the proportions of the lateral condyle. Adults of both sexes differ from juveniles by having a thicker neck of the head of the femur and a longer medial edge of the lateral condyle in posterior view. Adult females differ from males by having an anterolaterally-rotated head of the femur and an expanded proximolateral margin of the trochanter. Interestingly, the morphological differences of the trochanter are also dimorphic in *Kentrosaurus*. On the other hand, there are no significant morphological differences between sexes in the emu, but the adults are distinguished from juveniles by the robustness of the neck of the head of the femur, as seen in the ostriches. This suggests that the dimorphism in emus is only size-related and not morphological. Our study demonstrates that the presence of morphological sexual dimorphism is variable, even in closely related taxa. When morphological sexual dimorphism is present, it may be detected in the femora using geometric morphometrics. An understanding of the sexual dimorphism in ratites has implications for the interpretation of sexual morphological dimorphism in dinosaurs, as dinosaurs may exhibit both sexual size dimorphism and morphological sexual dimorphism.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW INFORMATION ON *NQWEBASAURUS THWAZI*, A COELUROSAURIAN THEROPOD FROM THE EARLY CRETACEOUS (HAUTERIVERIAN?) KIRKWOOD FORMATION IN SOUTH AFRICA

CHOINIERE, Jonah N., Bernard Price Institute, University of the Witwatersrand, Johannesburg, South Africa; FORSTER, Catherine A., George Washington University, Washington, DC, United States; DE KLERK, William J., Albany Museum, Rhodes University, Grahamstown, South Africa

We performed additional preparation on the holotype skeleton of *Nqwebasaurus thwazi* and discovered new material from the holotype. We describe this material, which includes a maxilla with small, conical, unserrated teeth and bones of the braincase, as well as parts of the holotype postcranial anatomy that were previously poorly documented. We incorporate this new anatomical information into a broadly sampled matrix designed to test theropod relationships. Our phylogenetic results hypothesize that *Nqwebasaurus* is the basalmost ornithomimosaur, and we recover numerous characters supporting this relationship, including features of the maxilla, frontal, dentition, axial skeleton, forelimb and hindlimb. *Nqwebasaurus* is the first African ornithomimosaur and the first Gondwanan member of this group known from articulated skeletal material, supporting the hypothesis that coelurosaurian groups were cosmopolitan during their early evolutionary history. The presence of reduced dentition and a gastric mill in Nqwebasaurus strongly suggest that this taxon was herbivorous. Additionally, some features of the anatomy suggest alvarezsaur affinities, strengthening the possibility that alvarezsaurs and ornithomimosaurs are more closely related than currently thought.

Romer Prize Session (Thursday, October 18, 8:45 am)

CHANGING DIETARY NICHES IN MAMMALIAN COMMUNITIES ACROSS THE CRETACEOUS/PALEOGENE BOUNDARY

CHRISTENSEN, Hilary, The University of Chicago, Chicago, IL, United States

The extinction event at the K/T boundary was responsible for the demise of most animals larger than a kilogram. The subsequent radiation of mammals into herbivorous niches vacated by the dinosaurs is a well-known phenomenon that is reflected in a general body size increase and the appearance of dentitions capable of the shearing forces required for the breakup of tough plant matter. The timing and nature of this transition has not yet been evaluated, however: multituberculates radiated in size and, presumably, function just prior to the K/T extinction, but the degree to which the placental mammals that replaced them were ecologically similar is unknown. Changes in mammalian diet in the Paleocene were investigated using molar shearing crest length in series with low-magnification microwear techniques, which together allow for the evaluation of an animal's dietary niche (insectivore, carnivore, grazer, browser, hard-object feeder) more precisely than is usually possible by analyzing either tooth shape or microwear alone. There was an initial transition from predominantly insectivorous communities in the Judithian to a more dietarily diverse mammalian community in the Maastrichtian, in which some multituberculates adapted to a high-fiber (leaves/browse) diet. These larger and more herbivorous forms disappeared at the boundary; the Puercan communities that immediately followed were dominated by insectivory and hard-object feeding/omnivory. Hard-object feeding remained dominant among mammalian faunas through the Paleocene even as both taxonomic and size diversity increased. Evidence of predominant high-fiber diets does not re-appear in any taxa until the late Paleocene, when a general drying trend in the Western interior triggered a change from closed-canopy Paleocene rainforests to more open vegetation. This delay in widespread high fiber herbivory for several million years is remarkable and may reflect both intrinsic biological factors, such as the need to re-evolve the herbivore gut flora, and extrinsic environmental factors, such as the potential abundance of fruit fall in the Paleocene forests of the western interior before regional drying led to more open environments.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

BODY SIZE RECONSTRUCTION FOR FOSSIL NORTH PACIFIC PINNIPEDIA (MAMMALIA: CARNIVORA): PROBLEMS AND IMPLICATIONS

CHURCHILL, Morgan, University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States; KOHNO, Naoki, National Museum of Nature and Science, Tokyo, Japan

Animal body size is strongly correlated with a variety of ecological variables, including trophic position, diversity of prey, and species range size. However, body size can be difficult to quantify for fossil taxa, as whole skeletons are rare. To produce estimates of body size for fossil pinnipeds (seals, sea lions, and walruses), we regressed the log of 14 cranial measurements against log body weight and total length. Cranial measurements were selected based on their frequency of preservation within fossil taxa, ease of measurement, and presence of the measured feature across different pinniped families. Over 700 adult specimens of both genders, representing all 33 extant species, were examined. Two different sets of equations were created: 1) a set based on measurements from specimens of known body size, and 2) a separate set of equations based on average body size and the average measurement of a given variable. Standard error, standard error of estimation, percent prediction error, and R^2 value were used to test the accuracy of the different regressions. PCA analysis of log measurements was used to determine if a separate equation of body size was needed for Phocidae and Otariidae, and which equation was most appropriate for extinct pinniped groups.

Of individual cranial characters, mandible and condylobasal lengths were found to provide the best estimates of body size. Overall, estimates performed using known body sizes were more reliable than those using mean values. Estimations of total length were more accurate than estimates of body weight. Body weight is more variable than body length, due to seasonal changes in body condition reflecting fasting, and animals collected as stranded specimens may be underweight due to illness. PCA analysis of measurement data was able to recognize two major groups: 1) a group comprised of Phocidae and the "enaliarctine" *Pacificotaria*, and 2) a separate group comprising Otariidae, Odobenidae, Desmatophocidae, and all other "enaliarctines". Body size estimates were created for a range of North Pacific taxa, spanning the late Oligocene through Pliocene. Based on these estimates, body length was limited to less than 2.5 m until the middle Miocene. Three main groups filled this large pinniped size category (total length > 2.5 m): allodesmines (middle Miocene); odobenids (late Miocene to early Pleistocene); phocids (*Mirounga*) and otariids (*Eumetopias*) (late Pleistocene to Present). Future work will evaluate the use of multivariate regressions of body size, as well as examine ecological factors which may explain changes in pinniped body size through the Neogene.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 8:15 am)

ELASMOBRANCH AND OSTEICHTHYAN DIVERSITY FROM TWO LATE CRETACEOUS (LATE CAMPANIAN) TRANSGRESSIVE LAG DEPOSITS ALONG THE NEUSE RIVER, LENOIR COUNTY, NORTH CAROLINA

CIAMPAGLIO, Charles N., Wright State University, Celina, OH, United States; CICIMURRI, David J., South Carolina State Museum, Columbia, SC, United States

Along the Neuse River in western and central Lenoir County, NC, two transgressive lag deposits expose copious amounts of vertebrate material, including chimaeroid jaw plates, elasmobranch teeth and denticles, and bony fish remains. The first site, commonly referred to as Auger Hole Landing, is located at the junction of the Neuse River and the Wayne/Lenoir county line, and consists of the basal Bladen Formation. The lithology consists of three distinct horizons, including a basal arenitic shell bed, a calcareous sandstone that contains a diverse assemblage of well-preserved mollusks, and an upper greenish-gray, clayey, glauconitic sand. All three horizons contain well preserved elasmobranch and osteichthyan remains.

The upper horizon at Auger Hole Landing has been extensively sampled and investigated. This horizon can be divided into a lower and upper unit, each of which consists of marine clays overlain by poorly sorted quartz sands and clays. Both units contain abundant elasmobranch remains, including, but not limited to the following species: *Brachyzhizodus wichitaensis*, *Rhombodus laevis*, *Borodinopristis schwimmeri*, *Cantioscyllium* sp. cf. *C. meyeri*, *Chiloscyllium* sp., *Plicatoscyllium minutum*, *Ischyrhiza mira* (orals), *Ptychotrygon cuspidata*, *Ptychotrygon vermiculata*, *Squalicorax kaupi*, *Squatina hassei*. Bony fish include *Enchodus petrosus* and *Anomaeodus latidens*.

The second site is exposed just upstream of the US 70 bridge. Here, the lithology is composed of a basal, thinly laminated sand and clay, overlain by glauconitic sand that contains quartz gravel, phosphatic pebbles, and copious elasmobranch and bony fish remains. The exposure is capped by an approximately four-inch thick lens of arenitic limestone containing phosphate pebbles and vertebrate remains. Although this transgressive lag most likely represents the basal Donoho Creek Formation, the chondrichthyan fauna is associated with the Bladen Formation. The chondrichthyan fauna includes, but is not limited to: *Ischyodus bifurcatus*, *Chiloscyllium* sp., *Odontaspis aculeatus*, *Serratolamna serrate, Scapanorhynchus texanus*, *Borodinopristis schwimmeri*. Bony fish include *Pachyrhizodus* sp., and *Plethodus* sp.

Both sites expose well preserved abundant and diverse chondrichthyan and boney fish faunal elements. Taken together, the two sites preserve the vertebrate biota of the upper and lower boundaries of the Bladen Formation exposed within the coastal plain of North Carolina.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:45 am)

GUITARFISH PARAPHYLY AND THE ORIGIN OF SKATES AND RAYS: ESTIMATING ACCUMULATION RATES OF VERTEBRAL FUSION AMONG BATOID FISHES

CLAESON, Kerin M., Ohio University, Athens, OH, United States; ASCHLIMAN, Neil C., Saint Ambrose University, Davenport, IA, United States; UNDERWOOD, Charlie, Birkbeck University of London, London, United Kingdom

Phylogenetic investigations of members of Batoidea (skates, rays, and guitarfishes) have typically relied on morphological data obtained exclusively from modern/Recent specimens. Recently, two independent hypotheses of batoid interrelationships were proposed using molecular data (mitochondrial and nuclear gene sequences) or paleontological data (morphological dataset including extinct and extant specimens). These two new hypotheses agree with the previous, modern-morphology hypotheses in indicating that "Rhinobatiformes" is paraphyletic to the exclusion of other derived batoid lineages. The consistency with which findings report a paraphyletic "Rhinobatiformes" and the phylogenetic instability of more derived monophyletic groups prompted our investigation into the evolutionary processes that shaped batoid evolution. We hypothesize that modern-day "guitarfish" paraphyly may retain the potential evolutionary scaffold for early batoid evolution. As such, we sought to determine the extent to which patterns and rates of phenotypic evolution vary among the "rhinobatiform" stems that are indicated to be ancestral to the more derived lineages of Batoidea. Using a phylogeny generated from a concatenated data set incorporating both modern and fossil data, we examine phenotypic trajectories using morphometrics of the post-cranial axial skeleton over a time calibrated phylogenetic history. In the process we investigate the hypothesis that modern "rhinobatiforms" are more like Jurassic forms than other groups of batoids. We find evidence of repeated similar phenotypic trajectories among disparate batoid groups. For example, in any lineage of batoid, similar changes to the synarcual, a well-supported synapomorphy of Batoidea, occur independently as one moves 'up the tree'. Synarcual hyaline and tessellated cartilages, derived from basiventral and basidorsal cartilages, become longer and are perforated by more and more spinal nerve foramina (i.e., the synarcual is short and incipient in Jurassic taxa, and more massive and complex in derived batoids). At the same time, the relative position of the first free vertebral centrum, composed of areolar cartilage, is found more posterior along the synarcual. Previously demonstrated for skates, this is now noted in electric rays, stingrays, and 'guitarfishes' independently. These changes coincide with modifications in lifestyle from an early (Jurassic) batoid 'rhinobenthic' habitus of bottom dwelling/feeding plus caudal propulsion, to parallel adaptations for less caudal forms of locomotion and additional pectoral specializations. Furthermore, although there are several superficial similarities between Jurassic batoids and modern "Rhinobatiformes," several differences are noted, thus their relationships remain uncertain.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE VERTEBRATE FAUNA OF THE MIDDLE-LATE JURASSIC SHISHUGOU FORMATION OF XINJIANG, CHINA: RECENT DISCOVERIES

CLARK, James M., GWU Biology Dept., Washington, DC, United States; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; CHOINIERE, Jonah N., Bernard Price Institute, Johannesburg, South Africa; EBERTH, David A., Royal Tyrrell Museum, Drumheller, AB, Canada; CHU, Hongjun, Forestry Bureau of Altay Prefecture, Xinjiang, Altay, China

Excavations since 2001 in the Shishugou Formation at Wucaiwan and other sites in the Junggar Basin, Xinjiang, recovered hundreds of articulated partial and complete skeletons of terrestrial vertebrates. Radiometric dating of tuffs indicates the formation spans the poorly known Middle-Upper Jurassic boundary, and sediments indicate a change to more xeric, seasonal conditions in the upper part. The most abundant and diverse fauna is from the upper part of the formation at Wucaiwan, and is dominated by relatively small dinosaurs (<2 m total length), tritylodontids, crocodyliforms, and turtles. Thus far 8 new genera and species have been described. The theropods are especially diverse at Wucaiwan, including four recently named taxa of basal coelurosaurs, the unusual ceratosaur *Limusaurus*, and a poorly known allosauroid. Among herbivores in the upper part of the formation the ornithischians are less abundant than tritylodontids, perhaps due to a preservational bias towards the burrowing tritylodontids, but include the most basal ceratopsian (*Yinlong*) and excellent material referred to the poorly known basal ornithopod *Gongbusaurus wucaiwanensis*. Other taxa include a rhamphorhynchid and a pterodactyloid pterosaur, five species of turtles, abundant remains of the shartegosuchid crocodyliform *Nominosuchus*, and articulated remains of two squamates and a docodont mammaliaform. Here we provide new details about recently described taxa, the implications of the hand of *Limusaurus* for theropod digital homologies, the sedimentology of the Shishugou Formation, and comparisons between the Shishugou fauna and other Middle-Late Jurassic faunas of Asia. Along with the Middle-Late Jurassic fauna at Daohugou the diverse coelurosaur fauna of the Shishugou Formation demonstrates that coelurosaur diversification was well under way by the beginning of the Late Jurassic. The well known Middle Jurassic faunas of the Lower and Upper Shaximiao Formations in Sichuan differ at the species level and lack representatives of most of the lineages present in the Shishugou. This is due at least in part to a temporal difference, but the Shaximiao formations are poorly dated.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:00 am)

BAYESIAN APPROACHES TO THE INVESTIGATION OF MORPHOLOGICAL RATE HETEROGENEITY IN DISTINCT ANATOMICAL SUBREGIONS

CLARKE, Julia A., The University of Texas at Austin, Austin, TX, United States; MIDDLETON, Kevin, University of Missouri, Columbia, MO, United States

A concept of anatomical mosaicism has a long history in comparative biology and stems from observation of apparently disjunctive change localized in parts of an organism. While different rates of change in distinct characteristics of an organism are explained by combinations of plesiomorphy and apomorphy (characters with differing evolutionary histories and timings of origin), a proposed pattern of localization or organization of changes in distinct anatomical subregions is not. Model based methods allow potential evolutionary linkages among characters or their rates to be explored by comparing models differing in the number and character composition of partitions used to represent the character data as well as other parameters. Here we expand on our previously proposed methods for exploring the performance of different morphological character partition models in a Bayesian phylogenetic framework. We explore previously proposed patterns in discrete character change in two datasets relevant to (1) the assembly of avian flight and (2) the evolution of wing propelled diving of extant penguins. We compare the effect of using different available estimators of model likelihoods (harmonic mean [HM] and stepping stone sampling [SS] approaches) and the implications for model choice. We found that the SS estimators for these morphological datasets yield more stable estimates of model likelihood values in replicate analyses, as previously reported for molecular datasets. In Bayes factor comparisons of estimated model likelihoods from SS and HM, distinct models were preferred. In these real datasets the SS method for likelihood estimation does seem to overcome difficulties proposed for the HM estimator by yielding more consistent estimates of model likelihood values and less systematic bias towards more parameter rich models. Comparing among different character partitioning schemas, we find a preference for a two-partition model in which pectoral vs. all other characters are allowed independent rate parameters. We also analyze likelihood estimates for models with the same number of parameters but randomized character contents for partitions, which permit null hypothesis testing in assessment of the performance of biologically-informed partitioning models.

Romer Prize Session (Thursday, October 18, 9:00 am)

CHEMICAL AND MOLECULAR CHARACTERIZATION OF ENDOGENOUS PROTEINS FROM THE BLOOD VESSELS OF *BRACHYLOPHOSAURUS CANADENSIS* AND *TYRANNOSAURUS REX* CORTICAL BONE

CLELAND, Timothy P., North Carolina State University, Raleigh, NC, United States

Vessel-like structures (referred to herein as vessels for brevity and clarity) have been observed after demineralization of extant and fossil bone from the Recent to the Cretaceous; however two competing hypotheses have been suggested as the source of these structures: they are endogenous, representing original blood vessels; or they are the result of recent invasion and colonization of biofilm-producing bacteria. We hypothesized that if original, the structures would exhibit proteins in common with comparable vertebrate material that are not expressed by bacteria. Vessels from a specimen of *Brachylophosaurus canadensis* (MOR 2598) and *Tyrannosaurus rex* (MOR 1125) were collected after cortical bone fragments were demineralized with ethylenediaminetetraacetic acid (EDTA) using aseptic techniques in a laboratory dedicated solely to fossil analyses to avoid contamination. Antibodies against several vascular proteins differentially bind these dinosaur soft tissues in multiple assays, supporting the hypothesis of endogeneity. The same antibodies do not bind to bacterial biofilm. High-resolution mass spectrometry also supports an endogenous source, as peptides from myosin, tubulin, actin, and tropomyosin have been detected from the *B. canadensis* specimen and peptides from myosin and actin have been detected from the *T. rex* specimen. Myosin and tropomyosin are only found in metazoan taxa, and tubulin is only found in eukaryotic taxa; these proteins are not common lab contaminants, and all controls are negative. This suite of proteins is expected for vascular walls and is associated with vascular smooth muscle in extant taxa. In addition, no bacterial peptides were detected from the vascular extracts. Localization of antibodies to these tissues in *in situ* studies, and presence of metazoan peptide sequences supports an endogenous source and no data support a microbial source. The most parsimonious explanation for all the data given is that these vessels are remnants of original dinosaur vasculature.

Technical Session XIII (Friday, October 19, 2:00 pm)

PATTERN OF IMMIGRATION OF PURGATORIIDS AND OTHER EUTHERIANS INTO THE NORTHERN NORTH AMERICAN WESTERN INTERIOR

CLEMENS, William A., University of California Museum of Paleontology, Berkeley, CA, United States; WILSON, Gregory P., University of Washington, Seattle, WA, United States

Immigration played a major role in reconstitution of mammalian faunas of the northern North American Western Interior after the extinctions marking the Cretaceous/Paleogene boundary. Plesiadapiform primates were among these immigrants. Large samples of vertebrate local faunas of Lancian and Puercan (Puercan 1 and probably Puercan 3 Interval Zones) North American Land Mammal Ages have been recovered from the Hell Creek and Tullock formations of northeastern Montana. In the collections of the University of California Museum of Paleontology from probable Puercan 3 local faunas found in the Garbani Channel, approximately 18 percent of over 7,800 currently cataloged mammalian specimens are referable to *Purgatorius* and possibly other plesiadapiformes. Purgatoriids had not been found in large samples of Lancian or Puercan 1 local faunas. For example, two thoroughly studied Puercan 1 local faunas documented by over 1,700 mammalian specimens lack any records of purgatoriids. Similarly they are unknown in any Lancian local fauna. Here we report discovery of a purgatoriid in the Puercan 1 local fauna found at the McKeever Ranch, Harley's Point, locality. Lithostratigraphic correlations with magnetostratigraphically analyzed sections indicate that this local fauna lived during the more recent part of C29R. Continuing sampling of the locality has resulted in discovery of five isolated teeth, approximately three percent of the available sample, documenting the presence of a purgatoriid. Additional material will be needed to determine if it is referable to a currently recognized species of *Purgatorius.* This occurrence of a purgatoriid in Montana is approximately contemporaneous with or possibly slightly older than the recently reported first occurrence of *Purgatorius, P. coracis,* in Canada. Together they indicate that the immigration of purgatoriids into the northern Western Interior occurred soon after the immigration of the eucosmodontid multituberculate *Stygimys* and the "archaic ungulates," *Oxyprimus, Protungulatum*, *Mimatuta*, and *Baioconodon.*

Technical Session V (Wednesday, October 17, 2:45 pm)

ONTOGENETIC VARIATION IN DENTAL STABLE ISOTOPE VALUES OF TWO SPECIES OF BASILOSAURIDS (ZYGORHIZA KOCHII AND DURUDON ATROX)

CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States; UHEN, Mark D., George Mason University, Fairfax, VA, United States

Basilosauridae represent the most derived of the Eocene archaeocete cetaceans, and yet they retained the primitive mammalian trait of diphyodonty, or two sets of teeth. These dentitions formed and erupted at different stages in an individual's life, and provide a useful means of gathering life history information for fossil species. Previous stable isotope analysis of a few deciduous and adult teeth from one specimen of basilosaurid (*Zygorhiza kochii,* USNM 16638) demonstrated this effect; clear shifts in $\delta^{13}C$ and $\delta^{18}O$ values were evident across a tooth row, and were indicative of dietary changes associated with prenatal and postnatal intervals in an individual's life. The most pronounced of these shifts was associated with the consumption mother's milk during nursing, a dietary change resulting in a 3.0‰ offset from prenatal and post-weaning enamel $\delta^{13}C$ values. Here, we expand upon this earlier work by assessing the robustness of these ontogenetic differences in stable isotope values through analysis of additional tooth and bone material from USNM 16638, a second specimen of *Z. kochii* (USNM 11962), and multiple specimens of another species of basilosaurid, *Dorudon atrox*.

Our prior analysis of multiple teeth (n = 9) along the lower left tooth row of USNM 16638 was augmented by sampling teeth from the other side of the jaw as well as both sides of the upper dentition, which more than tripled the total number of samples taken from this specimen (n = 33). For USNM 11962, sampling was limited to upper and lower adult dentition (n = 25), and, for specimens of *Dorudon atrox*, published values for deciduous and adult canines were compared with new data for *Z. kochii*. Enamel $\delta^{13}C$ values for all specimens showed a consistent 3.0‰ offset between teeth that formed early (most deciduous teeth, P1s and M1s) and those that formed later in time. Enamel $\delta^{18}O$ values, in contrast, were more variable, spanning a 2.0‰ range across a single tooth row. Likewise, enamel $\delta^{13}C$ values for canines from *Dorudon atrox* showed a similar 3.0‰ offset between deciduous and adult teeth, whereas the difference in enamel $\delta^{18}O$ values was less pronounced. The consistent offset in enamel $\delta^{13}C$ values between deciduous and adult teeth across toothrows within a single specimen, within specimens of the same species, and within species of the same family (Basilosauridae), confirm that these isotopic patterns are original and not a result of post-burial alteration. If similarly true for enamel $\delta^{18}O$ values, oscillations in these values across tooth type may reflect seasonal movements of individuals between waters of different oxygen isotopic composition.

Preparators' Session (Thursday, October 18, 9:45 am)

THE USE OF HIGH-RESOLUTION XRAY CT TO INTERPRET MATRIX VARIABILITY AND GUIDE FOSSIL PREPARATION

COLBERT, Matthew W., The University of Texas at Austin, Austin, TX, United States; BROWN, Matthew A., Vertebrate Paleontology Laboratory, The University of Texas at Austin, Austin, TX, United States

The process of fossilization is complicated and can be influenced by a multitude of geological, biological, and chemical factors. Because of this, variable patterns of sediment sorting, mineralization, and cementation are often found at the scale of an individual specimen. Such variability potentially complicates mechanical and/or chemical preparation, and may require different techniques to be applied to different regions of a fossil. The differences in preservation may also have taphonomic significance (e.g., evidence of bioturbation, preserved soft tissues), the context of which -or even the information in its entirety- is lost during conventional preparation. Commonly used for visualization of anatomical structures, CT scanning is a powerful tool that can often reveal variations in sediment sorting, cementation and mineralization, in addition to physical damage to specimens, and thus serves as a useful guide during preparation. Here we present CT data showcasing the convoluted taphonomic histories of a variety of specimens ranging from the Paleozoic to the Quaternary. While these data illustrate a spectrum of preservational situations, they also demonstrate some commonalities in the fossilization process (e.g., predictable loci for cementation, and predictable patterns of sediment dispersal) that can inform specimen preparation. These data also serve as a caution against over-preparation, as there may be valuable information preserved in the matrix encasing a fossil. CT technology can be effectively used to develop a preparation or conservation strategy for a specimen that increases efficiency and minimizes information loss.

Technical Session IX (Friday, October 19, 11:00 am)

NEW SPECIMENS OF 'CROCODYLUS' PIGOTTI (CROCODYLIDAE) FROM RUSINGA ISLAND, KENYA, AND A REFINED UNDERSTANDING OF THE SPECIES

CONRAD, Jack L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; JENKINS, Kirsten, University of Minnesota, Minneapolis, MN, United States; DUNSWORTH, Holly M., University of Rhode Island, Kingston, RI, United States; HARCOURT-SMITH, William E., Lehman College, Bronx, NY, United States; MCNULTY, Kieran P., University of Minnesota, Minneapolis, MN, United States

During June and July of 2011, we recovered parts of more than a dozen '*Crocodylus*' *pigotti* (Pigott's Crocodile) a poorly known and relatively small (approximately 2.5 m long), early Miocene crocodylid from Rusinga Island, Lake Victoria, Kenya. We report on previously unknown parts of the anatomy and provide an updated phylogenetic analysis. Known only from one relatively complete skull and limited, fragmentary, referred material, *'Crocodylus*' *pigotti* lacks a detailed description. We describe numerous new remains of '*Crocodylus*' *pigotti* recovered from a locality within the Fossil Bed Member of the Hiwegi Formation at Kaswanga Point, Rusinga Island. The new material includes parts of at least a dozen skulls, cervical, dorsal, and caudal vertebrae, scapulocoracoids, humeri, ulnae, parts of the manus, an ilium, an ischium, femora, and tibiae. The postcranial skeleton reveals a somewhat robust crocodylid with a 'generalist' skull. '*Crocodylus*' *pigotti* was originally compared to the *Crocodylus niloticus* morphotype and allied with it phylogenetically. However, recent phylogenetic analyses have shown '*Crocodylus*' *pigotti* to be an osteolaemine crocodylid, a result further supported by our own analyses. Even so, the gestalt of the relatively long-snouted '*Crocodylus*' *pigotti* is more that of a subadult *Crocodylus nilotcius* than the relatively shorter-faced *Osteoleamus*. This lends credence to the early suggestion that '*Crocodylus*' *pigotti* might have been ecologically similar to small or subadult generalist predator *Crocodylus niloticus*. An unnamed Miocene fossil from Lothagam Kenya probably represents another new Miocene osteolaemine similar to '*Crocodylus*' *pigotti*. Over its history, osteolaemine diversity has mirrored that of crocodylines—a fact not immediately apparent based on the two extant relictual species. Ranging from two to five-plus meters

and with a variety of snout and tooth types, Osteolaeminae includes generalist dwarfs, presumably piscivorous giants, and a variety of forms between. Osteolaemines were a significant part of the Miocene freshwater fauna in Kenya.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RECONSTRUCTION OF SUBFOSSIL LEMUR BITE FORCES USING DENTAL FRACTURE MECHANICS

CONSTANTINO, Paul J., Marshall University, Huntington, WV, United States; GODFREY, Laurie R., University of Massachusetts, Amherst, MA, United States; MEADOR, Lindsay R., University of Massachusetts, Amherst, MA, United States; SCHWARTZ, Gary T., Arizona State University, Tempe, AZ, United States

Nearly 20 species of now-extinct lemurs inhabited the island of Madagascar only a few thousand years ago. Each of these species was larger in body size than the largest of living lemurs, and some at least appear to have occupied niches that have not been refilled by surviving lemur species. To better understand lost niche space, we seek to reconstruct the maximum bite forces these lemurs could have exerted by using information on the fracture resistance of their teeth. Tooth enamel is a hard substance that does not deform easily under load. However, it is also brittle and highly susceptible to fracture. Previous work has shown that such fractures can be used as a diagnostic tool for reconstructing bite force in mammals with bunodont dentitions. Through simulated biting experiments on model tooth structures and extracted human molars, two principal fracture modes in enamel – longitudinal cracks and chipping – have been identified. Fracture mechanics theory from materials engineering allows one to derive explicit relations for quantifying critical bite forces from each crack type in terms of characteristic tooth size and enamel thickness. We determined values for these variables using whole teeth and sections of teeth in a number of subfossil lemurs. We then used these data to calculate and compare bite forces among these primates. Such a comparative study of bite forces can reveal important dietary differences among extinct species and can narrow the range of foods to which these creatures would have had access.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

FUNCTIONAL MORPHOLOGY OF ELONGATED VERTEBRAE IN *BASILOSAURUS* TO INTERPRET AQUATIC LOCOMOTION PATTERNS

CORRIE, Joshua E., Marshall University, Huntington, WV, United States

The elongated vertebral column unique to the archaeocete *Basilosaurus* is a highlight in the evolutionary transition within Cetacea from a semi-aquatic lifestyle to the fully aquatic lifestyle typical of modern whales. Because whales swim by dorsoventral flexion of the vertebral column, swimming speed and maneuverability are influenced by dimensional variations in the vertebrae. In this study, vertebrae from the posterior thoracic, lumbar, and caudal regions were analyzed from fossil specimens of *Basilosaurus*. Analyses of vertebral characteristics included dimensions of centra, length and orientation of processes, and description of the zygapophyses. Results were compared to analyses of vertebrae from other archaeocetes to depict changes in vertebral morphology during the Eocene land-sea transition, and the coinciding evolution of aquatic locomotion. In addition, extant Odontoceti and Mysticeti specimens were used, providing examples of highly derived modern taxa to assess the morphological change from mid-Eocene basilosaurids (36-40 Ma) to modern Cetacea. Furthermore, vertebral dimensions (centrum length, width, and height) were used to compute the Vertebral Length Index (VLI) to show variations in centrum length across the vertebral column. The VLI included cervical vertebrae to observe foreshortening as aquatic competency increased during the land-sea transition. Vertebral characteristics observed in *B*asilosaurus indicate a high degree of flexibility, leading to an interpretation of a derived aquatic locomotion pattern combining dorsoventral and laterally oriented anguilliform swimming patterns with fluke generated propulsion. Furthermore the high level of flexibility of the vertebral column in *Basilosaurus* probably allowed high maneuverability, but relatively low speed. The VLIs in *Basilosaurus* increase rapidly, beginning in the posterior thoracics and reaching values of ~225. Values remained just below 200 through the lumbars and ~175 in the anterior caudals before rapidly decreasing in the mid-caudal region. Rapid increase and sustaining of high VLIs indicates extreme elongation of centrum length. Alternatively, uniquely low VLIs in the cervicals indicate increased shortening of cervical length in *Basilosaurus* to allow stability for an elongated body plan. Studying vertebral morphological changes in *Basilosaurus* and archaeocetes throughout the Eocene will help provide insight into the functional impact of changing vertebral morphology during the evolution of aquatic locomotion during the land-sea transition.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE MIDDLE EOCENE ADAPIFORM PRIMATES FROM THE SHANGHUANG FISSURE FILLINGS, JIANGSU PROVINCE, PEOPLE'S REPUBLIC OF CHINA

COSTER, Pauline, Carnegie Museum of Natural History, Pittsburgh, PA, United States; NI, Xijun, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; BEARD, K. C., Carnegie Museum of Natural History, Pittsburgh, PA, United States

Adapiform primates are widely considered as stem members of Strepsirrhini, a primate suborder that includes the crown clade containing lemurs, lorises and galagos. During the Eocene Epoch, these primates were common, diverse, and widespread, being recorded from Europe, Asia, North America and Africa. While the fossil record of European and North American adapiforms is reasonably well documented, our knowledge of African and Asian adapiforms remains meager and inadequate. Since the early 1990s, field parties from the Institute of Vertebrate Paleontology and Paleoanthropology and the Carnegie Museum of Natural History have explored five fossiliferous karstic fissure-fillings (Fissures A-E) near Shanghuang in southern Jiangsu Province, east-central China. These sites have yielded rich middle Eocene vertebrate faunas, including remarkable primate assemblages currently considered to be among the best known Asian records of early primates. Three adapiform taxa, including two sivaladapids (*Hoanghonius* sp. nov. and *Rencunius wui*, both of which belong to the subfamily Hoanghoniinae) and the adapid *Adapoides troglodytes* have been identified from the Shanghuang fissure-fillings. All previously described adapiform fossils from Shanghuang, including specimens that were previously interpreted as pertaining to a taxon resembling *Europolemur*, can now be attributed to *Adapoides*. Newly collected specimens of *Adapoides* significantly improve our knowledge of its anatomy and relationships. A phylogenetic analysis incorporating the Shanghuang adapiforms has been conducted to explore the relationships of these taxa. Shanghuang sivaladapids are the oldest undoubted members of Hoanghoniinae and extend the geographic range of this subfamily to Jiangsu Province. These fossils provide crucial information for understanding the origin and subsequent radiation of sivaladapids in Asia, revealing previously unsuspected taxonomic and paleoecological diversity during the early history of the group. *Adapoides troglodytes* shows affinities with European Adapinae, supporting the hypothesis of adapine dispersal from Asia to Europe during the middle Eocene. The phylogenetic and biogeographic affinities of the Shanghuang fauna reflect the complex role played by Asia during the early evolution of adapiform primates.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:00 am)

BRIDGING THE GAP: NORTH CAROLINA'S ROLE IN LATE CRETACEOUS (CAMPANIAN) RESEARCH AND ITS IMPLICATIONS FOR REGIONAL PALEOBIOGEOGRAPHY AND FAUNAL CORRELATIONS

CRANE, Cynthia D., Department of Geological Sciences, East Carolina University, Greensville, NC, United States

New research from a vertebrate fossil site discovered near Elizabethtown, Bladen County, North Carolina, has contributed to an updated Late Cretaceous (Campanian) age faunal list. The new data support previous paleobiogeographic interpretations and indicate latitudinal extensions of species previously restricted to other localities of the Atlantic and Gulf Coast region. They also permit a faunal comparison and correlation with known localities to the north (Ellisdale, New Jersey) and to the south (Hannahatchee Creek, Georgia).

During the Campanian, a fluvially-dominated estuarine system preserved vertebrate elements from a multitude of organisms in a ca. 10 cm thick bonebed at the top of the Bladen Formation of the Black Creek Group. The bonebed, overlain by Cenozoic terrace deposits, is exposed at the new site, approximately 6 km from Phoebus Landing. The Elizabethtown site has yielded a greater abundance and diversity of vertebrate material than Phoebus Landing, thus permitting a more detailed understanding of the regional paleoecology. Bulk samples from the bonebed have yielded a diverse assemblage of fresh water, brackish water, and terrestrial organisms representing at least 44 taxa, including 22 species of selachians, seven species of osteichthyes, as well as crocodylians, mosasaurs, freshwater and saltwater turtles, plesiosaurs, four dinosaur taxa, one genus of Mammalia, and one genus of Amphibia. Of particular note are the occurrence of *Cimolomys* sp., *Albanerpeton* sp., *Deinosuchus rugosus, Ornithomimus* sp., Dromaeosauridae gen. and sp. indet., Tyrannosauridae gen. and sp. indet., Hadrosauridae gen. and sp. indet., and *Borodinopristis* sp.

Technical Session II (Wednesday, October 17, 8:15 am)

***DELTOPTYCHIUS:* CRANIAL CHARACTERS AND RETHINKING EARLY HOLOCEPHALAN PHYLOGENY**

CRISWELL, Katharine E., University of Chicago, Chicago, IL, United States; FINARELLI, John A., University College Dublin, Dublin, Ireland; FRIEDMAN, Matt, Oxford University, Oxford, United Kingdom; GARWOOD, Russell, Manchester University, Manchester, United Kingdom; COATES, Michael I., University of Chicago, Chicago, IL, United States

In the early 1980s the noted fossil collector S. P. Wood discovered a pair of exceptionally intact specimens of *Deltoptychius*, a Lower Carboniferous holocephalan, while excavating the fossil fish site at Bearsden, Scotland (Serpukhovian: ~326-318 Ma). We obtained a CT-scan of the most complete *Deltoptychius* specimen and have identified and digitally isolated parts of the skull, mandible, and pectoral girdle. *Deltoptychius* traditionally was diagnosed by features including a head shield made up of dermal plates and scales, supraorbital sensory line grooves on the surface of the dermal bones, presence of mandibular spines, but lack of frontal spines in contrast to the array present on the rostrum of its close relative, *Menaspis*. This specimen of *Deltoptychius* reveals numerous characters that were not previously known, including details of the braincase concealed by the dermatocranium. The orbits are separated by endocranial space: there is no interorbital septum. The quadrates are positioned anterior to the orbit and there is some evidence for a large cranio-quadrate passage perforating the broad suborbital shelf. For the first time we can begin to see the internal structure of the otic capsules: these are small, as in living chimaeroids. Postcranially, the axial skeleton shows no synarcual plate, consistent with absence of a dorsal fin and associated spine. It is also apparent that mineralized chordacentra are absent. These new data fill in previously-missing character state information for this taxon, and serve to falsify previous hypotheses of the evolution several functional character complexes, in particular the evolution of the paired sensory organs. Holocephalans represent an important component of the post-Devonian evolutionary radiation of modern vertebrate clades. This is a topic of

increasing interest as we begin to explore the refilling of vertebrate ecomorphospace in the recovery period following the Hangenberg extinction.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:45 am)

A SYNTHESIS OF CENOZOIC NEOTROPICAL MAMMAL EVOLUTION IN SOUTH AMERICA: BIOGEOGRAPHY AND INFLUENCES FROM HIGHER LATITUDES

CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States

Fossil assemblages from the Southern Cone have long been the basis for understanding patterns of Cenozoic mammal evolution in South America. More recent studies of assemblages from other parts of the continent have added a geographic dimension to this mainly temporal framework, revealing additional complexities. The present study synthesizes the past two decades of research on terrestrial Cenozoic mammals of tropical South America (the Neotropics). Within this region, spatial gaps in sampling and shared characteristics among faunas of each region permit the recognition of two subregions: low latitude (LL) faunas north of about 15° S and mid-latitude (ML) faunas south of 15° S.

The pre-Oligocene record of terrestrial mammals in tropical South America includes only two well characterized ML localities, Tiupampa, Bolivia and Itaboraí, Brazil. The lack of unambiguously correlative and well-sampled extratropical localities during the Paleocene and early Eocene hampers biogeographic conclusions based on these sites, but cingulate xenarthrans and microbiotherian marsupials may have originated in the tropics during this interval. New middle Eocene mammals from Contamana, Peru (LL) mostly remain undescribed but are noteworthy in including the oldest rodents in South America, suggesting a LL tropical origin for caviomorphs. Pyrotheres may also have originated in the LL tropics by the late Eocene.

The earliest interval for which detailed time-correlated comparisons of tropical and extra-tropical localities are possible is the late Oligocene. Such studies reveal few clear examples of supragenerically endemism in the Neotropics, but argyrolagid and caenolestoid marsupials and tolypeutine armadillos may have originated in the ML tropics by this time. By the early Miocene, distributions of some suprageneric clades, such as mesotheriid notoungulates and chinchillid rodents, clearly differ among LL and ML Neotropical localities and between tropical and extratropical regions. This pattern persists into the middle Miocene with these and other groups. Primates become restricted to tropical latitudes during the middle Miocene and groups such as pampatheres may have originated in LL areas by this time. Range contractions of older lineages into the tropics and extratropical expansions of newly originating clades continues into the late Miocene and Pliocene. Mammals such as astrapotheres are last recorded in LL localities during this interval. Neotropical evidence of the earliest stages of the Great American Biotic Interchange is surprisingly scarce, but a proboscidean and artiodactyls from the LL Madre de Dios Formation have been proposed to represent its first phase in South America.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

MODELING FUNCTIONAL TRADE-OFFS OF TEETH FROM EXTINCT AND EXTANT HARD PREY CRUSHING TAXA

CROFTS, Stephanie B., University of Washington, Seattle, Seattle, WA, United States

The dense mineral composition of teeth, especially enamel and enameloid layers, means that they are commonly found in the fossil record. Because of the tight connection between tooth morphology and function, tooth shape is often used to infer the diet of organisms; and tooth morphologies are generally placed in one of three categories: cutting, piercing, and crushing. Experiments measuring the mechanics of cutting blades and puncturing devices, as well as experimental measurements of tooth performance in these two categories have found that notched blades reduce the energy needed to cut through animal flesh, and that the need to prevent tooth failure leads to a trade-off in the ability of canine teeth to puncture flesh. In this study I set out to test the relative ability of different tooth morphologies to crush prey items. I constructed four series of archetypal tooth models that graded from one morphological extreme to another, covering the range of morphologies used for durophagy. Using a tooth with a flat occlusal surface as 'tooth zero,' I varied the degree of convexity and concavity of the occlusal surface to generate two series of models. To generate the other two series, I added a conical stress concentrator to the center of the occlusal surface and changed its morphology. To vary the shape I changed two parameters: the height, or how far a force concentrator would extend above the occlusal surface of 'tooth zero,' and the radius, which determined how far the base of the force concentrator spread over the occlusal surface 'tooth zero.' By mounting these models in a materials testing system, I was able to measure the force needed by these shapes to crush morphologically and compositionally identical prey items. I compared these results to finite element models of these same tooth shapes to determine whether prey-breaking or prevention of tooth breakage plays a more important role in the evolution of crushing tooth shape. Based on these two data sets, it appears that there is a trade-off, similar to that seen in puncturing teeth, between tooth shape durability and tooth function.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

***OGMOPHIS, CALAMAGRAS* AND THE 32 MILLION YEAR OLD AGGREGATION OF SNAKES FROM THE WHITE RIVER FORMATION: ARE THEY ERYCINES?**

CROGHAN, Jasmine A., University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada

Fossil taxa attributed to the Erycinae, like many other fossil snakes, are defined almost entirely by vertebral forms. The 'erycine' serpent aggregation from the Oligocene White River Formation consists of four largely complete and articulated individuals, including skulls. The observed vertebral variation, rostral to caudal, provides a unique opportunity to identify potential overlap of existing vertebral form taxa with the columnar variation present in these four individuals. More importantly, these complete skeletons, rich in critical anatomical details, provide key data for synonymizing numerous vertebral form taxa and for systematizing these animals using complete skeletal data. For example, the caudal vertebrae visible on the specimens do not display the additional complex processes definitive of Erycinae with the exceptions of *Lichanura* and *Albaneryx*. The mid trunk vertebrae of the Oligocene aggregation possess low neural spines and flattened neural arches (similar to modern Erycinae), yet vary throughout the vertebral columns of all four individuals. Vertebral descriptions at the subfamilial, generic, and importantly, the species level, are loosely defined in extant erycines. Therefore, the previous assignment of these snakes to *Ogmophis* sp. and *Calamagras* sp., or to any other genus of erycine, extant or extinct, is presently unsupported. External examination of the available skulls revealed the presence of one cranial character attributable to Erycinae: a lacrimal foramen not entirely surrounded by the prefrontal bone. Preliminary analysis of the individuals in this White River ophidian aggregation demonstrates the presence of three out of the six diagnostic features of the subfamily Erycinae, and strongly suggests that these specimens require recognition as new taxa, not as *Ogmophis* or *Calamagras*.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

FUNCTIONAL MECHANICS OF ORNITHOMIMOSAUR CRANIA COMPARED TO OTHER THEROPODS

CUFF, Andrew R., University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily J., University of Bristol, Bristol, United Kingdom

Ornithomimosaurs have long been referred to as ostrich mimicking dinosaurs due to their apparent cranial convergence with many of the extant palaeognaths. Both groups possess lightweight skulls with large orbits and derived ornithomimosaurs become edentulous and possess a keratinous rhamphotheca. Whether this convergence is superficial or functional is of importance to understanding the evolution of this group and theropods in general. 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. Geometric morphometric methods allowed us to compare the deformation undergone by the skull in addition to analysing strain patterns. These were then compared to an ostrich model that was validated by the author, and previous finite element studies of other theropods (*Allosaurus* and *Coelophysis*).

Results show that sutures play a role in reducing overall strain in skulls. As with the ostrich skull, using a homogeneous material property with a Youngs modulus less than that of cortical bone makes a good compromise when sutures are not easily segmented from CT scans. Beaks reduce strain in the skulls, with more extensive morphologies capable of much higher feeding loads. The derived ornithomimids have smaller muscle loads but strain similarly to the more primitive *Garudimimus*. When scaled to the same sizes and loaded equivalently the derived species deform differently suggesting that they might be exploiting different diets. Based on the results we suggest that derived ornithomimids experience more similar strain patterns to those of ostriches, but ostrich skulls experience higher strain magnitudes under equivalent loads.

When compared to typically carnivorous theropods (*Allosaurus* and *Coelophysis*) ornithomimosaurs have very different strain patterns due to their edentate nature which are exaggerated by the presence of a beak. This has implications for feeding method and may be linked to the hypothetical herbivorous diets of the ornithomimosaurs and the repeated evolution of beaks in theropod dinosaurs.

Technical Session I (Wednesday, October 17, 10:15 am)

MULTI-ELEMENT HISTOLOGICAL ANALYSIS OF AN ORNITHOMIMID (DINOSAURIA) BONE BED FROM THE HORSESHOE CANYON FORMATION, ALBERTA

CULLEN, Thomas M., Carleton University, Ottawa, ON, Canada; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan

Data from bone beds and osteological microstructure provide information from which hypotheses regarding ontogeny, metabolism, ecology, and behaviors of ancient vertebrates can be established. Multiple hind limb elements (femora, fibulae, tibiae, metatarsals, and pedal phalanges) from three individuals from the first North American bone bed of Late Cretaceous ornithomimids were examined histologically. Each specimen showed

fibrolamellar tissue, near-equal spacing of lines of arrested growth (LAGs), and osteon development at outer bone margins, indicating that they were experiencing rapid growth at the time of death. However, this rate was decreasing in the largest individual, possibly indicating the onset of maturation. The two smaller individuals were determined to be two and three years of age at death, while the approximately 10% larger individual was found to be four years old at the time of death. Of note is that LAGs and other histological signals remain consistent across the different hind limb elements examined within individuals. This indicates that for at least some small theropods, age at death can reliably be determined from various postcranial long bones. This has the potential to significantly increase the database available for determining growth patterns within various taxa as long as body size at the time of death can be determined.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

TEEN SCIENCE SCHOLARS AT THE DENVER MUSEUM OF NATURE AND SCIENCE: NURTURING THE NEXT GENERATION OF SCIENTIFIC LEADERS

CUSHING, Paula, Denver Museum of Nature & Science, Denver, CO, United States; STUCKY, Richard, Denver Museum of Nature & Science, Denver, CO, United States; GARNEU, Nicole, Denver Museum of Nature & Science, Denver, CO, United States; MILLER, Ian, Denver Museum of Nature & Science, Denver, CO, United States; PETRIE, Lesley, Denver Museum of Nature & Science, Denver, CO, United States

The Teen Science Scholar program (TSS) at the Denver Museum of Nature & Science involves high school youth (ages 15 to 18) in authentic scientific research in order to encourage their selection of an academic and career path in science. The program began in 2007 with a focus in vertebrate paleontology and is now in its sixth year. Scholars are selected based upon academic performance, a personal objective to pursue an interest or career in science, recommendations on leadership and science interests, and their potential to be future community leaders. Special emphasis is placed on students who are underrepresented in the sciences, women and minority students, and who will be the first in their family to attend college. The program began in vertebrate paleontology and now includes additional tracks in zoology since 2009, health sciences since 2010 and archeology since 2011. Scholars in paleontology, zoology, and archaeology spend time doing field research collecting data and specimens. This is followed by six weeks of specimen preparation, identifications, and analysis in the Museum laboratories. Students in health sciences are involved in laboratory experiments and analysis. Students are paid for their work during the summer. The objective of each year's program is to provide an authentic research experience that results in the development of new scientific knowledge and helps students understand the complete process of science. Scholars have finalized their research work through abstract publication, peer-reviewed papers including the description of new taxa, video presentations, public lectures and posters. Many of the students continue as Museum volunteers after the summer program. Students who have participated in the program are tracked to follow their educational development, careers, and interests in science. Among those that have graduated from high school over half are majoring in a science or engineering field. Of those who have graduated from college, all three are in postgraduate programs in science, one in paleontology. We anticipate that graduates in TSS will eventually become science mentors and role models for students in their communities.

Technical Session VI (Thursday, October 18, 4:00 pm)

BONE HISTOLOGY OF A DWARF SAUROPOD DINOSAUR FROM THE LATEST CRETACEOUS OF JORDAN AND A POSSIBLE BIOMECHANICAL EXPLANATION FOR "TITANOSAUR-TYPE" BONE HISTOLOGY

D'EMIC, Michael D., Georgia Southern University, Statesboro, GA, United States; WILSON, Jeffrey A., University of Michigan, Ann Arbor, MI, United States

Titanosauria is a globally distributed, diverse, morphologically disparate sauropod clade that exhibits a dramatic range of adult body sizes. A new titanosaur specimen of very small body size from the Maastrichtian of Jordan has completely fused sutures among the neural arches, centra, and ribs of a posterior dorsal vertebra, sacrum, and posterior caudal vertebrae. A thin section of the midshaft of the femur reveals a cortex completely remodeled by multiple generations of overlapping secondary osteons, indicating the adult status of the individual. Secondary osteons are composed of lamellar and parallel-fibered bone. Extensive remodeling and lamellar to parallel-fibered bone also characterizes the femoral bone histology of several titanosaurs (*Magyarosaurus*, *Lirainosaurus*, *Ampelosaurus*, *Neuquensaurus*, *Alamosaurus*) and to a lesser extent, closely related non-titanosaurs (*Phuwiangosaurus*, *Chubutisaurus*). These histological similarities exist despite the large absolute size difference among these species (adult femur length 57–200 cm). A possible biomechanical explanation for this histological pattern is that it is related the evolution of wide-gauge posture and more dynamic locomotory abilities in titanosaurs. Under this hypothesis, the inferred bending moment placed on the limbs of wide-gauge titanosaurs would have engendered more spatially heterogeneous strain (i.e., compression medially vs. tension laterally) and higher rates of microcracks in limb bones relative to those of narrow-gauge sauropods, even at small body size and/or early in ontogeny. In modern animals, higher rates of microcracks are implicated in elevated bone remodeling rates and may explain the observed histological pattern in titanosaurs. This hypothesis is currently supported by the coincident phylogenetic distribution of wide-gauge posture and 'titanosaur-type' bone histology; testable predictions of this hypothesis include: (1) bones not involved in wide-gauge posture will not display earlier and more extensive remodeling than those bones do in narrow-gauge taxa; (2) primary bone in titanosaur limb bones will contain a higher number of microcracks per unit area than limb bones do in non-titanosaurs.

Technical Session II (Wednesday, October 17, 9:30 am)

TRANSFORMATION OF THE PECTORAL GIRDLE DURING THE FIN-TO-LIMB TRANSITION

DAESCHLER, Edward, Academy of Natural Sciences, Philadelphia, PA, United States; SHUBIN, Neil, The University of Chicago, Chicago, IL, United States; JENKINS, Jr., Farish A., Harvard University, Cambridge, MA, United States

Investigations of the fin-to-limb transition within the stem tetrapod lineage have tended to focus more on the appendages and less on the girdles that buttress and orient the appendages. We examined the pectoral girdles in a series of Late Devonian tetrapodomorph sarcopterygians including *Eusthenopteron*, *Tiktaalik*, and *Acanthostega* in order to track the dramatic transformation of this integral functional component during the transition. The reduction of the ventral portion of the cleithrum and the concomitant expansion of the endochondral scapulocoracoid are recognized as key changes in this segment of the tree. A complex of other changes reflect shifting function of the pectoral appendage and decoupling of the head and pectoral girdle. Specific character changes include the loss of the dorsal portions of the supracleithral series (post-temporal and supracleithrum), increase in the relative size of interclavicle, and flattening of the ventral body wall. The glenoid fossa assumes a more ventral position and posteroventrolateral orientation. Additionally, the shape of the glenoid fossa changes from rounded to elongate, and the re-oriented appendage necessitates changes in the action of the muscles that drive the appendage, specifically reflected in the loss of the subscapular fossa in the scapulocoracoid plate of early tetrapods. In summary, the transformation of the pectoral girdle within the stem tetrapod lineage involved a reduction and loss of continuity with the skull, redirection of the appendage to more ventrolateral orientations, and reorganization of the associated musculature to provide mechanisms of support.

Technical Session XV (Saturday, October 20, 10:30 am)

PHYLOGENY, BIOGEOGRAPHY AND HIGH CLADE DIVERSITY OF LAMBEOSAURINE DINOSAURS OF THE EUROPEAN ARCHIPELAGO

DALLA VECCHIA, Fabio M., Grup de Recerca del Mesozoic, Institut Català de Paleontologia Miquel Crusafont, Sabadell, Spain; PRIETO-MARQUEZ, Albert, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; GAETE, Rodrigo, Museu de la Conca Dellà, Isona, Spain; GALOBART, Àngel, Grup de Recerca del Mesozoic, Institut Català de Paleontologia Miquel Crusafont, Sabadell, Spain

We document new specimens of lambeosaurine dinosaurs recovered from the upper Maastrichtian Tremp Formation (Tremp Syncline, south-central Pyrenees, northeastern Spain) and re-evaluate the phylogenetic position of all European taxa, providing an assessment of the diversity and historical biogeography of these animals in the European Archipelago. Maximum parsimony analysis indicates that representatives of at least four clades of lambeosaurines lived during late Maastrichtian times in the Ibero-Armorican Island of the European Archipelago: the *Aralosaurus*, *Tsintaosaurus*, *Parasaurolophus*, and *Lambeosaurus-Hypacrosaurus* helmet-crested clades. The aralosaur Ibero-Armorican material comes from the Auzas Marls Formation and Gensac marly limestones of southern France. The maxillae of these specimens, which may represent one or more taxa, share with that of *Aralosaurus tuberiferus* (Santonian Bestobe Formation of southwestern Kazakhstan) an expanded rostrodorsal region with prominent and anteroposteriorly extensive subrectangular flange that raises vertically above the anteroventral process. Tsintaosaurs are represented by *Pararhabdodon isonensis*, from the upper Maastrichtian Tremp Formation, which shares dentary and maxillary characters with *Tsintaosaurus spinorhinus*. Parasaurolophs are represented by *Blasisaurus canudoi*, from the Arén Formation; this taxon forms a sister relationship with *Charonosaurus jiayinensis* (upper Maastrichtian Yuliangze Formation of northeastern China) supported by dentary teeth with a single median ridge and lacking marginal denticulation, and dentary with short (less than 20% dental battery length) proximal edentulous margin. Finally, *Arenysaurus ardevoli*, from the Tremp Formation, was deeply nested within helmet-crested lambeosaurines based on the possession of nasal articulation surface of the frontal shaped into an anteroventrally-sloping platform, among other characters. Dispersal-vicariance analysis indicates that the most recent common ancestors of aralosaurs, tsintaosaurs, and parasaurolophs were widespread in Eurasia; their presence in the upper Maastrichtian of the Ibero-Armorican Island is most parsimoniously explained in this analysis by vicariant events taking place no later than the Santonian, early Campanian, and late Maastrichtian, respectively. Explaining the occurrence of *A. ardevoli* requires a dispersal event from North America to the European Archipelago or Eurasia no later than the late Campanian. However, those results are in contrast with the information yielded by the whole hadrosaurid record of Europe, and the Late Cretaceous paleogeographical reconstructions of the Northern Hemisphere and its geodynamic history. They are biased by the absence of hadrosaurid records from southwestern Asia during the Campanian-Maastrichtian.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A NEW LARGE-BODIED THEROPOD DINOSAUR FROM THE UPPER MORRISON FORMATION (LATE JURASSIC, TITHONIAN) OF COLORADO

DALMAN, Sebastian, Department of Geosciences, Fort Hays State University, Hays, KS, United States; PAULINA CARABAJAL, Ariana, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina; CURRIE, Philip J., University of Alberta, Edmonton, Canada

In 1953, J. T. Gregory and D. Techter of the Yale Peabody Museum of Natural History discovered a partially preserved theropod skeleton in the Morrison Formation (late Tithonian) of McElmo Canyon in Montezuma County, Colorado, U.S.A. The specimen consists of several well-preserved cranial, axial, and appendicular elements, some of which are still unprepared and embedded in hard sediment, explaining why this material lay largely unnoticed in the collections of the Museum until now. All the cranial elements, including the braincase, left premaxilla, maxilla, quadratojugal, and dentary were CT scanned so that digital 3D reconstructions could be done, allowing morphological description and comparisons. The McElmo specimen represents a large-bodied theropod, distinct from *Allosaurus* and *Saurophaganax* from the same formation. The specimen is characterized by a short and deep premaxilla (with 4 teeth), deep maxilla, and a robust quadratojugal. These cranial elements are more massive than the equivalent elements in known specimens of *Allosaurus*. Preliminary phylogenetic analysis, based on previous phylogenies of this clade, positions this new form within Allosauroidea, more closely related to *Allosaurus*, *Fukuiraptor* and *Neovenator*.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

MOLAR WEAR GRADIENT ANALYSIS IN EXTANT AND FOSSIL KANGAROOS (MARSUPIALIA, MACROPODOIDEA)

DAMUTH, John, University of California, Santa Barbara, CA, United States; JANIS, Christine M., Brown University, Providence, RI, United States; TRAVOUILLON, Kenny J., University of Queensland, Brisbane, Australia; ARCHER, Michael, University of New South Wales, Sydney, Australia; HAND, Suzanne J., University of New South Wales, Sydney, Australia

We have developed techniques for the analysis of both relative and absolute rates of abrasive molar wear among species of kangaroos and wallabies (Macropodoidea). The molars of fossil and extant macropodoids are lophodont, with relatively simple crowns dominated by large transverse ridges. These ridges wear down through a recognizable wear morphology sequence that is similar in all species. The overall rate of wear, however, appears to differ consistently among species. We assess relative wear rates for a species based on a comparison of the degrees of wear among the lower molars of each individual. Since the four molars erupt in sequence from front to back, anterior molars will experience wear earlier in the animal's lifetime than will posterior molars. Thus, for most of the adult lifetime there is a wear gradient along the molar row. The steepness of the gradient should indicate the average rate of abrasive wear, irrespective of the animal's age.

We tested this in a sample of 1,660 museum specimens (representing 73 species) of extant macropodoids. For each specimen, we visually scored the lower molar cusps according to a set of eight wear classes. The results confirm that steeper gradients (measured by linear least-squares slopes of wear class versus tooth position) are associated with species that are usually considered to experience higher rates of dental abrasion. For example, browsing, forest-dwelling macropodoids (*Dorcopsis* spp., *Thylogale stigmatica*) and tree kangaroos (*Dendrolagus*) show slopes that are approximately one-third of those of the mixed feeding, open country *Macropus robustus* and the grazing *M. giganteus*. As expected, molar gradient slopes change little with known or apparent age (when including only those teeth still functional and in occlusion). That these gradient slopes reflect mostly differences in wear rates, rather than differences in developmental timing, is supported by measures of absolute wear rates based on molar height from known-age individuals of extant species. Browsing *Dendrolagus lumholtzi* shows absolute wear rates of 0.25mm/yr or less, approximately one third that of the mixed-feeding *Macropus robustus* (0.65 mm/yr.) — roughly the same difference as seen in the gradient slopes.

The gradient wear technique is straightforward to apply to fossil species. Gradient slopes of Pleistocene *Macropus giganteus* from Victoria Fossil Cave, South Australia are as steep as those of the extant grazing species of *Macropus*, whereas the short-faced kangaroo *Sthenurus gilli*, found in the same cave deposit, has a gradient that is shallower by a factor of four or five. Thus it is likely that these two sympatric species differed in their wear rates to at least the same degree as do extant grazing and browsing macropodoids.

Technical Session XIX (Saturday, October 20, 2:30 pm)

TESTING THE ACCURACY OF ECOLOGICAL NICHE MODELS USING THE LAST GLACIAL MAXIMUM FOSSIL RECORD OF MAMMALS

DAVIS, Edward B., University of Oregon Museum of Natural and Cultural History and Department of Geological Sciences, Eugene, OR, United States; MCGUIRE, Jenny L., University of Washington School of Environmental and Forest Sciences, Seattle, WA, United States; KOO, Michelle S., University of California Museum of Vertebrate Zoology, Berkeley, CA, United States

The geographic distributions of many species are expected to change dramatically over the next century to accommodate global climate change. Conservation biologists model these expected changes using a suite of techniques called Ecological Niche Models (ENMs). ENMs sample physical environmental parameters (temperature, precipitation, seasonality) and vegetation parameters from known modern distributions of species, creating a multidimensional model of the current realized niche of the species. This niche model can then be mapped on hypothesized future climate surfaces, producing hypotheses of future species distributions. These hypotheses have been used to plan conservation efforts, and some researchers have suggested programs of assisted migration to transition species to new optimal environments. We test the accuracy of the most commonly used ENMs by projecting models of 50 mammal species onto Last Glacial Maximum (LGM, ~18-21 Ka) paleoclimate surfaces and comparing their hindcast distributions to the LGM fossil record. Our fossil data are drawn from the FAUNMAP II database, and include sites with dates from 30-10 Ka that clearly cross the LGM, ~20Ka. We tallied the number of sites both within and outside each ENM that contain and do not contain each species, allowing us to quantify the mismatch between hindcast and fossil distributions. The ENMs for many species predict distributions south of the southernmost fossil occurrences, but there is no apparent consistency in the model-data mismatch. At one extreme are species like *Marmota flaviventris*, which has a close match between its LGM fossil distribution and ENM. On the other end of the spectrum, *Procyon lotor*, *Vulpes vulpes*, and *Ursus americanus* have ENMs that reconstruct LGM distributions entirely south of all of their known LGM fossil distributions. Most surprisingly, some species, like *Synaptomys cooperi*, have almost no LGM territory within their ENMs, suggesting the LGM conditions contained little to no analog to their current realized niches. We seek the phylogenetic and ecological controls on the mismatch between models and data, which will be valuable information to consider for future-climate ENMs. We hypothesize that observed mismatches could be caused by one or a combination of three factors: 1) niche evolution between LGM and today, 2) modern realized niche undersampling fundamental niches, or 3) problems with the LGM climate model properly parameterizing glacial edge effects.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

WHAT IS THE APPROPRIATE SPATIAL AND TEMPORAL SCALE OF FAUNMAP DATA?

DAVIS, Matt, Yale University Department of Geology and Geophysics, New Haven, CT, United States

Paleo occurrence databases like Neotoma and FAUNMAP II are crucial to understanding macroecological changes that occurred during the late Cenozoic. However, the temporal and spatial grain size appropriate for these data is unclear. Care must be taken to only interpret paleontological data at a scale where they are still accurate, especially when comparing them to modern occurrence data. Mammal occurrence data for the last 50,000 years were examined from the most densely sampled portion of the FAUNMAP II database. Simple null models based on poor sampling accurately predict patterns of taxa similarity over time at both the continental and regional scale. It appears that even relatively densely sampled FAUNMAP data can only be viewed at a much coarser grain size then previously utilized and that many of the patterns we see could be the results of poor sampling and taphonomy. Future research must take into account the error associated with all spatial occurrence data and the taphonomic biases inherent in the fossil record.

Technical Session XIII (Friday, October 19, 1:45 pm)

DIVERSITY OF THE MAMMALS FROM HAININ, BELGIUM, THE OLDEST PALEOCENE MAMMAL FAUNA OF EUROPE

DE BAST, Eric, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The locality of Hainin in the Mons Basin, Belgium has yielded the only well diversified land vertebrate fauna of the Early to Middle Paleocene of Europe. Mammal specimens mainly consist of isolated teeth. A little over 250 complete and fragmentary jugal teeth have been recovered from screenwashing of the sediments. Multituberculates account for a little less than 20% of the fauna. They are represented by two species of the kogaionid genus *Hainina*: *H. belgica* and *H. godfriauxi*, the genus being endemic to Europe; and by the problematic *Boffius splendidus*, known only from Hainin and whose affinities are unclear. Most eutherian taxa are very small, 75% of the specimens exhibiting an M1,2/m1,2 length comprised between 1 mm and 2 mm. The most abundant and diversified group is the adapisoriculids, with at least four species dispatched in three genera: *Afrodon gheerbranti*, *Bustylus marandati*, *Bustylus folieae* and *Proremiculus lagnauxi*. Pantolesta are represented by a small pentacodontid of a new genus. Condylarths are rare, with only two species, the arctocyonid *Prolatidens waudruae* and the louisinid *Monshyus praevius*. A small new species of leptictid is presented for the first time. One relatively well preserved taxon needs more work in order to ascertain its relationships. One upper tooth of a cimolestid is identified. *Russellodon haininense* was previously described as a plesiadapid; however, new data suggest closer relationships with picrodontid plesiadapiforms.

Many taxa from Hainin are extremely primitive, with the notable exception of *Monshyus praevius*, which belongs to one of the most derived louisinids, closer to the genus *Microhyus* than to the primitive *Paschatherium*. Adapisoriculids appear more primitive than in Cernay and Berru or Walbeck. *Prolatidens waudruae* accounts for one of the most primitive known condylarths despite some relatively derived characters. The new pentacodontid seems to be close to the most primitive North American members of the family.The comparisons with North American taxa suggest a correlation between the deposits from Hainin and the North American Torrejonian.

In conclusion, the mammals from Hainin stand out by their originality despite the few similarities with other European faunas observed in the kogaionids and the adapisoriculids.

This probably indicates a markedly older age for Hainin than the only well-known continental deposits of Europe that are Cernay-Berru and Walbeck. Few species clearly show close phylogenetic affinities with North American or Asian taxa, even at family-level, enhancing the endemic character of the European region during roughly the first half of the Paleocene.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW FRESH-WATER HYBODONTID SHARK FROM LIMA CAMPOS BASIN (EARLY CRETACEOUS), BRAZIL, AND ITS PALEOGEOGRAPHIC CONTEXT

DE FIGUEIREDO, Ana Emilia Q., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; PINHEIRO, Felipe L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; DENTZIEN-DIAS, Paula C., Universidade Federal do Rio Grande, Rio Grande, Brazil; FORTIER, Daniel C., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; SCHULTZ, Cesar L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Hybodontiforms are recorded from the Devonian to Cretaceous, with widespread geographic distribution. In Brazilian sedimentary basins, they were recognized in Permian and Triassic deposits of the Paraná Basin, along with some Jurassic-Cretaceous units from the northeast part of the country. In the latter deposits, they are diverse, representing four genera after the recent discovery of a yet unrecorded genus: *Planohybodus*. The fossil specimens were from Early Cretaceous of Malhada Vermelha Formation, Lima Campos Basin (Ceará State, Brazil) and represent a new species, characterized by stronger ornamentation composed by simple non-branching folds that almost reach the apex of the main cusp and distinctly divergent lateral cusplets. The genus *Planohybodus* was recorded in the Early Jurassic of Luxemburg, and in the Middle Jurassic (Batonian) of France, Scotland and England. Late Jurassic remains occur in Northeastern Spain, France and England. Thus, in the Jurassic, they were restricted to Europe, in a number of different paleoenvironments, associated with marine facies. This scenario radically shifted during the Cretaceous. The European fossils are still present on the Barriasian/Hauterivian of Spain, and Barremian of Denmark. Additionally, a dispersion event is identified through the South American records of Malhada Vermelha Formation of Lima Campos Basin and Missão Velha Formation (Araripe Basin). The latest fossils were found in the Santonian of New Mexico (USA). Differing from the European predominance during the Jurassic, the Brazilian record is strictly related to continental environments. The Malhada Vermelha and the Missão Velha formations are associated to fluviolacustrine facies, even though the latter one has some marine influence. The discovery of *Planohybodus* in continental facies of northeast Brazil corroborates recent discoveries of this taxon in fluviolacustrine deposits of Spain. Curiously, the dispersion of *Planohybodus* to South America, probably from European forms, occurred when the separation of Gondwana and Laurasia was completed with the opening of the Atlantic Ocean.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE BACTERIAL FLORA OF REPOSITORY FOSSILS: SOURCES, SURVIVAL AND REMOVAL

DE LA GARZA, Randolph G., Sam Houston State University, Huntsville, TX, United States; LEWIS, Patrick J., Sam Houston State University, Huntsville, TX, United States; PRIMM, Todd P., Sam Houston State University, Huntsville, TX, United States

Microbes are well known for their ability to degrade a wide range of substances, including rock and bone. Fossils are generally of similar composition as the rock matrix that they are found in, suggesting that microbes known to weather rocks may also affect fossils. Although there is considerable attention and effort applied to the preservation and conservation of fossils for long term storage, research concerning the detection and prevention of microbial growth is lacking in the scientific literature. Given the premise that microbes could damage fossils, our research question focuses on the presence of bacteria on fossils that are stored in repositories. Roughly twenty fossil bones, varying from early Triassic to late Pleistocene in age, were tested for presence of culturable bacteria. Some of these fossils were unprepared while others had been cleaned and curated. Fossils were swabbed with sterile cotton tip swabs which were streaked onto R2A and nutrient agar plates. Colonies that grew over time were identified using staining and biochemical tests. Additional experimental protocols were also used to determine the state of bacteria found on the fossils. Bacteria that were present on these fossils were extracted into microcentrifuge tubes and were heated to near boiling point to kill vegetative cells, selecting those that produce spores to survive. Initial results from both experiments indicate that microbial counts on stored fossils are relatively low and that the bacteria that are present are predominantly gram-positive, chained bacteria, with evidence that the microbes are in an active, vegetative state on fossils. The persistence of human-derived microbes was also investigated by the addition of concentrated solutions of the ubiquitous human skin bacterium *Staphylococcus epidermidis* onto decontaminated fossils. Human-derived microbes were determined to survive on fossils for relatively short durations, with 98% of *S. epidermidis* dying off within 24 hours. The most effective decontamination method was placing fossil specimens in an incubator at 95ºC for 15-20 hours, although this is impractical for most specimens. Ethanol and acetone were also tested as potential antimicrobial agents, but were found to be ineffective in thoroughly reducing microbial populations, with acetone being the lowest in effectiveness. We are currently identifying bacteria isolated from the fossils in an effort to determine if they are primarily human-derived or soil-derived. This work paves the way for examination of potential bacterial degradation/modification of fossils.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

SIGNIFICANT MESOZOIC VERTEBRATE FOSSIL LOCALITIES DISCOVERED DURING CONTINUING PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING AT ARCHES NATIONAL PARK

DEBLIEUX, Donald D., Utah Geologica Survey, Salt Lake City, UT, United States; MADSEN, Scott K., Utah Geologica Survey, Salt Lake City, UT, United States; KIRKLAND, James I., Utah Geologica Survey, Salt Lake City, UT, United States; INKENBRANDT, Paul, Utah Geologica Survey, Salt Lake City, UT, United States; SANTUCCI, Vincent L., National Park Service, Washington, DC, United States

Through a systematic program of paleontological resource inventory and monitoring, the National Park Service (NPS) has been at the forefront of paleontological resource management on public lands. After more than a decade of work, initial inventories have been completed in many parks and the NPS has moved onto a second phase which involves monitoring of known sites and targeted inventory of specific formations identified as having high potential for significant discoveries during preliminary surveys. A baseline paleontological resource inventory of Arches National Park focusing on the documentation of previously known sites and survey of the highly fossiliferous Upper Jurassic Morrison and Lower Cretaceous Cedar Mountain formations was completed in 2000 by NPS personnel in cooperation with the Utah Geological Survey (UGS). Recently, the UGS produced Potential Fossil Yield Classification (PFYC) maps of the park using newly updated geologic maps. In the fall of 2011, the UGS and NPS conducted additional field inventory in the park, targeting rocks of the Chinle, Wingate, Kayenta, and Navajo formations. These formations were chosen because of their potential for discovery of significant vertebrate fossils based on sites known from areas adjacent to the park. Also, these formations are located along the flanks of the Salt Valley, where uplift, collapse, and erosion of these rocks due to salt tectonics has made typically cliff-forming strata more accessible for ground survey. Our survey resulted in the identification of over 50 new localities. Numerous vertebrate localities were documented in the Chinle Formation. The first dinosaur body fossils from the Kayenta Formation in Utah were found in the park. Vertebrate tracksites were found in the Chinle, Wingate, Kayenta, and Navajo formations. In addition to providing ground truth for PFYC maps, we field checked the new geologic maps and refined several contacts including the recognition of more extensive exposures of the Moenkopi Formation that were confirmed by the discovery of *Chirotherium* track localities. In our effort to establish baseline data for the monitoring of weathering and erosion, we did detailed photogrammetry of an important vertebrate track and feeding trace locality discovered in the Cedar Mountain Formation during the previous survey.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

PLESIOSAUR FLIPPER HYDRODYNAMICS AND ITS IMPLICATIONS ON PLESIOSAUROMORPH AND PLIOSAUROMORPH ECOMORPHOLOGY

DEBLOIS, Mark C., Marshall University, Huntington, WV, United States

Plesiosaurs are a group of extinct, secondarily marine tetrapods unique for evolving two pairs of hydrofoil-shaped flippers that propelled the animal by producing lift. They are divided into two distinct morphotypes: plesiosauromorphs, characterized by long necks and small heads, and pliosauromorphs, characterized by short necks and large heads. Plesiosauromorphs are thought to be cruising predators whereas pliosauromorphs are thought to be active pursuit predators. If true, then plesiosauromorphs ought to have flippers optimized for efficiency while pliosauromorphs ought to have flippers optimized for maneuverability. The present study is the first to quantify the hydrodynamic properties of flippers from various taxa within Plesiosauria. These hydrodynamic data were then used to test the hypothesized predatory styles of the plesiosauromorph and pliosauromorph body types. Flipper hydrodynamics were approximated via static comparison of shapes across cross-sections at the propodial, epipodial, metapodial, and phalangeal regions from plesiosauromorph and pliosauromorph taxa including Elasmosauridae, Polycotylidae, and Pliosauridae. The thickness, chord length (the line connecting the leading and trailing edges of the flipper), and maximum camber (the mean curvature of the top and bottom surfaces of the flipper) were measured at these cross-sections and used to determine the resulting lift and drag using FoilSimU III, an aerodynamics program developed by NASA based on wind tunnel data. The ratio of lift to drag was used as an index of flipper efficiency. The degree of camber was used as a measure of maneuverability since increasing the camber reduces the speed at which a given angle of attack no longer produces lift (the stall speed). Flippers from plesiosauromorph taxa had high lift-to-drag ratios and low camber whereas those from pliosauromorph taxa had lower lift-to-drag ratios and higher camber. This study is the first to examine plesiosaur hydrofoils quantitatively and will have broad application for our understanding of plesiosaur biology, for the biology of other aquatic tetrapods, and for the behavior of biological hydrofoils in general.

Romer Prize Session (Thursday, October 18, 9:15 am)

PATTERNS AND PROCESSES AT ORIGIN OF BIRDS: MACROEVOLUTIONARY TEMPO AND MODE

DECECCHI, Thomas A., McGill University, Montreal, QB, Canada

The origin of powered flight in birds marks one of the major transitions in vertebrate evolution. Birds represent one of only three known occurrences of flight in tetrapods, and the only one with a well resolved fossil record preceding its origins. Here I use a compilation of quantitative and qualitative data of this transition to generate high resolutions of the

patterns and processes that shaped this macroevolutionary event. Underlying trends in theropod evolution were isolated so that particular phenotypic changes could be identified and their potential drivers investigated. This presentation looks at two proposed trends that have functional consequences for the origin of flight: forelimb discrete character change and appendicular length evolution. The findings demonstrate that character change in the theropod forelimb skeleton is not uniform, the node Aves is not associated with high levels of concentrated character change, and the forelimb phenotype does not evolve similar to other modules, such as the skull, axial column, or the hind limb. Although allometry does not explain the tempo and mode of forelimb quantitative changes, the general trend of body size reduction within Coelurosauria does drive the observed pattern of forelimb elongation prior to the node Aves. At Aves however, a significant decoupling of fore- and hind limb scaling from body size occurred such that early avians have distinctively different allometries in these regions compared to their non-avian antecedents. Early birds have distinctly shorter hind limbs and longer forelimbs than expected based on non-avian regressions, indicating a novel selective regime compared to similar sized feathered maniraptorans. The three main ecological scenarios proposed to explain the transformation of a theropod forelimb into a wing (tree's down, ground up, and wing assisted incline running (WAIR)) were tested. Using an extensive dataset of extant and extinct mammalian, reptilian and avian climbers scored for 17 climbing related characters as well as individual indices correlated to scansorial ability, non-avian theropods are shown to not possess the morphological adaptations required by extant arboreal taxa. The WAIR model is also challenged based on allometry and ontogenetic factors, gross morphological differences in the pectoral region between non-avian theropods and extant birds and biomechanical limitations in the theropod body plan; all of which limit its explanatory power. These findings flesh out the pattern and ecology of a major evolutionary transition in a level of detail that has not previously been achieved and create a framework to examine other major transitions.

Technical Sesssion XII (Friday, October 19, 3:30 pm)

A NEARLY COMPLETE FOSSIL IGUANIAN FROM THE UPPER CRETACEOUS (CAMPANIAN) TWO MEDICINE FORMATION OF WESTERN MONTANA

DEMAR, Jr., David G., University of Washington, Seattle, WA, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; HEAD, Jason J., University of Nebraska-Lincoln, Lincoln, NE, United States; MOORE, Jason R., Dartmouth College , Hanover, NH, United States; WILSON, Gregory P., University of Washington, Seattle, WA, United States

The Late Cretaceous was an important interval for the early diversification of many extant lizard clades, but much of what is known of Late Cretaceous lizards from North America is restricted to disarticulated and isolated remains from vertebrate microfossil localities. This bias in the fossil record has made it difficult to fully assess their morphology, diversity, and evolutionary history. Here we report on a nearly complete and mostly articulated lizard from the Egg Mountain locality of the Upper Cretaceous (Campanian) Two Medicine Formation of western Montana. The specimen was preserved in heavily bioturbated, reworked terrigenous and volcaniclastic sediments with a potential palaeopedological overprint. The specimen was recovered as part of a vertebrate assemblage including isolated dinosaur teeth and eggshell, at least two partial egg clutches, an associated large hadrosaur skeleton, and several other well preserved lizard and mammal skeletons. We performed a phylogenetic analysis of 232 taxa that were scored for 363 morphological characters. Our analysis recovered an Adams consensus topology that places the taxon among pleurodontan iguanians forming a polytomy with Corytophanidae (e.g., basilisks) and Polychrotidae (e.g., anoles). Three unambiguous synapomorphies support the node: presence of postorbitofrontal rugosities on the jugal, relatively narrow pyriform recess, and clavicle with a proximal expansion. The new specimen represents the oldest record of the North and Central American clade including corytophanids and polychrotids and provides important new constraints on divergence timing and biogeographic histories of these groups.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 12:00 pm)

EXPLORING THE "LOST CONTINENT" OF APPALACHIA - THE ELLISDALEAN LAND FAUNA AND ITS IMPLICATIONS FOR LATE CRETACEOUS BIOGEOGRAPHY

DENTON, Robert K., GeoConcepts Engineering Inc., Ashburn, VA, United States; O'NEILL, Robert C., New Jersey State Museum, Trenton, NJ, United States

Since its discovery in 1980, the Ellisdale Site (Campanian Stage, Late Cretaceous) of the Marshalltown Formation of Monmouth County, New Jersey has produced the largest and most diverse fauna of terrestrial and freshwater vertebrates yet known from the Late Cretaceous of eastern North America. Ellisdale was the first site in Appalachia to produce a microvertebrate assemblage comparable to the well known localities of the western interior, and the possibility of Ellisdale Fauna serving as a reference for the Campanian of eastern North America was first proposed by Dr. Donald Baird of Princeton University in 1986.

A recent palynological study has established the age of the fossil-bearing facies at Ellisdale as Middle Campanian (76.4 – 80.6 ma), roughly equivalent to the Judithian + Aquilan North American Land Mammal Age(s); yet no genus or species level terrestrial taxon has been identified that is comparable to those from the Aquilan and/or Judithian faunas of the western interior. However in the thirty two years since the discovery of the site a better understanding has emerged regarding the Cenomanian and Turonian faunas of Laramidia, providing a new perspective to the interpretation of Ellisdale. A multituberculate taxon from the Ellisdale Site shows possible affinities with a primitive ptilodontoidean from the Cedar Mountain Formation of Utah, and may be close to the common ancestor of the ectypodid and cimolodontid multituberculates. An undescribed stagodontid metatherian from Ellisdale may have been derived from a Cenomanian taxon similar to *Kokopellia*, also from the Cedar Mountain Formation. These data suggest that Appalachia may have served as a refugium for some Cenomanian/Turonian taxa of Laramidian origin; nevertheless, many of the Ellisdalean taxa are unique, with no known Laramidian or Eurasian equivalents. The boreoteiid lizard *Prototeius* and batrachosauroidid salamander *Parrisia* are the least derived members of their respective families, and may have had an Appalachian origin.

Additional fossil discoveries from sites located throughout the eastern part of North America now suggest that the endemism seen initially at Ellisdale may be characteristic of the continent of Appalachia as a whole. This supports Dr. Baird's original contention that the "Ellisdalean" assemblage would eventually be recognized as an important reference fauna, and critical to unlocking the secrets of the "Lost Continent" of Appalachia.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST RECORD OF TRACKS IN THE PERMIAN (LOPINGIAN) OF THE PARANÁ BASIN, SOUTHERN BRAZIL

DENTZIEN-DIAS, Paula C., Universidade Federal do Rio Grande - FURG, Rio Grande, Brazil; PAES, Voltaire, Universidade Federal do Rio Grande do Sul - UFRGS, Porto Alegre, Brazil; SCHULTZ, Cesar L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Footprints are the most common vertebrate ichnofossils in the geologic record. These traces were unknown in the Lopingian of Southern Brazil until a new outcrop containing four distinct trackways and a partial track was found in the eolian facies of the Pirambóia Formation, in the southwestern region of the Rio Grande do Sul State. This outcrop is located at the eastern end of the municipality of Santana do Livramento (30 º 42'44'' S, 55º02'34'' W). The partial and two complete trackways occur at the same level, but none of these footprints allow distinguishing morphological details. These tracks have different sizes, the smallest being 2.8 cm in width and 2 cm in length, with a gauge of 5 cm and a stride of 8 cm, and the largest track is 14 cm in width, 12 cm in length, stride of 62 cm and gauge of 42 cm. There is no apparent morphological difference between the footprints of the same track making impossible to differentiate manus or pes prints. Two other trackways occur in an upper level, and are better preserved. These trackways comprise different sizes and shapes of footprints, representing fore and hind feet. The smaller tracks, representing the manus prints, are oval in shape, 8 cm in width and 7 cm in length. The larger tracks are triangular in shape and display 5 short digits, with a width of 8.8 cm (digits) and of 4.5 cm (heel), the footprint length is 10.2 cm. The gauge of this trackway is 24 cm and the stride is 28 cm. The hind feet display five digits, but in the forelimb it is not possible to distinguish the digits. The second track, which occurs at the same level, has very similar features, such as the same size and the same direction (moving north). All prints were preserved in a dune foreset wind, and exhibit structures of micro avalanche triggered by the weight of the animal. The probable trackmaker of the best preserved trackways is believed to be about 60 cm in length and due to the morphology of their paws, it is likely a therapsid. The complete lack of body fossils in the Pirambóia Formation and the rarity of vertebrate trace fossils mean that currently the footprint record provides the only evidence of the fauna that lived during the Lopingian in the southern part of the Paraná Basin. Thus, these tracks represent a highly significant addition to the paleontological studies of the Paraná Basin and to the footprint records of South America and of the global Permian.

Technical Session XVI (Saturday, October 20, 8:45 am)

TIMES NOT SO TOUGH AT LA BREA: DENTAL MICROWEAR TEXTURE ANALYSIS CLARIFIES THE FEEDING BEHAVIOR OF THE SABER-TOOTHED CAT *SMILODON FATALIS* AND AMERICAN LION *PANTHERA ATROX*

DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States; SCHUBERT, Blaine W., East Tennessee State University, Johnson City, TN, United States; SCOTT, Jessica R., University of Arkansas at Little Rock, Little Rock, AR, United States; UNGAR, Peter S., University of Arkansas, Fayetteville, AR, United States

The saber-toothed cat *Smilodon fatalis* and American lion *Panthera atrox* were among the largest terrestrial carnivores that lived during the Pleistocene, going extinct along with other megafauna ~12,000 years ago. Previous work suggested that times were tough at La Brea (California) during the late Pleistocene, as nearly all carnivores have greater incidences of tooth breakage (used to infer greater carcass utilization) compared to today. High-magnification microwear of *S. fatalis*, in contrast, has suggested they avoided bone, even more than do extant cheetahs. As Dental Microwear Texture Analysis (DMTA) can differentiate between different levels of bone consumption in extant carnivores (specifically, the avoidance of bone in the cheetah *Acinonyx jubatus*, durophagy in the spotted hyena *Crocuta crocuta*, and more generalized behavior in the African lion *Panthera leo*), we use DMTA to clarify the dietary niches of extinct carnivorans from La Brea. Specifically, we test the hypothesis that times were tough at La Brea with carnivorous taxa utilizing more of the carcasses (as suggested by tooth breakage data). We predicted that *S. fatalis* avoided bone more than *P. atrox*, as *P. atrox* has reduced canines and the highest percentage of tooth breakage of all Pleistocene carnivorans. Our results instead show no evidence of bone crushing by *P. atrox*, with lower complexity (*Asfc*) and texture fill volume (*Tfv*) than extant *P. leo* and *C. crocuta* ($p<0.001$). *Panthera atrox* is indistinguishable from *A. jubatus* in both *Asfc* and *Tfv* ($p>0.95$). In contrast, *S. fatalis* has DMTA characters most similar to *P. leo*,

with *Asfc* values intermediate between *A. jubatus* and *P. leo* (statistically separable from all extinct and extant taxa). *Smilodon fatalis* has significantly lower *epLsar* than *A. jubatus* ($p<0.01$) and significantly higher *Tfv* than both *A. jubatus* and *P. atrox* ($p<0.05$), suggesting that *S. fatalis* did not avoid bone to the extent previously suggested by SEM microwear data. Lower mean *Asfc* and *Tfv* values in *P. atrox* and *S. fatalis* compared with *P. leo* and *C. crocuta* suggest that carcass utilization by the extinct carnivorans was not necessarily more complete during the Pleistocene at La Brea; thus, times were not any "tougher" than today. Perhaps instead, increased tooth breakage may have resulted from consumption of larger prey that generated higher forces during capture. Additionally, minor to no significant variation was found when comparing specimens from older (pits 77 and 91, ~30-35 Ka) to younger (pits 67, ~11.5 Ka) deposits, suggesting that declining prey resources were not a primary cause of their extinction.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW INFORMATION ON THE HYPOBRANCHIAL SKELETON OF THE EARLY PERMIAN LEPOSPONDYL LYSOROPHID AMPHIBIAN *BRACHYDECTES*

DEVLIN, Kathleen R., California State University, San Bernardino, San Bernardino, CA, United States; SUMIDA, Stuart S., California State University, San Bernardino, San Bernardino, CA, United States

The Late Paleozoic Lysorophidae is a small Permo-Pennsylvanian lepospondyl amphibian family comprised of only two genera, *Brachydectes* and *Pleuroptyx*. The group is moderately well known given the frequently excellent preservation afforded by their location in aestivation burrows. The group is best known for their elongate bodies, reduced limbs, and highly fenestrate skulls and highly ossified hypobranchial skeleton.

Heretofore undescribed specimens collected by Everett C. Olson, and deposited in the UCLA Vertebrate Paleontology collections, provide additional information on the details of the hypobranchial skeleton in the North American genus *Brachydectes*. UCLA VP 2946, from the Lower Permian (Leonardian) Fairmont Shale, Hennessey Group near Norman, Oklahoma includes a small partial skull, articulated anterior presacral vertebrae, and exceptionally preserved hypobranchial apparatus. Preservation of the hypobranchial apparatus in lysorophids is not uncommon because of the highly ossified nature of the individual elements, but they are frequently disarticulated and somewhat scattered. UCLA VP 2946 preserves a robust and well articulated hypobranchial skeleton demonstrating previously undocumented patterns of articulation of the medial-most elements.

In previous studies a midline basibranchial element was unable to be identified. The specimen described here does not show clearly any of the hyoid arch elements; however, a very small midline element is present ventral to the margin of the mandible that could be a basibranchial. The hypobranchials of the first posthyoid arch appear to be very tightly articulated with one another in the ventral midline. Further, they are also very tightly articulated with the more lateral ceratobranchials. This hypo-ceratobranchial articulation is in fact so tight as to be potentially fused. Subsequent segments do not show a hypobranchial element, but ceratobranchials 2-4 are very well developed. Ceratobranchials of the second posthyoid arch articulate very closely with one another in the ventral midline. The ceratobranchials are strongly waisted, and their expanded distal ends give them an almost hourglass shaped outline.

The hypobranchial skeleton in *Brachydectes* shares certain features characteristic of juvenile amphibians on the one hand, and fully metamorphosed adults on the other hand. This mosaic of features is ascribed to the aquatic, neotenic features of an otherwise adult individual. A new reconstruction of the hypobranchial skeleton and its position relative to the ventral surface of the skull is offered.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

WRITING ABOUT VERTEBRATE PALEONTOLOGY AND MORPHOLOGY AS A WAY TO IMPROVE COLLEGE STUDENTS' WRITING SKILLS

DEWAR, Eric W., Suffolk University, Boston, MA, United States

Undergraduates come to college with a range of writing expertise from secondary education. Very few students, even prospective science majors, arrive with significant experience in scientific writing, and most do not get that experience until well into their major. Best practices for getting students to write about science effectively include beginning in the first-year experiences of students, integrating writing tasks of increasing sophistication throughout the major to support the broader course goals, and workshopping their writing intensively in a disciplinary writing course.

Evolution is the organizing theme of our junior-year writing course. Students choose a project in their area of interest to develop over the course of the semester. Many opt for organismic-level projects in vertebrate paleontology and morphology. In this course, students practice (1) formal writing in the style of scientific journals, (2) public writing intended to be understandable to the layperson, and (3) informal natural history journal-keeping and free-writing.

This writing course has several essential elements. One key aspect is that students are not simply given data to write about, nor are they set loose to search for keywords online. Students enter their projects as if they were members of a lab who were beginning research about paleontology. With guidance, students in a working group plan how to approach a relatively delimited research question for the semester. They visit museum collections to gather the data themselves, so that they can write authoritatively about their research methods. They find articles from the primary literature that support their work and are given some that represent exemplary science writing. Students write multiple drafts with time for peer review before grading. Evaluation by the instructor uses rubrics that are customized toward working with paleontological topics in order to get useful feedback to students without undue time spent marking papers. We keep the discipline of journal writing and free-writing throughout the course in order to increase their time on task and to understand the place of the notebook in scientific documentation.

Vertebrate fossils make a compelling entry for students to explore questions about evolution and functional morphology. Those with relatively little anatomical experience can develop the necessary background and place their new knowledge in a wider evolutionary context. Some students wish to continue or extend their projects into more expansive collaborative research projects. All students come away with more practice in disciplinary writing and a sense for how scientific research develops from a project's inception to its completion.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

THE ICHTHYOFAUNA, PALAEOENVIRONMENT AND PALAEOCLIMATE OF THE MID-MIOCENE WOOD MOUNTAIN FORMATION, SASKATCHEWAN, CANADA

DIVAY, Julien D., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

The Miocene Wood Mountain Formation of southern Saskatchewan has been the basis of studies describing its mammalian and herpetofaunas, but little has been reported on the fossil fish material found. The ichthyofauna is diverse, with fifteen taxa recognized to ordinal or lower levels. It includes Amiinae, Osteoglossiformes, Hiodontidae, two or more unidentified cypriniforms and one Leuciscinae, three ictalurid catfishes (*Ameiurus*, *Ictalurus* and cf. *Noturus*), *Esox* (*Esox*) sp., ?Moronidae, Centrarchidae (cf. *Pomoxis*), two Percidae (including *Stizostedion* sp.), and several more taxa that remain indeterminate. This material represents the last occurrence of an amiine in the Hudson Bay drainage and may constitute the earliest evidence of a North American moronid. The assemblage also represents the first North American percids. The ichthyofauna is characteristic of environmentally diverse, well-oxygenated fluvial lowlands. A wide variety of substrates and flow strengths are indicated, and some taxa additionally suggest abundant aquatic vegetation. The fauna is also indicative of a range of water clarities and depths near the depositional area. The temperature tolerance ranges of these fishes corroborate and complement previous palaeoclimatic reconstructions based on the herpetofauna of the formation. Normal average temperatures ranged between 28 and 5°C in the mid-Miocene, compared to current normal temperatures between 19 and -11°C in southern Saskatchewan. Normal minimum winter temperatures remained above freezing. Overall, the ichthyofauna suggests that the Miocene climate of Saskatchewan was similar to that of modern-day northern Mississippi or southern Tennessee.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

EVIDENCE FOR PERIODS OF INCREASED ARIDITY DURING THE LATEST CRETACEOUS OF NORTH AMERICA: A DESCRIPTION OF SEVERAL MASS DEATH ASSEMBLAGES OF TURTLES

DOMAN, Jessamy H., Yale University, New Haven, CT, United States; ROACH, Brian, Yale Peabody Museum of Natural History, New Haven, CT, United States; LYSON, Tyler R., Yale University, New Haven, CT, United States

Several localities (N=6) within the latest Cretaceous Hell Creek Formation of southwestern North Dakota and eastern Montana contain remarkable assemblages of numerous fossilized skeletal remains of riverine and ponded water turtles. Baenid turtles dominate the faunal assemblages. While trionychid soft-shelled turtles occur at each of these localities and a macrobaenid is found at one locality, all other North American Late Cretaceous turtles (adocids, chelydrids, kinosternids, and nanhsuingchelyids) are absent. These localities not only provide important insights into the vertebrate fauna and paleoecology of this region at the period just prior to the momentous K/T extinction, but are also interpreted to be the result of climate-induced mass mortality events. At each locality, differing degrees of articulation indicative of various stages of post-mortem decay among individuals suggest the turtles died over an extended period of time prior to burial. Furthermore, mudcracks are found in the layer immediately below the fossil-bearing bed in at least one of the localities. We review the occurrence of mass mortality events in modern riverine and ponded water turtle populations and interpret the fossil localities to be after-death assemblages. While mass death assemblages of terrestrial dinosaurs are common in the Campanian of Alberta (attributed to monsoonal rains and flooding), evidence for mass mortality events of aquatic animals is absent. We suggest the Western Interior of North America experienced more significant periods of drought during the Maastrichtian compared to the Campanian, and were responsible for the aquatic turtle death assemblages described.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FIRST STABLE ISOTOPE ANALYSES ON CROCODILES AND DINOSAURS FROM THE LATE CRETACEOUS "LO HUECO" FOSSIL SITE (CUENCA, SPAIN)

DOMINGO, Laura, Earth and Planetary Sciences Department, University of California Santa Cruz, Santa Cruz, CA, United States; BARROSO-BARCENILLA, Fernando, Grupo de Investigación IBERCRETA, Universidad de Alcalá de Henares and Departamento de Paleontología, Facultad de Ciencias Geológicas. Universidad Complutense de Madrid, Madrid, Spain; CAMBRA-MOO, Óscar, Laboratorio de Poblaciones del Pasado, Departamento de Biología, Facultad de Ciencias. Universidad Autónoma de Madrid, Madrid, Spain

The "Lo Hueco" fossil site (Cuenca, Spain) was fortuitously discovered in 2007 while constructing the high-speed railway Madrid-Levante. More than 8,500 macrofossils were recovered and the vertebrate assemblage suggested an age of Late Campanian-Early Maastrichtian.

Preliminary stable isotope analyses were performed on crocodiles and dinosaurs from two different levels: G1 and G2, with the former being older. Diagenetic alteration has been discounted based on two lines of evidence: 1) differences in dentine and enamel $\delta^{18}O_{PO4}$ values were detected, with the former showing consistently higher values, and 2) crocodiles have lower $\delta^{18}O_{PO4}$ values than dinosaurs (mean $\delta^{18}O_{PO4crocodile}$ = 19.4±0.9‰ *versus* mean $\delta^{18}O_{PO4dinosaur}$ = 20.8±0.8‰). This result is in good agreement with the observed low latitude $\delta^{18}O_{PO4}$ relationship between ectotherms and endotherms not only at present, but also in the Late Cretaceous. Calculated total mean $\delta^{18}O_{H2O}$ and temperature values are comparable for crocodiles ($\delta^{18}O_{H2O}$ = -3.2±0.7‰; temp. = 22.4±1.5ºC) and dinosaurs ($\delta^{18}O_{H2O}$ = -3.4±0.9‰; temp. = 22.1±1.9ºC). $\delta^{18}O_{H2O}$ values correspond to precipitation waters in tropical and subtropical locations, whereas temperature values are in good agreement with estimated temperatures during the Late Campanian-Early Maastrichtian for the paleolatitude of "Lo Hueco" (~31ºN). A slight increase has been observed in $\delta^{18}O_{PO4}$, $\delta^{18}O_{H2O}$ and temperature values from G1 to G2. G1 corresponds to a proximal muddy floodplain (close to distributary channels), whereas G2 represents a distal muddy floodplain (distant from distributary channels) and thus, in this last scenario, isotopic values may be influenced by slightly drier conditions. Another possibility is that there was a shift towards warmer conditions between G1 and G2. Finally, $\delta^{13}C$ values determined for dinosaurs are in the range of C_3 feeders, with theropods showing a mean $\delta^{13}C$ value of -10.7±0.8‰ and sauropods having a mean $\delta^{13}C$ value of -11.1±0.2‰, with similar isotopic values in G1 and G2.

These preliminary isotopic results on the recently discovered "Lo Hueco" fossil site allow a first approximation to the paleoclimatic and paleoenvironmental conditions in Iberia during the Late Cretaceous.

Technical Session VIII (Thursday, October 18, 3:15 pm)

NEW INSIGHTS ON MAMMALIAN FAUNAL DYNAMICS FROM THE MIOCENE OF SPAIN

DOMINGO, M. S., University of Michigan, Ann Arbor, MI, United States; BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States; AZANZA, Beatriz, Universidad de Zaragoza, Zaragoza, Spain; ALBERDI, Maria T., Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

The mammalian fossil record of Spain offers one of the best opportunities in the Eurasian Miocene to investigate patterns of faunal turnover through time due to its completeness, high taxonomical resolution and comprehensive coverage of the Miocene Epoch. We evaluated diversification in relation to environmental history for large mammals identified to the species level. Large mammal species included in the analysis belong to Artiodactyla, Perissodactyla, Hyracoidea, Proboscidea, Primates and Carnivora. We focused on the interval from 12.0 to 5.5 Ma, which contains 72 localities from 13 basins supported by paleomagnetic dating. The occurrence of localities in different basins makes it difficult to establish age correlations among them directly. We established a comprehensive chronological sequence through maximum likelihood appearance-event ordination. Changes in mammalian diversity of Spain have been traditionally analyzed using the Mammalian Neogene (MN) biochronological framework, which has long time bins of unequal duration. Applying an ordination method permitted us to analyze diversity changes at a finer time resolution. We parsed the localities into 0.5-Myr time bins. Since observed first and last appearances underestimate the real temporal range of taxa, we calculated 80% confidence intervals on the observed duration of each lineage. We evaluated rates of origination, extinction, diversification and turnover as well as changes in faunal composition and trophic structure. Three significant turnover periods were identified. The first one, between 12.0 and 11.5 Ma, was mainly driven by originations with a substantial number of immigrations. High turnover between 9.0 and 8.0 Ma arose from a combination of appearances and disappearances. Disappearance of some browsers and appearance of mixed feeders and grazers suggest that this period of faunal turnover was related to environmental change toward more open habitats. Finally, significant faunal change occurred between 6.5 and 5.5 Ma. The extinction rate for this interval was the highest for all the intervals evaluated. At this time, the Messinian Salinity Crisis extended throughout the Mediterranean Region and the mammalian fauna experienced a major reorganization. Finer temporal resolution and standardized diversity metrics have provided more detailed insight into the timing and pattern of faunal events over time and also will facilitate comparison with other Miocene records.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

TRADITIONAL CLASSROOM VISITS ARE NECESSARY WHEN EVOLUTION IS TAUGHT AS A CONTROVERSY: BROADENING THE IMPACT OF INDIVIDUAL CLASSROOM VISITS

DONOHUE, Shelly L., Vanderbilt University, Nashville, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States; YANN, Lindsey T., Vanderbilt University, Nashville, TN, United States; LOFFREDO, Lucas F., Vanderbilt University, Nashville, TN, United States

Recently, the state of Tennessee passed a law that permits teachers to teach scientific topics like evolution and global warming as controversial. While much debate has ensued about this legislation, Tennessee teachers can now choose to teach sound science as they always have, or introduce alternative ideas or explanations. While citizens are working on changing the current state of affairs, in the meantime, scientists and paleontologists aim to ensure sound science is taught in the classroom – one classroom at a time. Although classroom visits can be time consuming, they are a primary way of engaging with local students and teachers. Further, visits to one or two classrooms allow for replication of similar presentations and activities in future classroom visits, cutting down on preparation time. Here, we propose and discuss guidelines we have implemented to improve the quality and quantity of classroom visits by paleontologists. First, we carefully select schools and classrooms where we will have the greatest impact. This includes visiting students that will benefit from the types of experiences paleontology can provide. For example, we annually visit the Tennessee School for the Blind and teach lessons that require students to make inferences about fossils by their sense of touch. Unable to use visual teaching tools, students and faculty are challenged to communicate paleontological science through creative mediums. Second, we involve both graduate and undergraduate students in classroom visits to walk them through the teaching process by providing examples of appropriate classroom activities, and allowing them to build confidence in a new environment. Through group classroom visits, each student will quickly gain the confidence and knowledge to independently visit other classrooms throughout a given year. Third, we aim to tap into existing programs. Although independent classroom visits are beneficial to the individual classrooms visited, if we can infuse paleontological lessons into existing outreach programs that can be implemented by volunteers already engaged in classroom outreach, our efforts will stretch much further. As teachers are required to teach the standards, focusing on under taught standards such as evolution and climate change is an excellent way of ensuring these concepts are adequately discussed in public schools. Our guidelines help broaden the benefits of classroom visits while simultaneously giving students and teachers access to knowledgeable paleontologists who accept evolution. Classroom visits, while traditional and time consuming, are an important tool for improving communication outside of the ivory tower, and training undergraduate and graduate students in broader impact activities.

Technical Session XV (Saturday, October 20, 9:15 am)

DINOSAUR DIVERSITY IN THE ARCTIC: NEW RECORDS OF POLAR DINOSAURS BASED ON MICROVERTEBRATE ANALYSIS FROM THE UPPER CRETACEOUS PRINCE CREEK FORMATION, NORTHERN ALASKA

DRUCKENMILLER, Patrick S., University of Alaska Museum, Fairbanks, AK, United States; ERICKSON, Gregory M., Florida State University, Tallahassee, FL, United States; BRINKMAN, Donald B., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; BROWN, Caleb M., University of Toronto, Toronto, ON, Canada

The Upper Cretaceous Prince Creek Formation of northern Alaska preserves the single most informative record of dinosaur diversity from high paleolatitudes (82 degrees North) in North America. As such, it figures prominently in ongoing debates regarding dinosaur provinciality, migration, and overwintering strategies. Essential to hypothesis-based testing of these broader questions is a more comprehensive understanding of faunal composition of polar taxa from the Prince Creek Formation. However, current knowledge of the diversity and relative abundance of the Prince Creek Formation dinosaurs remains limited and available data is potentially biased given that most material has been collected from a small number of highly productive bone bed deposits. In order to more fully characterize its faunal composition, we analyzed teeth from microvertebrate assemblages, including Pediomys Point, from the Prince Creek Formation. Our results reveal considerably greater diversity among both ornithischians and theropods than has been previously recognized. As many as six ornithischians have earlier been documented in the formation; in addition to a known thescelosaurine, we note the presence of cheek teeth from a smaller, morphologically distinct basal ornithopod most similar to either *Orodromeus* or possibly *Zephyrosaurus*. Prior work recognizes five theropod taxa, most of which have been referred to largely non-contemporaneous taxa from lower latitudes. Our analysis is the first to document the occurrence of *Richardoestesia* sp. in the formation. Interestingly, previous reports of chondrichthyans from the formation are likely attributable to teeth of a small avialan dinosaur, or possibly a crocodilian. In contrast to earlier studies that suggest *Troodon* sp. is the most abundant theropod in the unit, its remains are relatively rare in our microvertebrate analyses. These new data significantly enhance the known diversity of dinosaurs from the Prince Creek Formation and provide critical new data for cross-latitudinal comparisons with temporally equivalent beds, such as the Horseshoe Canyon Formation of Alberta.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ASSESSING PREDATOR-PREY INTERACTIONS THROUGH THE IDENTIFICATION OF BITE MARKS ON AN AETOSAUR (PSEUDOSUCHIA) OSTEODERM FROM THE UPPER TRIASSIC (NORIAN) CHINLE FORMATION IN PETRIFIED FOREST NATIONAL PARK (ARIZONA, USA)

DRYMALA, Susan, University of Maryland, College Park, MD, United States; BADER, Kenneth, University of Texas, Austin, TX, United States

Paleoecological interactions of extinct tetrapods are typically difficult to infer. Although scarce, trace fossils can offer a rare glimpse into predator-prey interactions in ancient communities. Here we provide evidence for a Late Triassic predator-prey interaction based on an aetosaur osteoderm (PEFO 34869) with feeding traces. The partial paramedian osteoderm of the aetosaur *Typothorax* exhibits multiple tooth marks, presumably produced by a predator/scavenger feeding on the aetosaur carcass. The feeding traces include a series of four punctures forming an approximately 125-degree arc on the ventral surface of the osteoderm (interpreted as a single bite), with additional pit and scores with striations marking the dorsal surface. The punctures on the ventral surface have an average spacing of ~1.0 cm and range in width by 2.1-4.1 mm and in length by 4.6-9.1 mm. Carnivorous taxa from the same locality as well as other nearby sites from the Upper Triassic Chinle Formation, Petrified Forest National Park, include large-bodied (>3 meters) phytosaurs (*Pseudopalatus*), a rauisuchid, and numerous small-bodied (<3 meters) forms such as the dinosaur *Chindesaurus* and the non-archosaurian archosauriform *Vancleavea*. To identify the trace-maker, we compared the morphology of the bite marks to the tooth orientation and morphology of these taxa. *Chindesaurus* and *Vancleavea* were ruled out based on their smaller size and more compact tooth-spacing (<0.5 mm) compared to the spacing of the punctures in PEFO 34869. This leaves the rauisuchid, pseudopalatine phytosaur, or an as yet undiscovered large carnivorous reptile as the possible trace-maker. Despite the high degree of heterodonty in pseudopalatine phytosaurs, the observed pattern (spacing, arc curvature, and puncture size/shape) of the four punctures is inconsistent with any portion of their dentition. The almond-shape of the punctures and striation density (~3 per mm) of the bite marks are most consistent with the teeth of a rauisuchian-grade animal (such as *Postosuchus*). Furthermore, the spacing and arc curvature of the punctures on the ventral surface closely matches the premaxillary teeth of *Postosuchus kirkpatricki* (~1.0 cm spacing and 130-degree arc). Aetosaurs were protected by a dorsal and ventral carapace of osteoderms that was covered by skin or keratin in life, creating an obstacle to predators/scavengers trying to gain access to the flesh underneath. PEFO 34869 provides important insight into paleoecological interactions between terrestrial herbivores and carnivores in the Late Triassic of the American Southwest and may shed light on specialized feeding techniques used on heavily armored aetosaur carcasses.

Technical Session XIX (Saturday, October 20, 3:00 pm)

THE EFFECTS OF CRANIODENTAL SAMPLING ON ECOLOGICAL VARIABLES IN MODERN AND FOSSIL MAMMAL LANDSCAPE ASSEMBLAGES

DU, Andrew, The George Washington University, Washington, DC, United States; FAITH, John T., University of Queensland, Brisbane, Australia; BEHRENSMEYER, Anna K., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; PATTERSON, David B., The George Washington University, Washington, DC, United States; VILLASENOR, Amelia, The George Washington University, Washington, DC, United States

Accurate paleoecological reconstructions depend on obtaining a representative sample of the animals living on past landscapes. However, due to limited resources, surface collection and recording of mammal fossils in open-air sites is often limited to a subset of taxonomically informative specimens (e.g., teeth, horn cores). It is currently unknown how this selective sampling methodology could bias paleoecological reconstructions. Here we examine the effects of craniodental collection on three ecological variables: body size distribution, species richness, and relative abundance. Seventeen systematic transects in which *all* surface fossil specimens are documented were conducted in the Ileret Tuff Complex (1.53—1.51 Ma) of the Okote Member (Koobi Fora Formation, East Turkana, Kenya), resulting in a total mammalian sample of 430 identified specimens (NISP) with a craniodental subset of 130 NISP. Fifty-five systematic transects of modern skeletal remains in the Shompole Conservancy, Kenya, resulted in a total mammalian sample of 7,378 NISP and a craniodental subset of 767 NISP. To address our question of potential bias resulting from craniodental collection, various statistical analyses were conducted comparing the entire faunal samples to the craniodental subsets for both modern and fossil datasets. Results show that sampling only craniodental remains does bias body size distributions but not species richness or relative abundances. Thus, we expect that diversity measures should be minimally affected by craniodental sampling, but caution is required when analyzing body size distributions derived from only mammalian craniodental remains.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ONTOGENETIC CHANGE IN THE CRANIAL ENDOCAST AND ENDOSSEOUS LABYRINTH OF AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*): IMPLICATIONS FOR THE INTERPRETATION OF EXTINCT ARCHOSAURS

DUFEAU, David L., University of Missouri, Columbia, MO, United States; MORHARDT, Ashley C., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Extant crocodylian skulls undergo dramatic transformation during ontogeny. For example, rapid growth of the face and suspensorium relative to the braincase reorients neurosensory structures such as the eyes and tympanum. How this growth pattern impacts endocranial anatomy has never been evaluated. Moreover, although anecdotal reports suggest that "young" crocodylians resemble birds and mammals in having the brain largely fill the endocranial cavity, the relationship of ontogeny to any measure of how well the endocast serves as a proxy for brain structure has never been documented, which has implications for the study of extinct archosaur brain/endocast evolution. We present the results of an extensive ontogenetic analysis of *Alligator mississipiensis* comprising 15 specimens ranging from embryos to old adults and encompassing an 18-fold difference in skull length. Specimens were CT-scanned, and 3D representations of the inner ear and dural envelope were generated in Amira. Some specimens were soaked in an iodine/potassium-iodide solution to stain the neural tissues, allowing direct comparisons of the brain and endocast. Ontogenetic trends include: (1) the olfactory tracts become increasingly elongate and are less acutely angled from the cerebrum parasagittally; (2) the optic lobes become increasingly less prominent and lose contact with the meninges as the venous sinuses enlarge; (3) the general proportions of the brain change whereby the forebrain dominates in perinates, becoming about equal to the midbrain and hindbrain by a year of age, whereas in adults the midbrain and hindbrain together occupy most of the endocranial space; (4) the common crus of the inner ear elongates, resulting in a 20% increase in the angle of elevation of the rostral and caudal semicircular canals from the horizontal plane, increasing their effective length; and (5) this increase in the arc of the canals tracks an increase in the volume of the cerebellum situated medial to the labyrinth. Ontogenetic changes in endocranial anatomy may reflect ecological shifts from active pursuit of small prey to ambush predation of larger prey. Change in elevation of the olfactory lobes likely reflects the progressive enlargement of the feeding apparatus, whereas changes to the inner ear and cerebellum may reflect increasing reliance on the rapid head movements of ambush predation. More broadly, the ontogenetic trend of the endocast becoming a progressively poorer proxy of the underlying brain may pertain to extinct archosaurs, shedding light on anatomical interpretation of fossil endocasts, but also perhaps even allowing tests of similar ontogenetic shifts in functional and ecological roles, as has been suggested to occur in tyrannosaurids.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

BUILDING A BETTER DATABASE: PROTEIN IDENTIFICATION AND LONGEVITY IN CROCODYLIAN BONE AND TEETH

DZIKIEWICZ, Katherine M., North Carolina State University, Raleigh, NC, United States

Despite increasing evidence that informative biomolecules may persist across geological time, the phylogenetic utility of recovered molecules is hampered by, among other things, the lack of an appropriate extant molecular database for non-mammalians against which to compare recovered sequences. Without such a database, the entire proteome may exist, but be unrecognized by current search algorithms. Therefore, because members of Crocodylia are, along with birds, extant sister taxa to Dinosauria, we present the first representative bone and tooth proteome for extant members of this crown clade. Though few crocodylian proteins have yet been sequenced, we have conducted mass spectrometry on extant samples, and identified bone and tooth proteins using the databases of birds and other vertebrates. These data provide a baseline for comparing sequences recovered from extinct representatives of this clade as we begin the first ever time-point sampling across a single clade to test the hypothesis of a temporal limit to molecular preservation. Although bone and tooth DNA from a single organism are identical, the bone proteome as the expression of the "directions" of DNA, is different than the tooth proteome. Here we also compare bone and tooth proteomes because these tissues types are most likely to preserve in the rock record. This comparison will allow us to objectively state which tissues are the best targets for molecular recovery from fossils.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

COMPARATIVE NEUROANATOMY OF FOSSIL AND LIVING WATERBIRDS

EARLY, Catherine M., North Carolina State University, Raleigh, NC, United States; SCLAFANI, Michelle, North Carolina State University, Raleigh, NC, United States; BALANOFF, Amy M., American Museum of Natural History, New York, NY, United States; KSEPKA, Daniel T., North Carolina State University, Raleigh, NC, United States

Waterbirds are a diverse avian clade that includes species adapted to many unique ecologies such as wing-propelled diving, foot-propelled diving, and plunge-diving. Several shifts in neuroanatomy have been proposed to accompany these ecologies, and thus may offer insight into the prey-capture strategies of extinct species. We examined an array of fossil and living waterbird skulls through computed tomography imaging. Using the program Avizo, we rendered virtual endocasts of the brain and semicircular canals and estimated the volume of neuroanatomical structures such as the floccular lobe and sagittal eminence. Additional fossil species that had been studied using the same technique were included from the literature.

Previous workers have proposed that thickening of the subarachnoid space is characteristic of deep diving birds. Cerebellar folds were not visible in the endocasts of any deep diving taxa we examined. Deep diving birds sampled in this study also exhibited an expanded floccular lobe. While most lineages had a prominent sagittal eminence, interestingly this structure was poorly developed in fossil and living Suloidea and in the storm petrel *Oceanites*. This distribution suggests multiple independent reductions of this structure. Fossil representatives of the Sulidae and Spheniscidae show strong similarities to their extant relatives, suggesting that these groups had attained modern ecologies by at latest the

Oligocene Epoch. In contrast, stem members of Phaethontidae show marked differences from their extant relatives and may have differed from their modern equivalents in their ecologies.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ISOTOPIC INDICATORS OF SEASONAITY AT A LATE MIOCENE PRIMATE LOCALITY IN HUNGARY

EASTHAM, Laura C., University of Toronto, Toronto, ON, Canada; BEGUN, David R., University of Toronto, Toronto, ON, Canada; KORDOS, Laszlo, Geological Institute of Hungary, Budapest, Hungary

The Vallesian Crisis (9.7 Ma), a Late Miocene mammalian turnover event recorded throughout Europe, marks the extinction of many closed forest adapted faunal forms, including the hominoids. In western and eastern Europe, this turnover event is associated with increasing seasonality and aridity, as well as a shift in the vegetation from closed canopy subtropical evergreen to more open canopy deciduous forest and woodland. Floral and faunal data for Late Miocene central Europe indicate the persistence of humid and relatively aseasonal conditions throughout this period. The rich Late Miocene primate locality of Rudabánya in north-central Hungary provides a unique opportunity to examine the paleoecology of central Europe during this time. The degree of seasonal variation in temperature and/or precipitation was examined in four genera of medium to large bodied herbivores at Rudabánya by serially sampling stable oxygen isotope values found within tooth enamel. Sampled taxa include *Hippotherium intrans*, *Tetralophodon longirostris*, *Aceratherium incisivum*, and *Propotamochoerus palaeochoerus*. Serial samples were collected using a dental drill on the external tooth surface, as well as from thin sections using a computerized MicroMill. Oxygen isotope results for all sampled taxa reveal a pattern of seasonal enamel growth. Serial samples demonstrate an intra-tooth range of oxygen isotope of variation between 2.3‰ and 2.8‰, with a mean range of 2.7‰. The gomphothere, *T. longirostris* showed the greatest range of oxygen isotope variation (3.1‰), while the equid, *H. intrans* showed the least (2.2‰). These results suggest that the Rudabánya fauna experienced a moderate degree of seasonal variation in temperature and/or precipitation. The examination of intra-tooth isotopic variation provides insight into the paleoecology of Rudabánya during a highly dynamic period in the evolution of terrestrial mammals in Europe.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE FOSSIL RECORD OF THE DIAMONDBACK TERRAPIN, *MALACLEMYS TERRAPIN* (TESTUDINES: EMYDIDAE)

EHRET, Dana J., Monmouth University, West Long Branch, NJ, United States; ATKINSON, Benjamin K., University of Florida, Gainesville, FL, United States

New fossil materials of the diamondback terrapin (*Malaclemys terrapin*) are described from Late Pleistocene coastal deposits of South Carolina, Georgia, and Florida. The only previous records for the genus included two late Pleistocene carapace fragments recovered from South Carolina, a faunal list inclusion from the Page-Ladson locality in Florida (late Pleistocene), and a Holocene shell and postcranial elements from Bermuda. This paucity of fossil materials made it one of the least well-known fossil genera within the extant emydid turtles. Here we describe new fossil material of the diamondback terrapin from Edisto Beach, South Carolina, the South Brunswick River, Georgia, and specimens from Florida's Aucilla and Wekiva Rivers on the U.S. Gulf Coast. These newly described materials expand the fossil range for the genus *Malaclemys* into southeastern Georgia and peninsular Florida. Specimens represent carapacial bones from numerous individuals at each locality. Fossils are identified as *Malaclemys* based on the features of scute sulci and the presence of annuli scars on most specimens. Today, diamondback terrapins occur along the Atlantic and Gulf coasts of the United States from Cape Cod, Massachusetts to south Texas, with a disjunct population of unknown origin existing in the Bahamas. The general lack of fossil material for *Malaclemys* is likely the result of misidentification (or non-identification), inadequate collecting in areas where specimens may be found, and the fragile nature of the material. Furthermore, ecological restriction of *Malaclemys* to coastal salt marshes, mangroves, and tidal creeks limits the potential for fossilization. Fossil localities for *Malaclemys* appear to reflect historical shorelines during Pleistocene glacial-interglacial cycles. Based on current geographic and fossil distributions, it appears that *Malaclemys terrapin* evolved and dispersed along the southeastern Atlantic and Gulf coasts prior to the Late Pleistocene.

Technical Session V (Wednesday, October 17, 3:45 pm)

PHYSIOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE COCHLEAR MORPHOLOGY OF MIOCENE MYSTICETI (CETACEA)

EKDALE, Eric G., San Diego State University, San Diego, CA, United States

Mysticetes (baleen whales) are sensitive to low frequency (LF) vibrations, and the morphology of the cochlea that houses the organ of hearing reflects that sensitivity. Sensory thresholds are correlated with development of a secondary lamina for the basilar membrane along the outer wall of the cochlea, the number of turns completed by the spiral, and the tightness of apical coiling. Mammals with lower LF thresholds, such as extant Mysticeti, tend to have cochleae with reduced laminae, a greater number of turns, and more tightly coiled apical whorls when compared to mammals with higher LF thresholds, such as extant Odontoceti (echolocating toothed whales).

In an investigation of the evolution of auditory morphology and physiology of baleen whales, the internal and gross anatomy of fossil cochleae of mysticetes allied with two major exant clades, Balaenidae (right whales) and Balaenopteridae (rorquals), were reconstructed utilizing high resolution CT data. Most phylogenetic hypotheses suggest that the groups diverged early in mysticete evolution, most likely during the late Oligocene to early Miocene. The extinct taxa studied include new information from fossils of the Temblor Formation (middle Miocene), namely *Peripolocetus vexillifer* (stem balaenid) and *Parietobalaena securis* (stem balaenopterid), and published data of *Herpetocetus* sp. (stem balaenopterid; Yorktown Formation, Lower Pliocene). Anatomical features associated with LF sensitivity are present in the Miocene and Pliocene taxa, but variations reflecting phylogeny and functional differences also were observed. For example, extinct *Peripolocetus* and extant *Balaena* share a reduced secondary lamina that is restricted to the first half of the basal turn of the cochlea, whereas the lamina extends into the final third of the basal turn in the extinct and extant members of the balaenopterid lineage. The reduction of the secondary lamina unites the balaenid lineage, but it also suggests that the clade has evolved a lower LF threshold than the balaenopterids and allied taxa. Additionally, cochleae of the extant whales (*Balaena* and *Balaenoptera*) coil more loosely and to a lesser degree (<2.5 turns versus >2.7 turns in the fossils) than the extinct whales, suggesting independent evolution of the low degree of coiling in extant balaenopterids and balaenids, and an increase in LF thresholds through geologic time. Using this information, the most recent common ancestor of crown Mysticeti is hypothesized to have possessed a cochlea with over 2.5 turns, a tightly coiled apical whorl, and low LF thresholds relative to extant taxa. Reconstruction of the cochleae of Oligocene and Eocene outgroups is planned in order to polarize the anatomy and test this hypothesis.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

NEW SCIENCE OUTREACH MODEL FROM STUDENT-RUN PILOT PROGRAM, *PARADIGM SHIFT*

ELSHAFIE, Sara J., University of Nebraska-Lincoln, Lincoln, NE, United States; THOMPSON, Khari, University of Chicago, Chicago, IL, United States; CALAND PUYMARTIN, Guy K., University of Chicago, Chicago, IL, United States

Among the scientific disciplines, paleontology is particularly well suited for the hands-on, creative learning processes that students respond to best. There is high demand for programs that can take paleontology beyond natural history museums; programs that increase student involvement in outreach; and programs that bridge institutions with communities. A new student-run science outreach program, "Paradigm Shift," brings current science to classrooms through engaging, relevant activities and personalized, prolonged mentorship. In 2012, the authors successfully launched a pilot program that involved over twenty student participants at the University of Chicago and served over fifty minority students in a local middle school.

In the Paradigm Shift program, mentors work consistently with middle school students in weekly one-hour sessions over a nine-week period. A low mentor: student ratio, between 1:2 and 1:4, ensures direct interaction and personal attention, and the prolonged duration of the program allows mentoring relationships to develop.

Each mentor designs a 45-minute activity on a science topic of his or her choice. All activities include a hands-on component and emphasize critical thinking, use of the scientific method, and real-world application. Mentors share their expertise and enthusiasm while gaining teaching experience. Mentors also incorporate their own studies into the curriculum, giving middle school students insight into scientific fields and education and career opportunities.

In the second part of the program, students work with their mentors to create learning tools that communicate their topics of investigation to a general audience. Students then use these tools to educate the public at a culminating showcase event. This exercise reinforces concepts and gives students presentation and communication skills. Learning tools and activities developed through the Paradigm Shift program are available on an open-source web domain. Paradigm Shift also incorporates tracking mechanisms for immediate and long-term impact assessment.

The emphasis of the Paradigm Shift program on collaboration, hands-on activity, and scientific and creative thinking make it a viable model for education in paleontology and other natural sciences. Topics covered in the 2012 pilot program included Comparative Anatomy, Earth History, Plate Tectonics, and Natural Selection, in lessons designed using current research and resources rather than textbooks and conventional material. Paradigm Shift also offers an opportunity for students at multiple levels to connect and learn from each other. The program's emphasis on personalized and perpetual learning, as well as its versatile applicability, makes this model a valuable tool for any institution.

Technical Session XV (Saturday, October 20, 9:30 am)

COMPLEX DENTAL STRUCTURE AND WEAR BIOMECHANICS IN HADROSAURID DINOSAURS

ERICKSON, Gregory M., Florida State University, Tallahassee, FL, United States; KRICK, Brandon, University of Florida, Gainesville, FL, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States; SAWYER, W. G., University of Florida, Gainesville, FL, United States

The grinding teeth of mammals (e.g. horses) are biomechanical marvels. Their complex four-tissue composition strategically wears, creating course surfaces to comminute tough and abrasive plants (e.g. grasses), liberating nutrients inaccessible to other herbivores. Grinding dentitions evolved repeatedly and almost exclusively in mammals. A rare occurrence outside this group happened millions of years earlier (Coniacian-Santonian ~85 ma) in the reptilian duck-billed dinosaur group Hadrosauridae. This innovation fueled their 35-million-year reign over Laurasian herbivorous niches. How this was achieved is a mystery. Reptile teeth consist of just two dental tissues and presumably lack biomechanical attributes for grinding. Here we show hadrosaurids broke from the reptilian template by evolving six-tissue composition. The tissues vary in prevalence throughout the teeth, thereby exposing different configurations as the teeth erupted and crossed the chewing surface. Three-dimensional tribological modeling revealed: 1) how the intricate architecture morphed for grinding, 2) the functional significance of each tissue, and 3) how dietary changes were achieved in different taxa through histological modifications. Our results show that hadrosaurids evolved not only the most histologically and biomechanically sophisticated dentitions known among reptiles. They rivaled, and in some ways exceeded those of advanced herbivorous mammals in complexity.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ELONGATE BONE ORIENTATION IN RIVERS: BONE AZIMUTHS AND POLARITIES DO NOT CORRELATE WITH FLOW DIRECTION

EVANS, Thomas, Montana State University, Bozeman, MT, United States

Fluvial transport or reorientation in the taphonomic history of fossil skeletal material is typically inferred by measuring the long axis orientations of elongate bones, plotting the orientations on a rose diagram, and inferring a paleocurrent direction (or lack thereof) based on any preferred orientations observed. This method assumes there is a concrete and identifiable correlation between bone orientations and current direction. To test this assumption, ~1800 modern bones were seeded in two rivers (Big Beef Creek, WA; and East Fork Sevier River, UT), 3080 bone casts were seeded in three rivers (Big Beef Creek, WA; East Fork Sevier River, UT; and Levelock Creek, AK), and 13 rivers were searched for bones naturally occurring in them. The bones seeded were from many mammalian taxa and from all portions of the body, so many bones were not elongate (e.g. teeth, vertebrae, etc.). The bone casts were created from adult male domestic sheep (*Ovis aries*) bones, and include 22 bones from a single skeleton, only six of which had distinct long axes (femora, tibiae, humeri, radio-ulnae, metacarpals, and metatarsals). Trials are ongoing, however, 212 seeded bones and 871 bone casts have been recovered, and 474 naturally occurring bones and bone fragments have been located. Data was used only from those bones and bone casts that were found submerged in water, with a 1:1.5 aspect ratio or greater, and where a clear flow direction was measurable (excluding bones in eddies, pools, etc.). The long axis orientations and polarities of elongate bones were measured relative to current direction and plotted to observe any correlations. From the total data set, only data from three rivers, 112 bones, and 85 bone casts met the required criteria. When plotted, no correlation existed between bone long axis orientation and current direction, and no consistent polarity was exhibited by limb bones (though sample sizes for each limb element were small). The lack of consistent orientations relative to flow direction was also observed in bone cast orientations, though a weak preferred polarity was observed, probably caused by denser proximal ends formed during cast creation. Lack of correlation between flow direction and elongate bone orientation suggests this method of identifying fluvially transported and deposited remains is invalid, the method should be discontinued, and a new method developed.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

WAS STROMER RIGHT? THE AFFINITIES OF *SIGILMASSASAURUS BREVICOLLIS* (THEROPODA, TETANURAE)

EVERS, Serjoscha W., Ludwig-Maximilians-University, Munich, Germany; RAUHUT, Oliver W., Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; MILNER, Angela C., Natural History Museum, London, United Kingdom

Sigilmassasaurus brevicollis is an enigmatic theropod dinosaur from the "middle" Cretaceous of northern Africa. Originally described as "*Spinosaurus* B" by Ernst Stromer on the basis of isolated vertebrae from Egypt, the formal name was erected for very similar axial material from Morocco. However, the validity of *Sigilmassasaurus* is currently under debate. The fossil record of this taxon is problematic, because published material is limited to isolated vertebral remains. Several authors have suggested that *Sigilmassasaurus* is a junior synonym of *Carcharodontosaurus*, but this is not generally accepted. In this study previously unpublished material housed in the Bayerische Staatssammlung für Paläontologie und Geologie in Munich and the Natural History Museum in London is examined. The material includes at least one anterior dorsal and several well preserved cervical vertebrae, including two centra of strongly elongate anterior to mid-cervicals. The latter can be referred to *Sigilmassasaurus* on the basis of several characters, including a centrum that is considerably wider than high, the presence of a pronounced rim around the anterior articular facet, and an anterior median tuberosity on the anterior articular surface.

Cervical vertebrae of *Sigilmassasaurus* show numerous differences to known carcharodontosaurid cervicals, including a cervical of the genotype of *Carcharodontosaurus*, in having more elongate anterior cervicals, a considerably lower height/width ratio, reduced neural arch lamination and a spike-like neural spine. Furthermore, CT-scans reveal camerate pneumatic chambers, in contrast to the camellate structure of carcharodontosaurid vertebrae. The vertebrae share several characters with megalosauroid, and, specifically spinosaurid, elements, such as elongate anterior and middle cervicals, very broad centra, a pronounced rim around the anterior articular facet, a prominent keel in posterior cervicals and anterior dorsals, a parapophysis that is set low on the centrum in anterior dorsals, and strongly elongate transverse processes in the posterior cervicals and anterior dorsals. Thus, *Sigilmassasaurus* might represent a further taxon of spinosaurid, as originally suggested, indicating that spinosaur diversity in the Cretaceous of northern Africa was higher than currently recognized.

Technical Session XI (Friday, October 19, 2:30 pm)

PHYLOGENETIC ANALYSIS OF LATE TRIASSIC – EARLY JURASSIC NEOTHEROPOD DINOSAURS: IMPLICATIONS FOR THE EARLY THEROPOD RADIATION

EZCURRA, Martin D., GeoBio-Center, Ludwig-Maximilians Universität München, Munich, Germany

New discoveries and studies have improved our knowledge of early neotheropod dinosaurs in the last decade. However, an updated and comprehensive phylogenetic analysis of Late Triassic and Early Jurassic theropods is currently lacking. In order to assess the phylogenetic relationships of these taxa, a data matrix composed of 39 terminals and 633 informative characters was compiled. In the most parsimonious trees recovered by the analysis, *Eodromaeus* was found as the sister-group of Neotheropoda and *Liliensternus*, *Procompsognathus*, *Lophostropheus*, *Gojirasaurus* and a specimen previously identified as a juvenile of *Dracovenator,* were recovered within a polytomy at the base of Coelophysoidea. The latter taxa were the sister-taxa of a clade composed of a "*Syntarsus*" *kayentakatae* + *Kayentavenator* clade and a group including *Segisaurus*, *Coelophysis bauri*, *Coelophysis rhodesiensis*, *Camposaurus* and an unnamed Mexican coelophysoid. The position of *Kayentavenator elysiae* indicates that it should be considered a junior synonym of "*Syntarsus*" *kayentakatae*. The putative juvenile specimen of *Dracovenator* might actually represent a distinct form of basal coelophysoid. After *a posteriori* pruning of wildcard taxa, *Liliensternus* was placed as the most basal coelophysoid, *Lophostropheus* as the most basal member of Coelophysinae, and *Coelophysis bauri* as the sister-taxon of a clade composed of *Camposaurus*, *Segisaurus* and *Coelophysis rhodesiensis*. Outside Coelophysoidea, *Zupaysaurus* was found as the sister-taxon of a group including Dilophosauridae and Averostra. Dilophosauridae was composed of *Dracovenator*, *Cryolophosaurus* and *Dilophosaurus wetherilli*, in agreement with some previous analyses. Within Averostra, *Sarcosaurus woodi* was recovered as a basal ceratosaur, probably representing the oldest member of the clade. Optimization of femoral length under a maximum parsimony criterion revealed a reduction of body size in Coelophysoidea and an overall increase in the lineage leading to Averostra. However, a conspicuous increase in body size is not documented during the Early Jurassic, contra to some prominent hypotheses of 'ecological release' for theropods following the Triassic–Jurassic extinction. The results also indicate that basal coelophysoids (i.e. those outside the "*Syntarsus*" + *Coelophysis* clade) are currently the most abundantly sampled late Norian–Rhaetian theropods. However, following the Triassic–Jurassic extinction event, theropod assemblages are composed of derived coelophysoids, dilophosaurids and basal averostrans. Accordingly, this mass extinction appears to have had a deep impact on the early evolutionary history of Theropoda, resulting in a shift of the taxonomic content of the group across the Triassic–Jurassic boundary.

Technical Session V (Wednesday, October 17, 2:30 pm)

PREDATION OF *BASILOSAURUS ISIS* ON *DORUDON ATROX* (CETACEA, BASILOSAURIDAE): A CASE STUDY FROM THE EOCENE OF EGYPT

FAHLKE, Julia M., Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany; VOSS, Manja, Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany; GINGERICH, Philip D., University of Michigan Museum of Paleontology, Ann Arbor, MI, United States; ANTAR, Mohammed Sameh M., Egyptian Environmental Affairs Agency, Wadi Al-Hitan World Heritage Site, Egypt; ZALMOUT, Iyad S., University of Michigan Museum of Paleontology, Ann Arbor, MI, United States

Basilosaurus isis (adult body length ca. 16 m) and *Dorudon atrox* (adult body length ca. 5 m) are fully aquatic archaeocete cetaceans that are abundant and well-documented in the middle-to-late Eocene Gehannam and Birket Qarun Formations of Egypt. It has been assumed that adult individuals of *B. isis* preyed on *D. atrox* or their calves in shallow waters, because both adult and juvenile *D. atrox* but only adult *B. isis* are found in nearshore deposits. However, direct evidence for this scenario is missing, and lethal bite marks on juvenile *D. atrox* skulls could not be assigned to *B. isis* with certainty. Recent field work in Wadi Al-Hitan, Egypt, produced a skeleton of an adult *B. isis* and, associated with it, cranial and postcranial remains of a juvenile *D. atrox*, and remains of large teleosts and elasmobranchs. Although there are no indisputable bite marks on these remains, we interpret them as gut contents, based on their position within the *B. isis* skeleton, taphonomic conditions, and relative age of the juvenile. This discovery led us to reinvestigate previously described bite marks on four juvenile *D. atrox* skulls that we laser-scanned to create three-dimensional (3D) surface models. These models were digitally placed into the mouth of a 3D model of a *B. isis* skull extracted from computed tomography (CT) images. Additionally, imprints of *B. isis* tooth casts in modeling clay were produced. Imprint shapes and distances between *B. isis* teeth were compared with shapes of and distances between bite marks on the *D. atrox* skulls. We were able to digitally fit the bite marks to the dentition of *B. isis*. In all cases, the best fit was achieved when a bite across the head from the left or from the front was simulated. Imprints of tooth casts of *B. isis* match the bite marks in shape and size. *B.*

isis was likely a pursuit predator feeding on very young *D. atrox* and large fish. Prey was predominantly captured from a lateral position and killed with one or two powerful bites. Diet and predation strategy of *B. isis* can be compared to those of the modern killer whale, *Orcinus orca*. *B. isis* is the only archaeocete known to date that most likely preyed on other cetaceans.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RECONSTRUCTING LIMB KINEMATICS OF SMALL BIPEDAL DINOSAURS TRAVERSING SEMI-FLUID SUBSTRATES

FALKINGHAM, Peter L., Royal Veterinary College, London, United Kingdom; GATESY, Stephen M., Brown University, Providence, RI, United States

The fossil tracks described by Edward Hitchcock and housed at the Beneski Museum of Natural History, Amherst College, include a wide variety of track morphologies. Among them are a number of tracks, predominantly from the Wethersfield Cove locality, which show considerable variation over successive exposed surfaces. Commonly referred to as undertracks, these successive prints have recently been interpreted as subsequent exposures of penetrative tracks, where the trackmaker's foot has directly interacted with, and passed through, each layer throughout the course of the step cycle. Track morphology on uppermost surfaces displays extremely narrow slit-like digit impressions, highly elongated, often with a long posterior impression behind the apex of the digits. At the lowest levels, track morphology is reduced to 3 or less drag marks, formed during a sweeping motion of the foot in which only the digit tips deform the substrate. Intermediate exposed surfaces show transitional morphologies: digit tips appear to translate with increasing depth, becoming more parallel (thus altering interdigital angle). Common to most, if not all, surfaces within a volume is an exit trace, formed as the foot is withdrawn, digits together. This exit trace often occurs in a spatially consistent location throughout the track volume, indicating a vertical foot withdrawal, rather than a forwards removal of the foot as in other deep dinosaur tracks (e.g., those from Greenland). We interpret these features as resulting from a backwards sweeping motion of the foot and lower leg. The substantial deformation and considerable depth that some track volumes display, implies that the substrate was so soft as to behave in a semi-fluid manner. In order to understand the limb kinematics, including where, when, and how the substrate provided resistance and supported the foot during the step cycle, we used computer simulation and animation. Digitised fossil tracks were used to three dimensionally reconstruct the path of the foot. This foot motion was then used to generate virtual tracks that show similar track morphologies to those seen amongst the Amherst collection

Technical Session XVI (Saturday, October 20, 8:00 am)

THE RELATIONSHIP BETWEEN LOPHODONTY, HYPSODONY, BODY MASS AND DIET IN EXTINCT AND EXTANT UNGULATES

FAMOSO, Nicholas A., University of Oregon Department of Geological Sciences and Museum of Natural and Cultural History, Eugene, OR, United States; FERANEC, Robert S., Research and Collections Division, New York State Museum, Albany, NY, United States; DAVIS, Edward B., University of Oregon Department of Geological Sciences and Museum of Natural and Cultural History, Eugene, OR, United States

The interaction between tooth morphology and wear has an important effect on how well herbivorous mammals, specifically ungulates, combat the effects of elevated tooth wear from abrasive diets by either changing the occlusal enamel length, or by changing relative hypsodonty. This tradeoff is notably seen in the fossil record of Equidae (horses) as they adapted to living in cooler, drier, and more open habitats about 16 Ma. We expect that the enamel length and hypsodonty should be greater in ungulate taxa that feed on grasses than in non-grass feeders. We tested this hypothesis by digitally photographing 174 maxillary tooth rows from 72 species of extinct and extant ungulates (n= 1036 teeth) and measuring their occlusal enamel length and true occlusal area. We then statistically compared the influences of taxonomy, feeding strategy, tooth position, and tooth area on both hypsodonty and occlusal enamel length including principle components analysis (PCA), multiple linear regression, nested multivariate analysis of variance (MANOVA), and discriminate function analysis. Our PCA indicated a strong correlation between enamel length and tooth area, but little correlation of either with hypsodonty. Our multiple linear regression showed that tooth position (p=0.8718) had no significant relationship to hypsodonty, while only feeding strategy (p=0.4834) was not significant for enamel length. These results were also supported by our nested MANOVA. Our discriminate function analysis produced a significant prediction of feeding strategy from a combination of hypsodonty and enamel length with only 21.81% misclassified. Consequently, these data may be used to approximate feeding strategy in some extinct ungulate taxa. Our results suggest that the occlusal enamel length in ungulate teeth is constrained by the size of the tooth and, by proxy, the mass of the individual, not diet. However, hypsodonty is determined by diet, not mass.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW REBBACHISAURID SAUROPOD FROM TUNISIA

FANTI, Federico, Museo Geologico Giovanni Capellini, Bologna, Italy; CONTESSI, Michela, Dipartimento di Scienze della Terra e Geologico-Ambientali, Bologna, Italy; ANDREA, Cau, Museo Geologico Giovanni Capellini, Bologna, Italy

New material of a rebbachisaurid sauropod from the Tataouine region of southern Tunisia, represents the first record of an articulated dinosaur from the Aptian-Albian deposits of northern Africa. The partial skeleton was recovered in the fluvial and marginal-marine beds of the Oum ed Diab Formation, the youngest siliciclastic unit of the "Continental Intercalaire," that crops out extensively along the Jeffara escarpment in southern Tunisia. The preserved skeleton includes an articulated sacrum, the anteriormost five caudal vertebrae and an incomplete pelvis. The sacral neural arches and spines form a continuous lamina produced by the fusion of the interspinous ligaments and spinal laminae. The sacral and caudal neural spines are extensively laminated and petal-shaped. The first five caudal vertebrae were recovered articulated with each other and the sacrum. The first caudal centrum bears a pleurocoel. The neural arches are apneumatic. The caudal vertebrae bear hyposphenal ridges, a spinodiapophyseal lamina running along the lateral surface of the neural spine and distinct from the prespinal laminae (the latter confined to the anterior surface of the spine) and joined ventrally by an accessory vertical lamina. The ilium is acuminate anteroventrally and has a slender pubic peduncle directed ventrally. The iliac peduncle of the ischium shows a constricted neck, a dorsolateral scar and a large medial fossa. Phylogenetic analysis places this new taxon as the basalmost nigersaurine. In addition, a diverse vertebrate fauna has been recovered from the main quarry, including isolated elements of non-avian theropods, crocodilians (represented by three different taxa), actinopterygians, sarcopterygians, and shark teeth. Detailed stratigraphic and sedimentological analyses performed at the main site indicate that at the time of deposition sediments accumulated in a large estuarine system under arid climatic conditions. Similarly, the faunal assemblage (including microvertebrate remains) supports the co-existence of non-marine, brackish and marine taxa. Rebbachisaurid sauropods are primarily known from the mid-Cretaceous of Africa, South America and Europe. Albeit partially biased by poor sampling and the uncertain position of some fragmentary taxa, the paleogeography of the two recognised rebbachisaurid subclades may indicate some regionalism in their distribution: limaysaurine remains occur mainly in South America, while Nigersaurinae appears to be centered along the margins of western Tethys. In the peri-Mediterranean area rebbachisaurids play a fundamental role for paleobiogeographic hypotheses, whereas sites from South America provide information on ecological partitioning of these sauropods relative to contemporary titanosaurs.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ONTOGENY IN THE HADROSAURID DINOSAUR *PARASAUROLOPHUS* REVEALED BY AN ARTICULATED SKELETON FROM THE KAIPAROWITS FORMATION OF SOUTHERN UTAH

FARKE, Andrew A., Raymond M. Alf Museum of Paleontology, Claremont, CA, United States; CHOK, Derek, The Webb Schools, Claremont, CA, United States; HERRERO, Annisa, The Webb Schools, Claremont, CA, United States; SCOLIERI, Brandon, The Webb Schools, Claremont, CA, United States

The lambeosaurine hadrosaurid *Parasaurolophus*, distinguished by its elongated tube-like crest that contains a portion of the nasal passages, is well-represented by adult crania from Campanian-aged deposits in Alberta, New Mexico, and Utah. In contrast with other lambeosaurines, however, the cranial ontogeny of *Parasaurolophus* is poorly known. Thus, a juvenile skull and articulated skeleton from the Kaiparowits Formation of southern Utah, referred to *Parasaurolophus*, provide important new data. The specimen, RAM 14000 (Raymond M. Alf Museum of Paleontology) has a humerus and femur measuring 180 mm and 315 mm long, respectively. Because the tail is incomplete, scaling from other juvenile hadrosaurs estimates total body length between 1.9 and 2.5 m, roughly 25% of maximum adult body size. The skull measures 240 mm long from the snout to the posterior margin of the quadrate, and the dentary is 138 mm long. The parallel, fluted impressions of the soft tissue associated with the upper beak shows that the tip of the beak extended up to 30 mm beyond the end of the premaxilla. This not only reduced bite force at the tip of the beak relative to the condition without a keratin extension, but also would have increased the overall area cropped in each bite. In addition, the presence of the bill contributed to faster cropping of food. The crest is approximately 50 mm tall above the apex of the orbit and is semicircular rather than tubular in lateral profile. The crest-snout angle is approximately 155°, with a prominent premaxilla-nasal fontanelle. Although the morphology is similar to that in juvenile *Corythosaurus*, *Lambeosaurus*, and *Hypacrosaurus*, the crest in RAM 14000 is comparatively more strongly developed than in somewhat larger juveniles of the other taxa. This suggests that *Parasaurolophus* initiated growth of the crest at an earlier ontogenetic stage, as expected from the extreme adult morphology of the crest in this taxon. Unlike other juvenile lambeosaurines, the narial passages occupy nearly the entire volume of the crest in RAM 1400; additional morphological differences occur in the position and size of features such as the S-loop and common medial chamber. The comparatively early development of cranial ornamentation in hadrosaurs (and other dinosaurs) parallels the condition seen in extant mammals (e.g., bovids), but differs from the late onset seen in extant birds (e.g., hornbills, casuaries). The integration of the ornamentation into the respiratory system perhaps necessitated the early development of the crest in juvenile hadrosaurs.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

COMPARATIVE PECTORAL AND FORELIMB MORPHOLOGY OF ORNITHOPODA: DOES *ORYCTODROMEUS CUBICULARIS* EXHIBIT SPECIALIZATION FOR DIGGING?

FEARON, Jamie L., Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States

This study examined the forelimb morphology of the mid-Cretaceous basal ornithopod *Oryctodromeus cubicularis* using traditional and geometric morphometric statistical analyses to assess the presence of burrowing adaptations relative to other ornithopods. The holotype

of *Oryctodromeus* occurred with two juvenile specimens in a burrow structure, and the initial description suggested morphological features such as a robust and fused scapulocoracoid represented digging adaptations. As there is no analog for a forelimb-assisted scratch-digging bipedal dinosaur within the extant phylogenetic bracket or among mammals, quantifying the forelimb variation within Ornithopoda in a phylogenetic context is necessary to understand any specializations of *Oryctodromeus* and their potential application in burrowing. I analyzed scapular and humeral morphology of ornithopods using traditional and geometric morphometrics to describe the morphological variation. A principal components analysis (PCA) of measurements of the humerus and scapula describes the variance of the specimens in terms of principal components (PC). Locations of landmarks on the humerus and scapula were compiled using TPSDig2 and then a thin plate spline (TPS) analysis was used to describe the shape mathematically. PCA results for the humeri indicate that iguanodontians and hypsilophodontids have similar proportions, and that it is primarily adult size that describes variation between the groups. The iguanodontians and hypsilophodontid group is distinguishable from hadrosaurids based on deltopectoral crest morphology (PC1). TPS analysis of the humeri shows that hypsilophodontids and iguanodontians form two slightly overlapping groups, however *Oryctodromeus* does not graph near iguanodontians. PCA results for scapulae indicate that hypsilophodontids are morphologically distinct, while hadrosaurids and iguanodontians group together. Most variance in scapulae is due to the broadening of the anterior and posterior ends (PC1). *Oryctodromeus* scapulae group together, however more hypsilophodontid material is needed to determine if they are statistically distinct in the group. Geometric morphometric results for the scapulae indicate that *Oryctodromeus* is morphologically distinct from the hypsilophodontids and other ornithopods primarily due to the ventral flaring of the posterior margin of the blade in *Oryctodromeus*. Studies of ornithopod musculature identify the posterior scapular blade as the attachment site for the deltoideus muscle, a muscle used in digging in mammals, supporting the hypothesis that *Oryctodromeus* exhibited some specialization for digging.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ON THE MECHANICAL LOADING OF THE PUBIS IN EXTANT ARCHOSAURS AND ITS RELEVANCE FOR THE RECONSTRUCTION OF SOFT TISSUES IN ORNITHISCHIAN DINOSAURS

FECHNER, Regina, Ruhr-Universiät Bochum, Bochum, Germany; GÖSSLING, Rainer, Ruhr-Universität Bochum, Bochum, Germany; SVERDLOVA, Nina S., Ruhr-Universität Bochum, Bochum, Germany

Ornithischian dinosaurs are characterized by an opisthopubic pelvic architecture, in which the pubis is directed posteroventrally. The retroversion of the pubis is induced by changes in the biological roles of the associated muscles. According to the extant phylogenetic bracket, the biological roles of the muscles attached to the pubis of ornithischian dinosaurs comprise locomotion, ventilation, and trunk stabilisation. Locomotion and ventilation are especially important aspects of the biology of an organism. Accordingly, our understanding of the biology of ornithischian dinosaurs strongly depends on precision in the reconstruction of these muscles. For several reasons the reconstruction of the muscles attached to the pubis of ornithischian dinosaurs is not trivial. Besides the well-known limitations of the extant phylogenetic bracket, the fact that the pubis of most ornithischian dinosaurs is thin and rod-like bone also calls for caution. Thin, rod-like bones are subject to bending loading. Bending loading, however, results in high mechanical stresses which are not well addressed by a thin, rod-like bone. Although bones are adapted to tolerate bending loads to a certain extent, excessive bending loading is avoided. A mechanism to minimize bending loading is required.

In order to gain insights into those mechanisms, we studied the mechanical loading of the pubis of extant archosaurs using finite element analysis (FE) and force diagrams. For this purpose, specimens of *Crocodylus porosus, Gallus gallus*, and *Rhea americana* were dissected. Two-dimensional FE models were generated of the pelvis of *Crocodylus niloticus* and *Gallus gallus*. For *R. americana*, a force diagram was generated. Muscular data are based on own dissections and published data.

Our study reveals major differences in the mechanism of bending minimisation in *C. niloticus, R. americana*, and *G. gallus*. Whereas crocodiles use an active tension cord system in order to minimise bending loading (PIFE1 and PIFE2), a passive tension cord system based on the Membrana ischiopubica is present in neognath birds. In ratite birds, the active tension cord system (OM) is assisted by the Membrana ischiopubica.

In ornithischian dinosaurs, both active tension cord system and passive tension cord system are suitable for minimising the bending loading in the pubis. However, if an active tension is present in ornithischian dinosaurs, the ratite model with OM attaching to the pubis and ischium is preferred. Reconstructing a passive tension cord in ornithischian dinosaurs, the site of origin of OM has to move or the muscle has to be reduced.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EARLY EVIDENCE FOR THE ABUNDANCE OF C4 GRASSES FROM THE MIDDLE MIOCENE BARSTOW FORMATION, SAN BERNARDINO COUNTY, CALIFORNIA

FERANEC, Robert S., New York State Museum, Albany, NY, United States; PAGNAC, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, United States

The rapid increase in the geographical distribution of C_4 grasses in North America had a dramatic effect on paleoenvironments and fauna during the late Miocene. The record of C_4 grasses prior to this spread is limited, but the earliest fossil evidence in North America is derived from the middle Miocene Dove Spring Formation (late Barstovian-Clarendonian) in central California. A permineralized fossil exhibiting typical C_4 Krantz anatomy suggests the presence of these grasses in California by the middle Miocene. The age of the Dove Spring Formation is estimated at 12.15-8.5 Ma based on geochronologic dates and magnetostratigraphic correlation. New evidence in the form of carbon isotope values from ungulate tooth enamel suggests the abundance of C_4 grasses during deposition of the middle Miocene Barstow Formation. The Barstow Formation is exposed in various sections throughout the western Mojave Desert. It records a diverse and abundant paleofauna of late Hemingfordian to Barstovian age. Radioisotopic dates have constrained the geochronologic age of the formation from 19.3-13.4 Ma. Tooth enamel $\delta^{13}C$ values were examined from eight ungulate species including the hypsodont equids, *Acritohippus stylodontus, Scaphohippus sumani,* and *Scaphohippus intermontanus*, the camelids, *Aepycamelus* sp., *Hesperocamelus* sp., and *Procamelus* sp., the antilocaprid, *Merycodus* sp., and the proboscidean, *Gomphotherium* sp. More positive $\delta^{13}C$ values observed within the equids, camelids, and antilocaprids are suggestive of C_4 grasses being included in the diet. The equid, *S. intermontanus,* exhibited the most positive $\delta^{13}C$ values, indicating a higher component of C_4 grasses in its diet (upto 20%) when compared to the other sampled ungulate taxa. The tooth enamel isotope values presented in this study show the presence of C_4 grasses as a significant component of ungulate diets at least four million years earlier than the documented paleobotanical remains.

Technical Session VII (Thursday, October 18, 2:15 pm)

USING PHYLOGENY AS A FRAMEWORK FOR DIVERSITY STUDIES

FERRER, Elizabeth, U.C. Berkeley, Berkeley, CA, United States

Taxic counts are common in assessing diversity at multiple scales (temporal, taxonomic, and range). This provides a view of macroevolutionary dynamics, and is often put into a phylogenetic context, but having a phylogeny as the framework of the analysis can provide very different insight. It is common in community ecology to use metrics like “phylogenetic diversity” which account for the fact that the loss of the same number of taxa in different locations might produce very different evolutionary consequences. It is defined as the minimum length of all the phylogenetic branches needed to span a set of taxa on a phylogenetic tree (taxa defined as those present in communities being compared). Methods like this can be beneficial to paleontology because it accounts for the level of relatedness in taxa present, but paleobiodiversity studies differ from current biodiversity research in that the data are diachronous. I have taken this metric and modified it to focus on time bins instead of locations, now calling it phylogenetically weighted diversity (PWD). An example of this was previously shown on a species level canid tree, but since then the method has been improved by removing extinct taxa through time and testing the incorporation of trait data. An African varanid molecular phylogeny was chosen as another case study as they show a generally conservative morphology throughout their history but have become more diverse in some locations and not others. The analysis was conducted in the statistical program R where a time calibrated tree is the framework, and at designated time bins from the base to tips the phylogeny is “chainsawed” where any taxa existed before and after the bin are removed and a new tree representing that time bin generated. The branch lengths for the new tree are relative to how long the taxa included have been in existence to that point. PWD is measured for the new tree, and this is repeated until the end of the phylogeny is reached. If there are many deep lineages, then PWD will continue to increase or stay constant, but show the opposite if later time bins are made up of mostly short lived taxa. Simply comparing this to taxon counts through time can provide a different picture of diversity dynamics, but focusing on how specific groups within the tree compare can also show which taxa might be the most influential on the patterns of PWD seen. Branch lengths can also be equated to disparity or Markov models of per-characters per-unit time can be tested alongside PWD, so instead of time one might be able to view how morphological disparity relates to phylogenetic diversity. These phylogenetic metrics provide another form of insight into diversity patterns in the fossil record, and can complement other diversity measures.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

EXTINCT AND EXTANT QUATERNARY MAMMALS FROM SAN LUIS POTOSÍ, EAST-CENTRAL MEXICO: FAUNAL TURNOVER AND CLIMATE CHANGE

FERRUSQUÍA-VILLAFRANCA, Ismael, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico; DE ANDA-HURTADO, Patricia, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico; RUIZ-GONZÁLEZ, José, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico

Pleistocene and Holocene mammal faunas across Mexico are distinctly different from each other in taxonomic structure and ecology. To address questions about the nature of these differences, we have analyzed Quaternary records from the central Mexican state of San Luis Potosí, as part of a long-term study on Pleistocene mammals, with comparisons on different aspects of the fauna, extending them beyond the state in order to assess the extent of the change and determine possible causes.

The single known Irvingtonian locality in San Luis Potosí is small, so the focus of this study is the late Pleistocene (Rancholabrean) and Holocene. The state has 12 Ranchobrean localities, which have collectively produced 11 orders, 33 families, 55 genera, and 75 species of mammals. In terms of size, megabaric species make up about 35% of the fauna, whereas

microbaric ones account for 52%. Two orders are currently restricted to the Neotropics, three to the Nearctic, and the other six include taxa from both biogeographic provinces. The herbivore/carnivore species ratio is 3:1. The 75 species from San Luis Potosí is about 27% species of Mexico's known Rancholabrean mammals. Holocene values for San Luis Potosí mammals are 8 orders, 23 families, 72 genera, and 126 species; no megabaric species, with about 9% mesobaric species and 92% microbaric species; its Neotropical and Nearctic components include two orders each (14 total species), the other four are mixed; the herbivore/carnivore ratio is about 1:1; and it includes about 26% species of Mexico's extant fauna.

The Pleistocene/Holocene faunal turnover was drastic, including major losses of diversity at ordinal and family levels (from 11 to 8 orders, and from 33 to 23 families), largely involving expatriation and extinction; an important reduction of the Neotropical component; major biogeographic shifts involving disjunction of once continuous areas of distribution, wholesale displacement of many taxa both latitudinally and altitudinally, reduction of ranges, and seemingly a finer partitioning of habitats to allow a greater number in species in the same space (resulting from a greater speciation rate?). The change in the herbivore/carnivore ratio might be related to biodiversity loss. The extent of the change is similar to that of Mexico's Nearctic region, but greater than that of the Neotropical region. There is no agreement on the cause/causes responsible for the Pleistocene/Holocene faunal turnover, but it appears that environmental or climate change was one of them (largely operating through ecological stress), while selective hunting by humans adversely affected the population structure of megafaunal species.

Technical Session XVI (Saturday, October 20, 9:45 am)

ON THE PREDATORY BEHAVIOUR OF THE THYLACINE: A COMPARATIVE APPROACH BASED ON FORELIMB ANATOMY

FIGUEIRIDO, Borja, University of Malaga, Malaga, Spain; JANIS, Christine M., Brown University, Providence, RI, United States; WU, Dominic, Brown University, Providence, RI, United States

The recently extinct thylacine (*Thylacinus cynocephalus*, the "Tasmanian tiger" or "marsupial wolf") was never the subject of a scientific investigation of its behavior. Despite the existence of a few eye-witness accounts, its mode of hunting prey remains conjectural. While its overall morphology (e.g., relatively short metapodials) makes it unlikely that it was a pack-hunting pursuit predator like a placental wolf, its general fox-like appearance has led to the suggestion of fox-like pounce-pursuit behavior.

Our previous work showed that the morphology of the elbow joint (i.e., the distal humerus) of the thylacine was more like that of a cat-like ambush predator than of a either a wolf-like pursuit predator or a fox-like pounce pursuit predator. Here we continue this investigation of forelimb anatomy, including 54 features of all forelimb elements except for the second and third phalanges, to see how the morphology of the thylacine compared with other carnivores of known predatory style (pursuit, pounce-pursuit, and ambush). Our data set included felids (11 species/23 individuals), canids (15/27), hyaenids (3/7), mustelids (1/1), dasyurid marsupials (2/3), and 5 individuals of *Thylacinus*.

Principal component analysis of log-transformed data showed three significant factors explaining 87% of the variance. Factors two and three did not distinguish between pursuit and pounce-pursuit predators, but these together had little overlap with the ambushers. The thylacine specimens all clustered with the ambush predators. A step-wise discriminant analysis identified five significant variables, including aspects of shape of the humerus and the scapula, and metacarpal length. This resulted in a more clear separation of all of the three types of predators, with the thylacines again clustering with the ambushers. We thus conclude that, despite its overall canid-like appearance, the thylacine did not have the predatory style of any extant canid, which are all either pursuit or pounce-pursuit predators. Rather, its forelimb morphology is most similar to that of a medium-sized felid such as the ocelot.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE FIRST ARTICULATED CERVICAL SERIES OF AN ADULT *ALAMOSAURUS SANJUANENSIS* (DINOSAURIA: TITANOSAURIA) AND AN *ALAMOSAURUS* SKELETAL RECONSTRUCTION AT THE PEROT MUSEUM OF NATURE AND SCIENCE

FIORILLO, Anthony R., Museum of Nature and Science, Dallas, TX, United States; TYKOSKI, Ronald S., Museum of Nature and Science, Dallas, TX, United States; MAY, Peter, Research Casting International, Trenton, ON, Canada

In 1997 a joint Perot Museum of Nature and Science (PMNS) - University of Texas at Dallas (UTD) field party discovered a partial adult skeleton of *Alamosaurus sanjuanensis* (Sauropoda: Titanosauria) in the Javelina Formation (Late Cretaceous: Maastrichtian) of Big Bend National Park, Texas. The Javelina Formation consists of fluvial channel and overbank facies, including minor shallow lake deposits and paleosols that indicate a semi-arid or seasonal climate for the area in the Maastrichtian. The specimen included an articulated string of nine cervical vertebrae, the first articulated cervical series known for the taxon. Preparation of the material was accelerated when it was decided that a full skeletal reconstruction of *Alamosaurus* would be an iconic exhibit in the new PMNS. Partnerships formed with other institutions that possess additional *Alamosaurus* material, including the Smithsonian Institution (Washington, D.C.), and The University of Texas at Austin, and also Research Casting International (RCI) enabled further preparation of fossil material, laser scanning of specimens, and fabrication of the skeleton. The nine articulated vertebrae measure approximately six meters in length and come from the posterior part of the neck. Neurocentral and cervical rib sutures are fused, an indication that the individual was relatively mature at the time of death. The smallest, but incomplete, vertebra is more than 60 cm long, and over 50 cm tall from the edge of the parapophysis to the dorsal tip of the neural spine. More posterior vertebrae are much larger, some measuring more than 70 cm long, a meter high, and nearly a meter wide across the diapophyses and cervical ribs. The lateral surfaces of each centrum are excavated by anteroposteriorly elongate pneumatic fossae. The tall, triangular neural spines differ from the dorsoventrally low spines described in an immature individual from the area. The base of each neural spine is excavated by a deep spinodiapophyseal fossa, and the postzygapophyses reach to or extend posterior to the end of the centrum as in some other titanosaurs. In the most posterior vertebrae, the prezygapophyseal centrodiapophyseal fossa is divided into distinct dorsal and ventral subfossae by a delicate accessory lamina, a potentially diagnostic feature. Given the importance of vertebral morphology in sauropod systematics, this articulated cervical series is a unique and important resource. These specimens and the full skeletal reconstruction of *Alamosaurus* erected at the PMNS provide new insights into the paleobiology and relationships of this taxon.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 9:45 am)

WESTERN APPALACHIA DINOSAURIA AND ASSOCIATED VERTEBRATES OF THE LATE CRETACEOUS OF SOUTHEAST MISSOURI

FIX, Michael F., University of Missouri, Saint Louis, MO, United States; DARROUGH, Guy E., Bollinger County Museum of Natural History, Marble Hill, MO, United States; PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States; GRANDSTAFF, Barbara S., School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA, United States

The Late Cretaceous (Campanian) Chronister Site of southeastern Missouri is the only known locality in the state that contains Mesozoic terrestrial vertebrate remains. Current excavation by the Missouri Ozark Dinosaur Project is being conducted under an enclosure to keep out water, and utilizes a 60 m^2 hanging grid to facilitate detailed mapping and taphonomic record keeping.

Fossils occur within clay that shows considerable soft sediment deformation due to the close proximity of a normal fault, on whose downthrown block it has been preserved. The environment of deposition as indicated by faunal and stratigraphic evidence was a predominately low energy body of fresh water, with occasional influxes of higher turbulence as indicated by a prominent gravel zone. This deposit may represent a backwater, wetland, or oxbow lake.

The fauna includes three types of dinosaur that have been positively identified: *Hypsibema missouriense,* a hadrosaur of uncertain affinities;an undetermined genus of tyrannosaurid; and an undetermined genus of dromaeosaurid. Recently, skull material from *H. missouriense* has been recovered. This material includes dentitions that suggest affinities to *Gryposaurus.* The associated fauna of hybodontids, batoids, lepisosteids, amiids, hadrodontids, aquatic turtles, and crocodylians found with the dinosaurs indicates that a substantial body of water was located not far from the eastern shoreline of the epicontinental seaway. The selachian fauna suggests this body of water had some connection to the seaway in the adjacent southeastern lowlands. Virtually all major taxonomic groups thus far identified at the Chronister Site are also known from the Ellisdale Site, Campanian of New Jersey.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PALEOCLIMATE OF THE DINOSAUR-BEARING, MID-CRETACEOUS WINTON FORMATION, CENTRAL-WESTERN QUEENSLAND, AUSTRALIA: NEW OBSERVATIONS BASED ON LEAF MARGIN ANALYSIS, CLIMATE LEAF ANALYSIS MULTIVARIATE PROGRAM, BIOCLIMATIC ANALYSIS AND FOSSIL WOOD GROWTH INDICES

FLETCHER, Tamara L., University of Queensland, Brisbane, Australia

Over the last decade the mid-Cretaceous (late Albian–Cenomanian) Winton Formation of western Queensland, Australia, has proven to be a rich source of terrestrial vertebrates, boasting a fauna that includes dinosaurs, crocodilians, squamates, turtles and fishes. To support our understanding of this fauna I investigated the climatic and environmental indicators associated with vertebrate-bearing horizons at sites near Winton and Isisford. The former sites are dominated by sauropods, while crocodilians and fast-swimming teolost fishes are the most abundant remains at the latter sites. Significantly, many of these sites include well-preserved plant macrofossils. Using Leaf Margin Analysis, Climate Leaf Analysis Multivariate Program, Bioclimatic Analysis and fossil wood growth indicies, the climate associated with the Winton sites was found to be warm, wet and relatively equable. When the climate results are compared with current Cretaceous global climate estimates for the same paleolatitude (~54 degrees south), the signal is much more consistent with a late Cenomanian–Turonian age, rather than the current estimate of late Albian–Cenomanian (which is based mainly on palynology). The Isisford localities are significantly different in terms floral preservation; leaves are extremely rare, and wood associated with bone is typically preserved only as casts. This contrasts with the beds of finely preserved leaf impressions and wood that preserves microscopic internal characteristics at the Winton sites. These observations suggest that vertebrate-bearing sites in each of the two areas, previously considered to be near coeval, may be temporally separated. Refining the climatic signal and floral environments associated with these localities is improving our understanding of the

nature of the Winton Formation vertebrate fauna, the relationship between sites and details of related depositional settings.

Technical Session XVI (Saturday, October 20, 11:45 am)

SYNERGISM IN DENSER FOSSIL RECORDS: ECOLOGICAL COMPLEXITY EMERGES FOR MIDDLE MIOCENE SIWALIK RHIZOMYINE RODENTS

FLYNN, Lawrence J., Peabody Museum, Harvard University, Cambridge, MA, United States

The beauty of a dense fossil record, one with many superposed fossil samples, is that successive samples may be compared, and differences evaluated for passage of time or change in paleoecology. Increase in sampling density results in larger aggregate collections, records of more taxa, and finer scale metrical comparisons. For the Miocene Siwaliks of the Indian subcontinent, a multinational team has built a composite sequence on the Potwar Plateau, Pakistan. The sequence is well dated and spans 12 million years (18 to 6 Ma) and thousands of meters of sediment. Particularly densely sampled is the Middle Miocene Chinji Formation, with 29 small mammal levels distributed over a 3 million year interval (14.3 to 11.3 Ma). Although not evenly distributed, data are available for most 100,000 year subintervals. Previously, with very few of these sites studied, a simplistic view of faunal succession was developed under a model in which one or two small rhizomyines characterized Chinji faunas. Given sets of samples widely spaced in time, small mammals appeared formerly to show evolutionary stasis. The paradigm of a Chinji mammal community with characteristic rodents including a single (or two) small rhizomyines underestimates true diversity and fails to distinguish subtle biotic trends. The greatly expanded fossil record presently available shows more small rhizomyines contributing to the Chinji community, with up to four species present at a single locality. These rhizomyines were early root rats adapted to burrowing and above-ground foraging; a new paradigm must make room for multiple lineages in close proximity. In addition, the greatly expanded data set indicates change in size in some lineages, which can be evaluated with global trends of isotopic change, such as that associated with the end of the mid-Miocene climatic optimum. One may begin to pose paleoecological questions about body size correlated to paleohabitat. The present denser fossil record allows exploration of more complex paleobiological questions than could be approached constructively with limited data.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

THE OLDEST SCOLECOPHIDIAN SNAKE

FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Scolecophidians are primitive, tiny snakes represented by two extant families (Typhlopidae and Leptotyphlopidae) that live mainly in tropical areas. The only European representative of this group is *Typhlops vermicularis* that lives around the Mediterranean Basin. Here we describe two isolated procoelous trunk vertebrae from the early Paleocene locality of Hainin (MP1-5, Belgium). These vertebrae are clearly referable to a scolecophidian because of the following characters: they are 1.5 mm long and 1 mm high and wide; the centrum is narrow and does not bear a central carina; the orientation of the prezygapophyseal facets differs from the orientation of the prezygapophyseal processes; the neural arch is low and does not present a medial notch on its posterior border nor a neural spine.

Fossil scolecophidians can be identified based on their vertebrae but they are not generally considered to be diagnostic to a familial, generic or specific level. However, some characters have recently been proposed to differentiate families according to the shape and placement of the synapophyses, shape of the cotyle, size of the zygosphene, and shape of the prezygopophyseal facets. We thus also discuss these characters in the Belgian Paleocene taxon.

Fossil scolecophidians are known from North America, Europe, Africa and Australia. The oldest representative of this group is known from North Africa in the late Paleocene of Adrar Mgorn (Ouarzazate Basin, Morrocco). In Europe, the oldest scolecophidian was identified from the earliest Eocene of the Dormaal locality (MP7, Belgium). The scolecophidian from the early Paleocene of Hainin thus represents the oldest occurrence of this group.

Technical Session V (Wednesday, October 17, 3:15 pm)

LONG-TUSKED ARCHAIC OLIGOCENE ODONTOCETES FROM OREGON AND BAJA CALIFORNIA SUR, EASTERN PACIFIC MARGIN

FORDYCE, Robert E., Dept Geology, University of Otago, Dunedin, New Zealand; FITZGERALD, Erich M., Museum Victoria, Melbourne, Australia; GONZÁLEZ BARBA, Gerardo, Universidad Autónoma de Baja California Sur, La Paz, Mexico

Two new species of archaic dolphin from the eastern Pacific represent a new genus of putative basal odontocetes. One is USNM (US National Museum) 205491, of late early Oligocene age (~30 Ma; Alsea Formation, Yaquina River, Oregon), comprising skull, mandibles, teeth, tympanoperiotics and fragmentary postcrania. USNM 205491 has been mentioned in print as a "non-squalodontid", or an Eocene Eurhinodelphinidae, or an Agorophiidae. The second species is known from a partial skull with one cheektooth and a bulla (Universidad Autónoma de Baja California Sur-UABCS collections) of middle late Oligocene age (~25 Ma; El Cien Formation, La Paz, Baja California Sur). In both, the skull has a prominent narial "snout" separating bilateral facial fossae for nasofacial muscles implicated in high-frequency sound production. Archaic features include parietals exposed at a prominent intertemporal constriction, anteriorly-placed narial fossa, and premaxilla without a posterolateral fold but with a narrow elongate premaxillary sac fossa. USNM 205491 has long, tusk-like, procumbent anterior teeth, and cheekteeth with wide diastemata, delicate high triangular crowns, and barely-discernable denticles. The rostrum is long and dorsoventrally compressed, with an open mesorostral groove and gracile mandibles in which the large panbone is ventrally inflated. The incomplete feeding apparatus in the UABCS skull is of similar structure. These dolphins lack the highly disparate derived features of near-contemporaneous Xenorophidae and *Simocetus*, and are not clearly close to other Oligocene families such as Waipatiidae, Squalodelphinidae, and Squalodontidae. The rostral/tooth structure in the Oregon and Baja dolphins closely matches those of putative "dalpiazinid" dolphins from the New Zealand Oligocene. The latter, however, are more derived in many cranial features, raising the possibility of homoplasy in the feeding apparatus. New Zealand assemblages have not yet produced Late Oligocene dolphins of archaic grade comparable to those that dominate assemblages from the northeast Pacific.

Technical Session XV (Saturday, October 20, 10:15 am)

A NEW TAXON OF IGUANODONTOID DINOSAUR FROM THE KIRKWOOD FORMATION (VALANGINIAN) OF SOUTH AFRICA BASED ON AN ASSEMBLAGE OF JUVENILE SPECIMENS

FORSTER, Catherine A., The George Washington University, Washington, DC, United States; POOLE, Karen E., The George Washington University, Washington, DC, United States; DE KLERK, William J., Rhodes University and Albany Museum, Grahamstown, South Africa; CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa; ROBERTS, Eric M., James Cook University, Townsville, Australia

A new taxon of iguanodontoid dinosaur from the Early Cretaceous (Valanginian) Kirkwood Formation, Eastern Cape Province, South Africa, is represented by the disarticulated remains of numerous immature individuals from a single site. Based on non-overlapping parts of left femora, the most numerous element in our sample, at least 27 individuals are present. Complete femora range in length from 18.4 mm to 54.7 mm (n=12), which histological studies demonstrate to be recent hatchlings to young, rapidly growing juveniles lacking secondary osteons. Despite our scattered and disarticulated sample, nearly every element of the skeleton and skull is represented.

All specimens were recovered from a 30 cm thick zone within an upward-coarsening reddish brown, mottled, clay-rich paleosol in a localized area approximately 14 m^2. The bone-bearing paleosol is overlain by a sandy crevasse-splay deposit suggesting it developed on a flood plain. There is no preferred orientation of elements and only four instances of articulation between elements were noted during excavation and preparation despite the collection of well over 200 individual elements. Although many elements are complete, others exhibit pre-burial breakage and crushing. Immature iguanodontoid elements comprise 96% of all remains at the site; rare turtle shell fragments, fish bones, a sphenodontian braincase, elements from a sub-adult iguanodontoid, and crocodile, theropod, sauropod, and stegosaur teeth also occur. These factors suggest that the site may represent seasonal attrition at or near a nesting area.

A phylogenetic analysis places the new Kirkwood taxon within the Iguanodontoidea, along with *Iguanodon*, *Mantellisaurus*, *Jinzhousaurus*, and others. Characters supporting its inclusion in this clade are marginal denticles of the teeth with mammillated edges and hatchet shaped sternal plates. Although all confirmed specimens of the Kirkwood iguanodontoid are immature, these characters are not known to change through ontogeny, lending confidence to its placement within Iguanodontoidea. This is the first confirmed, well-represented iguanodontoid from sub-Saharan Africa.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PLEISTOCENE CROCODYLIANS FROM VENEZUELA, AND THE DESCRIPTION OF A NEW SPECIES OF CAIMAN

FORTIER, Daniel C., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; RINCÓN, Ascanio D., Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela

The fossil record of post-Miocene caimans is sparse and fragmentary, but caimans have been recovered in many localities all over South America. Here, we present the first crocodylian remains from the Pleistocene of Venezuela, found in the asphalt deposits of El Breal de Orocual, which is a high diverse mammalian fossil locality. Most of the fossil crocodylians found in this locality are undiagnostic fragments. However, some of them could be either associated to indeterminate Caimaninae of *Caiman* sp. The most important material represents a new taxon which is described on the basis of fragmentary but diagnostic remains. The species is unique among caiman species by the possession of a premaxilla that is twice as long than it is wide in ventral view, with a long contact between the premaxillae posterior to the incisive foramen. The El Breal de Orocual is one the most diverse localities in South America, and is probably the most important crocodylian bearing locality from the continent during the Pleistocene.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

3D FINITE ELEMENT ANALYSIS OF A CAPITOSAURIAN SKULL (TEMNOSPONDYLI) FROM THE TRIASSIC OF MADAGASCAR

FORTUNY, Josep, Institut Català de Paleontologia, Cerdanyola del Valles, Spain; MARCÉ-NOGUÉ, Jordi, Universitat Politecnica de Catalunya, Terrassa, Spain; STEYER, J. S., Muséum national d'Histoire naturelle, Paris, France

Capitosaurians are Triassic temnospondyl amphibians characterized by large, parabolic and heavy skulls as well as extensive pectoral girdles. They exhibit aquatic features such as flattened skulls, decreased bone ossification, and lateral line canals. Cosmopolitan in distribution, these amphibious top-predators haunted the brackish, fluvial, and sometimes coastal ecosystems. They are usually compared with crocodilians because they seem to capture prey by direct bite using active swimming, but their precise feeding ecology remains poorly known. To start to solve this problem, we analyzed the skull of *Edingerella madagascariensis,* a basal capitosaurian from the marine Olenekian (Early Triassic) of Madagascar, using 3D Finite Element Analysis (FEA). A CT scan of an exquisite adult skull resulted in a 3D model. We analyzed this model under three different biting simulations (bilateral, unilateral and lateral cases). Previous works testing 2D FEA on capitosaurs suggested that the skull of *E. madagascariensis* is one of the weakest among capitosaurians during feeding. Our 3D analyses reveals that the skull roof displays an important amount of stress near the circumborbital region and the otic notch area during biting. In the palate, the stress is considerable on the parasphenoid and pterygoid whereas the cultriform process shows low stress during biting. The stress also increases in the vomerine plate during unilateral biting. These results are interesting because they are similar with those obtained from archosaurian skulls in which the secondary palate provides lower stress values. This stress is especially important during unilateral bite. We therefore interpret that this unilateral type of bite was not optimal for taxa without secondary palates, such as temnospondyls.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

CRANIAL MORPHOMETRICS, DISPARITY AND EVOLUTIONARY HISTORY OF PTEROSAURIA (DIAPSIDA: ARCHOSAURIA)

FOTH, Christian, Bayerische Staatssammlung für Paläontologie und Geoloigie, Munich, Germany; BRUSATTE, Stephen L., American Museum of Natural History, New York, NY, United States; BUTLER, Richard J, Ludwig-Maximilians-Universität München, Munich, Germany

Pterosaurs, the Mesozoic flying reptiles, are an intensively investigated clade that were morphologically, ecologically and taxonomically highly diverse during their >145 million year evolutionary history. Substantial research has focused on the establishment of long-term patterns and trends in pterosaur diversification, and the timing of peak pterosaur morphological diversity (disparity). Here, we use landmark-based geometric morphometrics to characterise broadscale patterns of cranial morphological diversity for 31 taxa of pterosaurs. This approach allows us to quantify the principal ways in which pterosaur skulls differ and determine major evolutionary changes in cranial morphology. The majority of cranial shape variation is summarised by the first two PC axes, which together describe over 65% of total variance. The first PC axis describes the relative length of the snout, the relative size of the orbit and postorbital region, the size and dorsoventral depth of the naris–antorbital fenestra region and the position of the jaw joint relative to the orbit. The second PC axis describes the relative position of the orbit, the depth of the anterior part of the skull roof posterodorsal to the orbit and the position of the jaw joint relative to the orbit along the dorsoventral axis. In order to assess the relationship between phylogenetic relationships and cranial morphology, we mapped phylogeny into cranial morphospace, recovering a significant phylogenetic signal. Measurements of cranial morphological disparity suggest that monofenestratan pterosaurs were more anatomically diverse than non-monofenestratan pterosaurs (at least when the aberrant anurognathids are excluded). Moreover, peak cranial disparity may have occurred in the Early Cretaceous, relatively late in pterosaur evolution. We recognize broad congruence between our results from cranial disparity analyses and disparity measures from analyses based on whole skeleton discrete character and limb proportion datasets. This congruence suggests that these different approaches might document a consistent pattern of pterosaur morphological evolution. Therefore, pterosaurs provide an exemplar case showing that different proxies for morphological form converge on the same disparity signal. This result is encouraging, because often only one such proxy is available for extinct clades represented by fossils.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

HOW TO EAT A *TRICERATOPS*: LARGE SAMPLE OF TOOTHMARKS PROVIDES NEW INSIGHT INTO THE FEEDING BEHAVIOR OF *TYRANNOSAURUS*

FOWLER, Denver W., Museum of the Rockies, Montana State University, Bozeman, MT, United States; SCANNELLA, John B., Museum of the Rockies, Montana State University, Bozeman, MT, United States; GOODWIN, Mark B., University of California Museum of Paleontology, Berkeley, CA, United States; HORNER, John R., Museum of the Rockies, Montana State University, Bozeman, MT, United States

Tooth-marked bone, created by the feeding behavior of carnivorous dinosaurs, provides direct evidence of ecological interactions between predator and prey. However, examples are typically limited to small sample sizes, restricting behavioral inferences for specific taxa. In this study, we present one of the largest samples (n=14) linking a single carnivore, *Tyrannosaurus* (Tyrannosauridae), with a prey taxon, *Triceratops* (Ceratopsidae), revealing consistent patterns of carcass processing. Approximately 100 *Triceratops* specimens have been collected from the late Maastrichtian of Montana as part of the multi-institutional Hell Creek Formation Project (1999–2011). From this, toothmarks were identified on eight individuals of *Triceratops*, with possible toothmarks on an additional six individuals. With the exception of one ilium, all tooth-marked elements are from partially to fully disarticulated complete or partial skulls. Although the total sample includes many *Triceratops* collected from sandstones, all tooth-marked elements are derived from mudstones. In the absence of any signs of healing, all toothmarks presumably formed during post-mortem carcass processing.

Specimens exhibit a suite of puncture, bite-and-drag, and drag marks, which in combination with tooth-spacing patterns are similar to traces previously attributed to tyrannosaurid theropods. This supports our assignment of these scars to *Tyrannosaurus,* the only accepted tyrannosaurid from the Hell Creek Formation. Two unassociated juvenile squamosals exhibit extensive punctures up to 2 cm wide, and bite-and-drag marks up to 10 cm long. An associated young subadult juvenile squamosal and parietal show multiple parallel drag marks. These might be unexpected as the parietosquamosal frill would have been mostly bone and keratin, yielding little edible flesh. However, the marks may have been formed as the *Tyrannosaurus* attempted to move the frill to access the generous neck muscles connected to the skull. This would be consistent with deep parallel gouge marks observed on two occipital condyles, one associated with a punctured braincase. By contrast, 3–4 short, parallel drag marks on an unassociated nasal and premaxilla are more consistent with delicate and precise bites from the incisiform premaxillary arcade.

The laterally thickened teeth of adult tyrannosaurids appear well-suited for resisting lateral stresses, which may have enhanced their ability to dismember carcasses. Relatively older *Tyrannosaurus* individuals may have employed different feeding strategies than younger individuals as their tooth morphology thickened with a concurrent reduction in total tooth count in the dentary.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PALEOECOLOGICAL AND PALEOENVIRONMENTAL RECONSTRUCTIONS OF LATE QUATERNARY MAMMALIAN FAUNAS FROM EASTERN WYOMING AND COLORADO

FOX-DOBBS, Kena, University of Puget Sound, Tacoma, WA, United States; LIGHTNER, Erik, University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States

We report carbon and nitrogen stable isotope records from four late Pleistocene and early Holocene sites in southern Wyoming and northern Colorado. Specifically, we analyzed bone collagen from Animal Trap, Bell, Horned Owl, and Little Box Elder Caves (approximately 20 taxa, including 10 carnivores). These sites have yielded thousands of specimens, and present a unique opportunity to investigate paleoecological and paleoenvironmental conditions along the eastern edge of the Laramie Basin. The goal of this work is three part; establish a general model of trophic and niche structure at each site, identify isotopic differences among sites, and compare paleoecological patterns within these new datasets and with published records from Little Box Elder Cave (bioapatite) and Natural Trap Cave (bioapatite and collagen).

Horned Owl, Bell, and Little Box Elder Caves are all located in the northern region of the Laramie Basin, and we combined data from these sites into a 'northern' dataset. There was a systematic offset in carbon isotope values between the northern and southern (Animal Trap Cave) sites that likely is due to differences in vegetation and climate. Once we were able to account for this offset, we found remarkably consistent patterns of trophic structure and niche separation at each site. We were able to identify potential predator-prey interactions, among several size classes of mammals (e.g. marmot and fox, and wolf and bison). Interestingly, we found evidence for high proportions of C4 grass in the diet of bison at the southern site, and large-bodied predators (lion and wolf) at both the northern and southern sites. This may reflect temporal changes in C4 grass abundance, or movement to areas with higher C4 grass abundance outside the Laramie Basin.

Technical Session VIII (Thursday, October 18, 3:45 pm)

WARMER CLIMATES WEAKEN BIOTIC LATITUDINAL GRADIENTS

FRASER, Danielle, Carleton University, Ottawa, ON, Canada; HASSALL, Christopher, Carleton University, Ottawa, ON, Canada; GORELICK, Root, Carleton University, Ottawa, ON, Canada; RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada

Ecological studies on short timescales (<100 years) demonstrate dramatic range shifts, retractions, and expansions for many groups of terrestrial animals in response to modern global warming. On longer timescales, disproportionate increases in high latitude productivity may enable larger numbers of taxa to persist farther north either through increasing speciation or decreasing extinction. We hypothesize that such polar amplification on a geologic timescale acts to weaken biotic latitudinal gradients. We also expect the opposite during global cooling; biotic latitudinal gradients should be steeper. We tested this hypothesis by comparing latitudinal trends in hoofed mammal diversity between the mid (warm, Arctic sea ice likely absent; ~15 Ma) and late (cool, perennial Arctic sea ice present; ~7 Ma) Miocene. We created occurrence matrices and used detrended correspondence analysis (DCA) as well as non-metric multidimensional scaling (NMDS) to test for taxonomic turnover with latitude and longitude. To compare the strength of mid and late

Miocene taxonomic gradients to modern communities, we also created locality data by randomly sampling the geographic ranges of all extant North American mammals. Mid Miocene taxonomic turnover was not well explained by latitude and longitude due to high primary productivity and the absence of Arctic sea ice. In contrast, late Miocene community composition varied strongly with both latitude and longitude as a result of lower productivity and the formation of perennial Arctic ice. Finally, we found that modern latitudinal and longitudinal biotic gradients are uniformly stronger than for the Miocene, supporting our hypothesis. The current presence of a strong latitudinal biotic gradient is the result of our relatively cool climate, and the associated steep latitudinal climate gradient. Given the rate of current warming, however, we can expect dramatic changes to high latitude faunas and the alteration of faunal patterns as we know them today.

Technical Session XIV (Saturday, October 20, 10:30 am)

A LONG-SNOUTED PROTOROSAURIAN FROM THE MIDDLE TRIASSIC OF SOUTHERN CHINA

FRASER, Nicholas C., National Museums Scotland, Edinburgh, United Kingdom; LI, Chun, Institute of Vertebrate Palaeontology and Palaeoanthropology, Beijing, China; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States

The "Xingyi fauna" of southwestern Guizhou and eastern Yunnan Provinces, China is characterized by a remarkable diversity of Middle Triassic (Ladinian or earliest Carnian) marine reptiles and fishes. These include the protorosaur genera *Tanystropheus* and *Macrocnemus*, both of which are known also from Alpine Europe. We describe a new protorosaur on the basis of a single specimen from Guizhou Province. It is somewhat unusual among protorosaurians in possessing a markedly elongate snout. Like the tanystropheids, *Tanystropheus* and *Tanytrachelos*, it has a neck with 13 cervicals and, while the neck is longer than the trunk, it does not show the extreme neck elongation of *Tanystropheus* and the cervical ribs do not extend across more than two intervertebral joints. The nature of the neck is therefore intermediate between the condition of *Tanystropheus* and *Tanytrachelos*. More significantly, the new form lacks a definitive thyroid fenestra. A re-examination of a fourth protorosaurian taxon, the bizarre long-necked *Dinocephalosaurus* from the Anisian of Guizhou Province, suggests that it too may have lacked a thyroid fenestra. The new form potentially adds to the growing diversity and disparity of protorosaurian taxa from the Middle Triassic of southern China. On the other hand it also casts some doubt on the diagnosis and constitution of the protorosaurs.

Poster Session I (Wednesday, October 17, 4:15 – 6:15 pm)

CRANIAL DEVEOPMENT OF *CENTROSAURUS APERTUS*: UNDERSTANDING HORN VARIATION AND EVOLUTION THROUGH AN ONTOGENETIC APPROACH

FREDERICKSON, Joseph A., Temple University, Philadelphia, PA, United States

Centrosaurus apertus, a large bodied ceratopsid from the Late Cretaceous of North America, is one of the most common fossils recovered from the Belly River Group. The known fossil record for this animal includes complete specimens, dozens of partial to complete skulls, and hundreds of isolated bones, which are derived from mass death assemblages found in the Dinosaur Park Formation of Alberta, Canada. This fossil record demonstrates a wide diversity in morphology and size, with specimens ranging from putative juveniles to fully-grown individuals. The goal of this study was to reconstruct the ontogenetic changes that occur in the skull of *C. apertus* through a quantitative cladistic analysis. Once all ontogenetic changes were ordered other sources of variation (sexual dimorphism or individual variation) could be determined. Eight nearly complete cranial specimens were coded for 53 hypothetical growth characters. The analysis was executed as an exhaustive search with all characters unordered and equally weighted. The results were a single most parsimonious tree of 74 steps. The resulting tree ordered specimens with the hypothetically least mature individuals near the base and progressively more mature specimens moving up the tree. The arrangement of specimens demonstrates no apparent pattern to horn growth on the parietal; relatively less mature specimens may have larger parietal processes than relatively more mature individuals. Conversely, the nasal horn shows a progression where the least mature individuals possess a recurved nasal horn, more mature individuals have a straight nasal horn, and the most mature individuals have a procurved nasal horn. The development of the nasal horn may represent a heterochronic shift from the basal straight horned condition to the derived procurved condition.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

OSTEOPATHY IN HADROSAURINES (DINOSAURIA: ORNITHISCHIA) OF THE JUDITH RIVER FORMATION (CAMPANIAN) OF NORTHCENTRAL MONTANA

FREEDMAN, Elizabeth A., Museum of the Rockies, Montana State University, Bozeman, MT, United States; TANKE, Darren H., Royal Tyrrell Museum of Paleontology, Drumheller, AB, Canada; WOLFF, Ewan D., Dept of Medical Sciences, University of Wisconsin School of Veterinary Medicine, Madison, WI, United States

Hadrosaurid dinosaurs suffered from a variety of trauma or infectious/inflammatory-based pathologies, as evidenced by two hadrosaurine specimens from the Judith River Formation of northcentral Montana. The first specimen, a member of Brachylophosaurini, possesses abnormalities in both dentaries and four caudal vertebrae. The dentaries have oval lesions surrounded by raised rings of remodeled bone. The right dentary has two lesions on its caudolateral surface superficial to the surangular articulation. The left dentary lesion is on the midventral surface. Although the exostoses resemble periosteal reactive areas, the erosive lesions indicate an infectious or inflammatory origin such as a granuloma, abscess, or viral plaque. Bacterial or parasitic infections can produce abscesses with a proliferative rim in extant archosaurs. In tyrannosaurid jaws, such lesions often perforate the bone; therefore, these hadrosaur lesions are at an earlier stage of infection. Four mid-caudal vertebrae exhibit lesions with fracture and healing that angled the distal tips of the neural spines laterally leftward. The first two neural spines have calluses with indentations that may represent osteomyelitis, displacement of fracture fragments, or blood supply to the remodeling bone. The third and fourth neural spines are less affected, with minor remodeling where they angle laterally. These neural spines may not have been fractured, instead remodeling due to pull of tendons in the affected tail region. The second specimen, a partial hadrosaurine, includes an articulated distal caudal series. Two vertebral centra are greatly expanded across their articular faces and fused ventrally by proliferative bone forming a spondyloarthropathy that extends dorsally to cover the lateral centra, but does not extend into their articular faces; neural arches are unaffected. Intervertebral distance is reduced. Articular faces between the two pathologic centra display normal bone texture, but posses an interlocking hook-and-socket structure that joins the centra without endplate fusion. Absence of a fracture restricts the differential diagnosis to mechanical stress-induced fusion or inflammation due to infection. A degenerative disorder induced by mechanical stress, such as spondylosis deformans, is consistent with the ventral exostosis. However, extent of the exostosis and endplate remodeling is more consistent with diskospondylitis resulting from infection. Similar infection-derived exterior and endplate exostoses occur in *Alligator* and *Varanus*. Although osteopathy of hadrosaur neural spines has been commonly noted, pathologic centra are less well sampled. A global census of hadrosaur osteopathy is encouraged, to elucidate patterns in incidence rates and causes in populations over time.

Technical Session II (Wednesday, October 17, 11:45 am)

THE GEOLOGICAL AGE AND BIOGEOGRAPHY OF CICHLID FISHES: SETTING THE (FOSSIL) RECORD STRAIGHT

FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom

Cichlids represent an important model system in many areas of biological research, but considerable controversy surrounds their deep evolutionary history and large-scale biogeographic patterns. Living cichlids are widely distributed in freshwater habitats across southern landmasses exclusive of Australia and Antarctica, and their pattern of evolutionary divergences matches area cladograms for the fragmentation of the Mesozoic supercontinent Gondwana. The earliest cichlid fossils are Cenozoic in age and substantially postdate the mid-Mesozoic onset of Gondwanan breakup, but paleontological evidence has been used to argue both for and against the hypothesis of drift-based vicariance. This ambiguity stems from uncertainty about the reliability of the fossil record of cichlids specifically and teleosts more generally. In order to constrain this uncertainty, two contrasting approaches to estimating plausible times of evolutionary origin were applied to the fossil record of cichlids. The first method uses the distribution of cichlid-bearing fossil horizons plus a function describing fossil recovery potential, while the second draws on the sequence of stratigraphically consistent outgroups to cichlids. Despite considering different paleontological data, both approaches yield similar estimated times for the evolutionary origin of cichlid fishes. The distribution of fossil cichlid horizons implies an age of origin between 83.1 and 55.8 Ma (Campanian-Thanetian), depending on whether analyses included all cichlid fossils or were restricted to articulated material alone. Even when secular variation in available fish-bearing fossil horizons is considered, preservation potential of cichlids must have been approximately one to two orders of magnitude lower in the Cretaceous than during their sampled history in order for the Gondwanan vicarance to be plausible. Analysis of the ages of the oldest fossil representatives of cichlid outgroups yields similar age estimates for the clade. The divergence of cichlids is estimated between 87.8 and 56.3 Ma (Coniacian-Thanetian) depending on the hypothesis of outgroup relationships. These results strongly contradict the temporal predictions of the Gondwanan vicariance model of cichlid biogeography, and imply a role for dispersal in generating the modern geographical pattern of cichlid distribution. These results contribute to the broader debate on biotic connections between Africa and South America, with a growing body of evidence suggesting the migration of many groups with limited potential for oceanic dispersal from the latter continent to the former in the Paleogene.

Technical Session XVI (Saturday, October 20, 10:15 am)

TEMPO AND MODE OF ECOMORPHOLOGICAL DIVERSIFICATION IN CARNIVORA

FRISCIA, Anthony R., University of California - Los Angeles, Los Angeles, CA, United States; SLATER, Graham J., University of California - Los Angeles, Los Angeles, CA, United States

Carnivora (mammalian carnivores) are often used as a model group for evolutionary analyses because of both their taxonomic and ecological diversity. Recent studies have made excellent phylogenetic data freely available for both living and fossil taxa. We constructed a time-calibrated molecular phylogeny of Carnivora and used an ecomorphological dataset to examine rates of phenotypic diversification throughout the history of this group. The data show an early burst of evolution along the first ecomorphological axis, associated with degree of carnivory, early in the history of Carnivora, as families divided up this ecomorphological space. This is especially true at the extremes, with both felids and ursids moving to occupy the hyper- and hypocarnivorous (respectively) niches quickly, and staying in those areas of ecospace. Along subsequent ecomorphological axes, dealing mainly

with prey size and hardness, we find evidence for accelerating rates of ecomorphological evolution, indicative of late diversification within clades. Integration of fossil taxa into our phylogenetic model fitting strengthened our analyses and highlights Carnivora as a prime example of a Simpsonian adaptive radiation, with early diversification into major ecological roles, and later diversification within those roles.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MORPHOMETRIC ANALYSIS OF INTRACOLUMNAR AND INTRASPECIFIC VARIATION IN CERVICAL VERTEBRAE OF THE GREAT BLUE HERON *(ARDEA HERODIAS)*: IMPLICATIONS FOR PHYLOGENETIC CHARACTER SELECTION IN SAUROPOD DINOSAURS

FRONIMOS, John A., University of Michigan, Ann Arbor, MI, United States

The large number of distinct characters observable in sauropod vertebrae, combined with their great variability, has made these elements important to the interpretation of evolutionary relationships within the group, and many taxonomic proposals have been based upon the similarity or dissimilarity between the vertebrae of the taxa concerned. Determining whether vertebral characters are diagnostic above the species level requires understanding the extent of intracolumnar, ontogenetic, and intraspecific variability, as well as asymmetry associated with pneumatic features. As a consequence, the extent to which the character states of vertebrae, especially those of isolated specimens, can be used to identify species or more inclusive taxa depends on a number of factors that are not always well described or even known for a given taxon. Investigating the relative contributions of these factors can be facilitated by the use of extant taxa for which species identifications are well-established, material is abundantly available, issues of incompleteness, damage, and distortion are avoided, and interspecific as well intraspecific comparisons can be more easily performed. A morphometric analysis was conducted on cervical vertebrae from great blue herons (*Ardea herodias*), which share with sauropods hyper-elongation of the neck and complex, pneumatic vertebrae. The analysis reveals a high degree of within-series variation in great blue herons, with much of the shape change occurring over short spans between regions of comparatively consistent morphology. Considerable shape variation exists between individuals but is insufficient to obscure intracolumnar trends. Asymmetry of pneumatic features on the centrum and neural arch and of the length of cervical ribs is widespread. Characters prone to asymmetric development, such as pneumatic foramina and fossae, are more likely to be informative in their presence or absence throughout the column than in local variations in presence and position, for which developmental noise may overwhelm the phylogenetic signal.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW TOMISTOMINE FROM THE OSAKA GROUP IN KISHIWADA CITY, OSAKA PREFECTURE, JAPAN

FURUI, Sora, Natural History Sciences, Hokkaido University, Sapporo, Hokkaido, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; CHIBA, Kentaro, Natural History Sciences, Hokkaido University, Sapporo, Hokkaido, Japan

A partial skeleton of a crocodylian, the Kishiwada tomistomine, was found from the sediments near the lower boundary of Ma5 (approximately 0.6 Ma) of the Osaka Group in Kishiwada City of Osaka Prefecture in 1994. A brief preliminary study suggested that the Kishiwada tomistomine pertained to *Toyotamaphimeia machikanensis*, known from a younger horizon (0.4 Ma) of the same group in Osaka Prefecture. Detailed comparison of these two specimens shows that the Kishiwada tomistomine differs in: a more slender snout, wide postorbital region of the skull, circular supratemporal fenestra, anteriorly concave frontoparietal suture, a distinct foramen on the ventral surface of quadrate, and a small foramen on the ventral surface of the quadratojugal. The difference in these characters implies that the Kishiwada tomistomine is not *Toyotamaphimeia machikanensis*. The Kishiwada specimen belongs to Tomistominae because it has a deep splenial symphysis and the anterior portion of the splenial is narrow and V-shaped. Its phylogenetic position within Tomistominae is not resolved yet because of its poor preservation; however, it is probably a new taxon because it shows some unique features (foramina on the ventral surface of the quadrate and quadratojugal). In addition to the Kishiwada tomistomine and *Toyotamaphimeia machikanensis* from the Osaka Group, there are at least two more tomistomines known from Japan (more than 14 individuals from Pleistocene cave deposits in Shizuoka Prefecture and a skull from Oligocene marine deposits in Fukuoka Prefecture), suggesting that tomistomines had dispersed to Japan by Oligocene and were abundant in Japan especially during the Pleistocene.

Technical Session II (Wednesday, October 17, 8:00 am)

THE ORIGIN OF THE VERTEBRATE JAW: INTERSECTION BETWEEN DEVELOPMENTAL BIOLOGY-BASED MODEL AND FOSSIL EVIDENCE

GAI, Zhikun, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ZHU, Min, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

The origin of the vertebrate jaw has been reviewed based on the molecular, developmental and paleontological evidence. Advances in developmental genetics have accumulated that propose the heterotopy theory of jaw evolution, i.e., the jaw evolved as a novelty through a heterotopic shift of mesenchyme-epithelial interaction. According to this theory, the disassociation of the nasohypophyseal complex is a fundamental prerequisite for the origin of the jaw, since the median position of the nasohypophyseal placode in cyclostome head development precludes the forward growth of the neural-crest-derived craniofacial ectomesenchyme. The potential impact of this disassociation on the origin of diplorhiny is also discussed from molecular perspectives.

Thus far, our study of the cranial anatomy of galeaspids, a 435–370-million-year-old 'ostracoderm' group from China and northern Vietnam, has provided the earliest fossil evidence for the disassociation of nasohypophyseal complex in vertebrate phylogeny. Using Synchrotron Radiation X-ray Tomography, we further show some derivative structures of the trabeculae (e.g. orbitonasal lamina, ethmoid plate) in jawless galeaspids, which provide new insights into the reorganization of the vertebrate head before the evolutionary origin of the jaw. These anatomical observations based on new techniques highlight the possibility that galeaspids are, in many respects, a better proxy than osteostracans for reconstructing the pre-gnathostome condition of the rostral part of the braincase. The cranial anatomy of galeaspids reveals a number of derived characters uniquely shared with gnathostomes. This raises the potential possibility that galeaspids might be the closest jawless relatives of jawed vertebrates. Our study provides an intriguing example of intersection between developmental biology-based hypothesis and fossil evidence.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:45 am)

COMPARATIVE TAPHONOMY OF LATE CRETACEOUS VERTEBRATE FOSSIL OCCURRENCES IN THE ATLANTIC COASTAL PLAIN DEPOSITS OF APPALACHIA: TESTING THE HYPOTHESIS OF MASS MORTALITY AT THE K/PG BOUNDARY

GALLAGHER, William, Rider University, Lawrenceville, NJ, United States

Comparisons between the mode of vertebrate preservation in stratigraphic units of Late Cretaceous age were conducted to test the hypothesis that the basal Hornerstown Formation vertebrate fossil concentration in New Jersey is an entirely reworked assemblage. Bulk sampling, quadrat mapping, and museum collection censuses for sites in New Jersey and North Carolina show that vertebrate fossils commonly occur in one of several taphonomic modes in the Cretaceous sediments deposited on the eastern margin of Appalachia: 1) single partial skeletons, 2) one to several associated isolated bones; 3) single disarticulated elements (teeth, isolated bones) within well-defined fossil concentrations. Partial skeletons include *Hadrosaurus foulkii* in the Campanian Woodbury Formation, and *Dryptosaurus aquilunguis* and "*H. minor*" from the New Egypt Formation (Maastrichtian). Single to several bones are more typical of the Cretaceous transgressive deposits such as the Campanian Merchantville Formation, glauconitic Marshalltown Formation and Navesink Formation (Maastrichtian). Thin beds of vertebrate fossils are well known from several horizons in the Upper Cretaceous section, including the Ellisdale fauna, Phoebus Landing and nearby sites in Bladen County, NC, the Mount Laurel Formation, and the basal Hornerstown Formation fossiliferous layer. These fossil concentrations are mixtures of recycled and fresher single elements from terrestrial, estuarine and marine environments produced by physical transport. The exception is the basal Hornerstown fossil bed. This concentration contains partial and near-complete skeletons and is associated with an iridium excursion that shows extraterrestrial ratios of platinum group metals, remnant shocked quartz , and a K/Pg boundary age on the basis of dinoflagellate biozonation. Some taxa occur as single elements, associated or partial specimens (birds, sharks, mosasaurs), but other specimens (fishes, crocodylians, chelonians) represent the best examples of their species. Deposition in a sediment starved setting probably led to longer residence times on the sea floor for carcasses, and hence more time for biological modification of remains. Intense bioturbation contributed to disarticulation and settling of skeletons and smearing of geochemical indicators of bolide impact. The evidence supports the hypothesis that this unusual concentration of vertebrate remains indicates a protracted mass mortality event modified by bioturbation and biological activity at the K/Pg boundary.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW LATE CRETACEOUS MARINE VERTEBRATE ASSEMBLAGE FROM THE BASAL GREENHORN LIMESTONE IN SOUTHEASTERN COLORADO, U.S.A.

GALLARDO, Christopher, DePaul University, Chicago, IL, United States; SHIMADA, Kenshu, DePaul University, Chicago, IL, United States; SCHUMACHER, Bruce A., USDA Forest Service, La Junta, CO, United States

The Lincoln Limestone Member of the Greenhorn Limestone is an Upper Cretaceous rock unit largely consisting of calcareous shale interbedded with limestone and calcarenite beds that formed in the middle of an epicontinental sea in North America known as the Western Interior Seaway. Fossiliferous rock samples from the basal Lincoln Limestone were obtained from the Table Mesa locality (Baca County) in southeastern Colorado, USA. This layer formed sometime between 95 and 94.7 Ma (middle-late Middle Cenomanian), and its vertebrate contents have never before been examined. Vertebrate fossils were collected through acid treatment of rock samples and are curated in the Sternberg Museum of Natural History in Hays, Kansas, USA. Twenty-nine marine vertebrate taxa were identified including chondrichthyan and osteichthyan fishes and reptilian taxa. The chondrichthyans consist of 14 taxa, including *Ptychodus occidentalis*, *P. rhombodus*, *Cretoxyrhina mantelli*, *Archaeolamna* cf. *A. kopingensis*, *Megachasma comanchensis*, *Microcorax crassus*, *Squalicorax curvatus*, *Rhinobatos* cf. *R. incertus*, *Rajidae* incertae sedis, and *Cretomanta canadensis*. The most common chondrichthyan remains are teeth of *Squalicorax curvatus*,

followed by teeth of *Carcharias saskatchewanesis*. Osteichthyan fishes consist of 14 taxa, including *Micropycnodon kansasensis*, Pycnodontidae indet., *Protosphyraena* sp., *Eloposis* sp., *Pachyrhizodus minimus*, *Enchodus* cf. *E. gladiolus*, *Enchodus* cf. *E. shumardi*, and three additional unidentified teleosts. The most common identifiable osteichythyan fossils are teeth of *Enchodus* cf. *E. gladiolus*, followed by teeth of *Pachyrhizodus minimus*. Reptilian remains include two squamate taxa, *Coniasaurus crassidens* and an indeterminate terrestrial squamate, Scincomorpha indet. The taxonomic composition of the fauna broadly resembles previously described mid-Cenomanian localities in North America that further demonstrates the high taxonomic homogeneity of vertebrates in the Western Interior Seaway. Although the occurrence of terrestrial lizard is noteworthy, proportions of common taxa at the Table Mesa locality are particularly similar to another basal Lincoln Limestone locality situated about 100 km to the west where remains of bony fishes also dominate.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 8:30 am)

CHONDRICHTHYAN AND OSTEICHTHYAN MATERIAL FROM ELIZABETHTOWN, NC, AND BOWIE, MD, AND THE FISH FAUNA OF THE CAMPANIAN-MAASTRICHTIAN OF EASTERN NORTH AMERICA

GARCIA, William J., University of North Carolina Charlotte, Charlotte, NC, United States; HIPPENSTEEL, Scott P., University of North Carolina Charlotte, Charlotte, NC, United States

Material collected from the Late Cretaceous at the Bladen County Landfill Annex in Elizabethtown, NC and the Severn Formation of Bowie, MD (Maastrichtian) allows further description of the shallow marine fauna of the eastern seaboard during the Cretaceous, as well as comparison of this region to contemporaneous North American vertebrate localities such as those from the Western Interior Sea and Gulf Coast. *Scapanorhyncus texanus* and *Squalicorax kaupi* are the most common taxa at Elizabethtown, representing over half the specimens collected. This compares with published abundances from Phoebus Landing, NC where *S. texanus* was also the most common taxon, accounting for over 75% of the specimens collected; however, the relative abundance of *S. kaupi* at Phoebus Landing is not as high as at Elizabethtown. The Elizabethtown material contains a higher proportion of *Squalicorax pristodontus*, and a smaller proportion of ray material, than material previously reported from the locality. Notable osteichthyians from Elizabethtown include *Enchodus* sp., *Trichiurides* sp., and *Sphyaena* sp., which are present in small numbers. Material from Bowie, MD is dominated by *Cretolamna appendiculata, Squalicorax kaupi, Squalicorax pristodontis, Odontaspis* sp., and *Enchodus* sp. To test whether faunal differences between localities reflect biogeographic influence, cluster analysis and non-metric dimensional scaling of generic-level presence/absence data of selachians from 26 Late Cretaceous localities from the Western Interior Sea, Gulf Coast and Atlantic Coast was conducted. The results indicate affinities among Atlantic Coast faunas, specifically between faunas from New Jersey and North Carolina. Common Late Cretaceous genera such as *Squalicorax, Ischyrhiza* and *Odontaspis* are cosmopolitan across North America and have little utility at the generic level in discriminating regional differences. Differences between regions were more pronounced when the analyses were conducted using data at the species-level, although similarities between clusters are low overall. Abundance data from Atlantic Coast faunas indicates significant ecological differences between faunas, possibly reflecting differences in environment such as proximity to shore or water depth. The abundance of terrestrial material from Elizabethtown supports this explanation.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

VARIATIONS IN ECOMORPHOLOGICAL DIVERSITY OF SHARK TEETH FROM LATE CRETACEOUS THROUGH MODERN MARINE ECOSYSTEMS OF NORTH CAROLINA

GATES, Terry A., Ohio University, Athens, OH, United States

Marine sediments of North Carolina record a long history of vertebrate species ranging in age from Late Cretaceous through the modern. Shark teeth are some of the most common vertebrate fossils obtained from these sediments, and as such, offer the opportunity to study the ecomorphological diversity of this vertebrate group through time. Shark teeth accessioned at the North Carolina Museum of Natural Sciences, representing most of the known morphotypes (as documented by current taxonomic diversity) from the Cretaceous, Miocene, Pliocene, and Holocene deposits of that state, were subjected to ten measurements and discrete characters describing overall tooth form. The dataset was then subjected to Principal Components Analysis in order to show the approximate breadth of ecomorphological diversity within shark teeth from each time window. General taxonomic diversity trends depict increasing species richness through time with the Cretaceous beds producing only 17 species of sharks, whereas the Miocene, Pliocene, and modern yield 36, 28, and 56 species, respectively. Undoubtedly, disparate temporal sampling and variable taxonomic splitting plays some role in the observed taxonomic trends, but the data produced in this study demonstrate that ecological factors also were key. PCA results show that there is an ecomorphological subset that is largely conserved through the last 75 million years of North Carolina coastal ecosytems. Forms falling into this category include “tiger shark”-type teeth (e.g., *Squalicorax* and *Galeocerdo*) and long thin teeth with or without cusplets (cretolamnids). Tooth taxa pertaining to the latter morphotype are numerous through the study interval because of apparent clade-level turnover observed since the Cretaceous (that is, if current taxonomy of fossil sharks accurately reflects past diversity). Interestingly, shark teeth typified by long, wide central cusps with large denticles, such as seen within the genera *Carcarodon, Hemiprisits*, and *Charcharhinus*, are missing from the Cretaceous cohort, which possibly is a response to the presence of other large predatory vertebrates such as mosasaurs, plesiosaurs, and the actinopterygian fish *Xiphactinus* living in the same estuary/marine ecosystem, or alternatively a lack of prey items that required such cutting dentitions. Indeed, the Cretaceous shark fauna is overwhelming dominated by tearing-type dentition. A tooth size increase was observed from the Eocene to the Pliocene deposits, culminating in the giant *C. megalodon*, again as a possible response to larger and more diverse prey items (e.g.., cetaceans).

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A BIPLANAR X-RAY METHOD FOR 3-D ANALYSIS OF TRACK FORMATION

GATESY, Stephen M., Brown University, Providence, RI, United States; ELLIS, Richard, University of Colorado, Boulder, CO, United States

Tracks arise through a complex interplay between animal and substrate. Studying this dynamic process is challenging because most foot-sediment and sediment-sediment interactions are rapid and hidden from view. We sought to resolve a fundamental question in ichnology: how do sedimentary particles move from their starting locations in untrod ground to their ultimate resting places? Herein, we describe a new method for recording and quantifying the 3-D movements of a morphologically realistic indenter and sedimentary markers during track formation. Our method uses two (biplanar) x-ray systems and an animation-based workflow to reconstruct the trajectories of metal beads seeded throughout the sediment volume. X-rays allow sub-surface motion normally concealed by the foot and opaque matrix to be analyzed at sub-millimeter resolution. Video frequencies of 30 Hz and higher reveal temporal dynamics inaccessible by destructive methods, which provide only single snapshots of the track creation. Results from two case studies of tridactyl tracks in semi-liquid mud provide novel, animated visualizations of ensemble and particle-specific data. A biplanar x-ray approach has the potential to: mechanistically link specific track features to foot movement, clarify undertrack formation, validate computational models, and set a new standard for evidence-based reconstruction of locomotion from fossil footprints.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

PREMAXILLAE OF EXTINCT ANTILLEAN MEGALONYCHID SLOTHS *ACRATOCNUS* AND *NEOCNUS* AND A POTENTIAL NEW SYNAPOMORPHY FOR MEGALONYCHIDAE (XENARTHRA, MAMMMALIA)

GAUDIN, Timothy J., University of Tennessee at Chattanooga, Chattanooga, TN, United States

The sloth family Megalonychidae includes an endemic radiation of small to large bodied taxa from the islands of the Greater Antilles. Though the radiation dates at least to the Miocene, the best known taxa derive from Pleistocene to Holocene cave deposits in Puerto Rico, Hispaniola and Cuba, and include the relatively small bodied, semiarboreal genera *Neocnus* and *Acratocnus*. The skeletal material from these taxa are often spectacularly well-preserved. Nevertheless, in sloths the premaxilla is typically only loosely sutured to the skull, and is often missing even in otherwise perfectly preserved specimens. Despite numerous published descriptions of well-reserved crania, the premaxilla has never been described in either genus. Unrecognized, isolated premaxillae were found in the extensive collections of *Neocnus* and *Acratocnus* housed at the Florida Museum of Natural History and the American Museum of Natural History, respectively. The premaxilla of *Neocnus* is triangular, roughly resembling that of the extant megalonychid *Choloepus*, but its lateral ramus is much broader mediolaterally. The premaxilla of *Acratocnus* has an even broader lateral ramus, with a markedly wider medial ramus as well, and an anterior midline notch not present in either *Neocnus* or *Choloepus*. When compared to known premaxillae of the Santacrucian megalonychid *Eucholoeops* and the Pleistocene North American taxon *Megalonyx,* it would appear that a broadened, plate-like premaxilla may constitute a synapomorphy for the entire clade Megalonychidae. Furthermore, *Eucholoeops* retains a short anterior process of the premaxilla like that of other megatherioid sloths. This process is lacking in the other megalonychids, suggesting loss of the process may unite late Miocene – Recent megalonychids, in keeping with recent phylogenetic hypotheses.

Technical Sesssion XII (Friday, October 19, 3:00 pm)

ASSEMBLING THE SQUAMATE TREE OF LIFE: PERSPECTIVES FROM THE PHENOTYPE AND THE FOSSIL RECORD

GAUTHIER, Jacques A., Yale University, New Haven , CT, United States; KEARNEY, Maureen, National Science Foundation, Arlington, VA, United States; MAISANO, Jessica A., The University of Texas, Austin, Austin, TX, United States; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States

We assembled a dataset consisting of 192 carefully selected species (51 extinct and 141 extant) and 976 apomorphies distributed among 610 phenotypic characters to investigate the phylogeny of Squamata (= “lizards”, including snakes and amphisbaenians). These data enabled us to infer a tree much like those derived from previous morphological analyses, but with better support for some key clades. There are also a number of novel elements, some of which pose striking departures from historical ideas about lizard evolution (e.g., that mosasaurs and polyglyphanodontians are on the scleroglossan stem, rather than being parts of the crown, and related to varanoids and teiids, respectively). Long-bodied and limb-reduced taxa such as snakes and ‘snake-like’ fossorial lizards (most notably dibamids, amphisbaenians) have been and continue to be the chief source of character conflict in squamate morphological phylogenetics. Carnivorous lizards (especially snakes, mosasaurs

and varanoids) have proven a close second. Genetic data, presumably less burdened by the potential for adaptive convergence related to fossoriality, were expected to resolve these conflicts. Although recent gene phylogenies appear to do so, they also differ radically from any phylogeny based on the phenotype, especially for the most ancient crown-squamate divergences that occurred during the latter half of the Mesozoic. This result was all the more surprising as we anticipated that heavily burdened phenotypic characters and intermediate fossils would be especially useful for insights into deep-time phylogenetic events. Our study relied upon traditionally-prepared specimens as well as high resolution CT scans that afforded unprecedented access to the cranial anatomy of Squamata. This, along with the inclusion of stem fossils, provided an unparalleled sample of the phenotype enabling us to more fully explore the extreme incongruences between molecular and morphological topologies for the squamate Tree of Life. Despite this extensive new database, we were unable to find morphological support for the major rearrangement of the deep divergences in Squamata proposed by recent molecular studies. Instead, our data strongly support the same fundamental topology suggested by most previous morphological studies (an Iguania-Scleroglossa basal split, a sister-group relationship between Gekkota and Autarchoglossa, and the divergence between Anguimorpha and Scincomorpha) and documents the extreme degree of morphological homoplasy required by those molecular topologies.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DOES THE EARLY JURASSIC KAYENTA FORMATION PRESERVE MORE THAN ONE SPECIES OF SCUTELLOSAURUS?

GAY, Robert, Mission Heights Preparatory High School, Casa Grande, AZ, United States

The Lower Jurassic Kayenta Formation preserves a wide variety of armored archosaurs. These include several crocodylomorphs, as well as the ornithischian dinosaurs *Scelidosaurus* and *Scutellosaurus*. These genera have traditionally been considered monotypic. Considering that the Kayenta Formation is usually dated to the Sinemurian-Pliensbachian stages of the Jurassic, representing approximately three million years of evolutionary time, it should not be surprising if the monotypic view of the fossil record is not reflective of the actual paleobiology of the Early Jurassic Period in the American Southwest.

An examination of specimens of *Scutellosaurus* at the Museum of Northern Arizona indicates that there may be more than one species of *Scutellosaurus* preserved in the Kayenta Formation. The preserved appendicular and axial skeleton of both *S. lawleri* and *Scutellosaurus* n. sp. are virtually identical. The dermal armor, however, shows marked differences. While the specimen does not preserve a full complement of osteoderms, the partial and complete osteoderms (n=41) allow recognition of differences between the two taxa. In particular, the new species has simplified armor morphologies (from between 4–6 morphologies in *S. lawleri* to only one in *Scutellosaurus* n. sp.) and lacks the medial concavity in the osteoderms diagnostic of *S. lawleri*. In addition, the armor of *Scutellosaurus* n. sp. also has scalloped margins, unlike the rounded edge found in *S. lawleri*. This evidence together indicates that the genus *Scutellosaurus* is not monotypic and that the fauna preseved by the Kayenta Formation changed during the formation's deposition. Further work is also needed to determine if a fragmentary specimen from southwestern Utah is also attributable to *Scutellosaurus* n. sp. If so, this would represent a significant expansion of the known range of *Scutellosaurus*.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW POSTCRANIAL ELEMENTS FOR *TEILHARDINA BELGICA*, AN EARLY EOCENE FOSSIL PRIMATE

GEBO, Daniel L., Northern Illinois University, DeKalb, IL, United States; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; DAGOSTO, Marian, Northwestern University, Chicago, IL, United States

Teilhardina belgica is one of the most primitive fossil primates known to date and the earliest haplorhine with associated postcranials making it relevant to a reconstruction of the ancestral primate morphotype. Here we describe newly discovered postcranial elements of *Teilhardina belgica* that were recovered from the collections housed at the Royal Belgian Institute of Natural Sciences (Brussels, Belgium) from the site of Dormaal. *Teilhardina belgica* is a small primate similar in size to a mouse lemur (between 30-60 g). Its hindlimb anatomy (e.g., tarsals, a distal femur, a first metatarsal and phalanges) suggests frequent and forceful leaping with excellent foot mobility and grasping capabilities. *Teilhardina* exhibits critical primate postcranial synapomorphies such as a grasping hallux, a tall knee, and nailed digits. This anatomical pattern and behavioral profile is similar to what has been inferred before for other Early Eocene omomyids and adapiforms. The most unusual feature of *Teilhardina belgica* is its elongated middle phalanges (most likely manual phalanges) suggesting that this early primate may have had very long digits similar to those of living tarsiers.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

MORPHOMETRY.ORG, A NEW WEBSITE FOR SHARING MORPHOMETRIC DATA

GELNAW, William B., University of Texas at Austin, Austin, TX, United States

Morphometrics, the study of structure through size and shape, has blossomed as a field of study over the last two decades, with a proliferation of techniques for collecting and applying data. The most immediate impediment to advancing morphometrics as a mode of investigation has been the lack of an efficient way to share data between researchers. Morphometry.org is a new website for sharing traditional morphometrics, as well as 2D and 3D geometric morphometric data, in a searchable database. In the same spirit as GenBank and MorphoBank, Morphometry.org aims to improve morphometric investigations by eliminating time-intensive redundant data collection, enhancing collaboration, and allowing incremental addition to ongoing projects, facilitating peer-review of data accuracy and precision as well as the resulting analyses. Requirements of submission for all linear measurements and landmark coordinates include written definitions of how the measurement was taken or where the landmark is placed, the list of specimens examined with associated specimen numbers, and the values of the data as a tab-delimited table. For 2D geometric data, submissions must include the photographs used for landmark placement. Morphometry.org does not yet store voxel or surface maps for 3D morphometrics, but will do so in the future. Submitted data can optionally include illustrated references for taking measurements or placing landmarks, links to additional data about the specimens examined (such as in VertNet.org and Digimorph.org), geographic coordinates for the collection site of the specimen, and user-defined classification and metadata tags.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

SEMIONOTID FISHES (NEOPTERYGII: SEMIONOTIFORMES) FROM THE UPPER TRIASSIC CHINLE FORMATION OF SOUTHERN UTAH: NEW SPECIES AND COMMENTS ON THE RELATIONSHIPS OF FISHES WITHIN THE FAMILY SEMIONOTIDAE

GIBSON, Sarah Z., University of Kansas Department of Geology, Lawrence, KS, United States

Fossilized remains of ganoid semionotiform fishes from the Upper Triassic Chinle Formation of the southwestern United States are abundant, yet poorly studied and understood. The extinct family Semionotidae has been the subject of taxonomic confusion and is in need of further study. In this investigation, I describe two species of *Semionotus* from specimens collected from Triassic deposits (approximately 210–205 Ma) in Lisbon Valley, Utah, including one new species, as well as the previously described *Semionotus kanabensis*. The new species of *Semionotus* displays a unique combination of characteristics that diagnose it as a new species, including a unique cranial suspensorium with a short, ventrally-expanded vertical preoperculum; expanded infraorbitals that contact the preoperculum; deep body with pronounced postcranial hump; and dense tuberculation that begins on the skull roof and continues onto the dorsal ridge scales and dorsolateral flank scales. The new species is morphologically unique from *Semionotus kanabensis*, but the two species share a characteristic of the expanded infraorbitals that contact the anterior ramus of the preoperculum. This shared characteristic, observed only in *Semionotus* taxa from the western United States, may provide some insights into the evolutionary relationships of taxa within Semionotidae, which currently remain unresolved. This study also expands the known age and distribution of *Semionotus kanabensis* from the Early Jurassic to the Late Triassic, indicating that this species persisted through the Late Triassic mass extinction event.

Technical Session IX (Friday, October 19, 9:00 am)

LUGOL'S IODINE AS A CONTRAST AGENT IN X-RAY µCT IMAGING: METHODOLOGICAL REFINEMENTS AND POTENTIAL SIGNIFICANCE FOR INFERRING SOFT-TISSUE ANATOMY IN FOSSIL VERTEBRATES

GIGNAC, Paul M., Stony Brook University, Stony Brook, NY, United States; KLEY, Nathan J., Stony Brook University, Stony Brook, NY, United States

Visualization methods vastly enhance our ability to appreciate complex anatomical relationships and to harness these relationships for understanding the nature of developmental and/or evolutionary changes in morphology. Most notably, the now widespread use of non-destructive X-ray computed tomography (CT) and micro-CT (µCT) has greatly augmented our ability to comprehensively detail and quantify the internal anatomy of fossil vertebrates. Refining these techniques for use on hard tissues such as bone, dentine, and enamel has led to substantial gains in both the quality and quantity of anatomical comparisons among extinct taxa and between fossils and their extant descendants or analogues. However, the utility of X-ray imaging for gaining similar paradigm-altering insights into the soft tissues of living vertebrates has yet to be fully realized, as anatomists have been constrained to a large degree by the naturally low X-ray absorption of non-mineralized tissues and by a paucity of non-toxic and inexpensive contrast agents. Here we systematically test and quantify contrast in µCT images of intact neonate and yearling *Alligator mississippiensis* heads that were prepared with a simple, non-toxic, and inexpensive staining protocol using Lugol's iodine (I_2KI) that facilitates stunning visualization of soft tissue anatomy in high-resolution X-ray µCT images. To date, similar methods have been experimented with using collagen scaffolding, invertebrates, vertebrate embryos, adult mice, and a yearling alligator—in all cases yielding promising results. Our protocol expands upon these earlier studies by making possible extensive visualization of vertebrate soft tissues in X-ray µCT images. We demonstrate that the soft-tissue anatomy of the head and neck, including differences between white and grey matter of the spinal cord, nuclei of the brain, fascicle lengths of the cranial musculature, and the complete pathways of all cranial nerves, can be fully visualized and readily reconstructed using 3D computer imaging software. Similar to visualization work that has been done previously on sinuses and cranial nerve roots, these soft-tissue reconstructions can then be matched directly to the osteological correlates they leave behind for comparison to similar correlates in fossil forms. This technique will make rapid, non-destructive mapping of intricate anatomical relationships possible in a wide variety of extant vertebrates. We briefly demonstrate its

utility by: (1) quantifying differences between brain size and shape to those inferred from cranial endocasts; (2) generating reconstructions of the cranial musculature; and (3) mapping the courses of cranial nerves throughout the head, between our *A. mississippiensis* specimens and their fossil crocodyliform relatives.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RENEWED PALEONTOLOGICAL INVESTIGATIONS IN THE UPPER AND LOWER SIWALIKS OF INDIA: IMPLICATIONS FOR PRIMATE EVOLUTION VIS A VIS PALEOCLIMATE CHANGE

GILBERT, Christopher C., Hunter College of the City University of New York, New York, NY, United States; PATEL, Biren A., Keck School of Medicine at the University of Southern California, Los Angeles, Los Angeles, CA, United States; PATNAIK, Rajeev, Panjab University, Chandigarh, India; FLEAGLE, John G., Stony Brook University, Stony Brook, NY, United States

The fossiliferous Siwalik Hills of India and Pakistan are well known to vertebrate paleontologists. Over the past century, numerous specimens collected in the Siwaliks have proven vital to understanding the evolution and biogeography of many mammalian groups, with primates being no exception. At least three major groups of primates are found in the Siwaliks: hominoid apes and sivaladapine adapoids from the Lower and Middle Siwaliks, a C3 dominant environment, and cercopithecoid monkeys from the Middle and Upper Siwaliks, a C4 grassland dominant landscape. Particularly important primate specimens from the Siwaliks include early great apes (e.g., *Sivapithecus*), early Asian cercopithecoids (e.g., *?Presbytis sivalensis*), the easternmost specimen of the giant gelada *Theropithecus oswaldi*, and some of the latest occurring adapoids in the fossil record. Since 2010 we have renewed fossil prospecting in the Upper and Lower Siwalik deposits in an attempt to better understand the evolution, biogeographic timing, and paleoclimatic context of primate radiations in Asia. To date, our expeditions in the Upper Siwaliks have documented that the site of Mirzapur, which produced the lone *T. oswaldi* specimen in India, is now submerged under water. Our exploration of the Lower Siwaliks (in the Jammu and Kashmir region) has resulted in the identification of at least two new fossil localities as well as the relocation of Ramchand Ridge, a little-known site that has produced dental specimens conflictingly identified as the earliest Asian hominoids by some researchers and as the suid *Conohyus* by others. The results of our preliminary collection efforts in these areas are presented here, and recovered fauna includes typical Chinji zone taxa such as rodents, tragulids, bovids, suids, carnivores, giraffids, rhinoceratids, squamates, and crocodylians, all of which have previously been found in association with primates in these areas. Many of these faunal elements are important biostratigraphic and paleoclimatic indicators as well. Thus, future geological, paleontological and paleoclimatological research in the Lower Siwaliks of India should result in the eventual recovery of new primate specimens and help to clarify the nature and timing of primate and mammalian evolution in Asia.

Technical Session II (Wednesday, October 17, 8:30 am)

ENDOSKELETAL ANATOMY OF THE STEM ACTINOPTERYGIAN *CHEIROLEPIS* REVEALED BY HIGH-RESOLUTION COMPUTED TOMOGRAPHY

GILES, Sam, University of Oxford, Oxford, United Kingdom; BRAZEAU, Martin D., NCB Naturalis, Leiden, Netherlands; ATWOOD, Robert C., Diamond Light Source, Harwell Campus, United Kingdom; FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom

The Middle Devonian *Cheirolepis* occupies a critical position in vertebrate phylogeny: it is the sister group of all other actinopterygians and the earliest definitive ray-finned fish. Despite its significance and a comparative abundance of material, *Cheirolepis* remains poorly known in many respects. Previous treatments of this genus have relied heavily on unprepared specimens, and provide only vague details of endoskeletal structure. The model for early ray-finned fish anatomy has instead been based largely on the Late Devonian actinopterygians *Mimipiscis* and *Moythomasia*, which are known in stunning detail from acid-prepared, uncompressed specimens from the Gogo Formation of Australia. Re-examination of material of *Cheirolepis* from classic Old Red Sandstone localities of Scotland using lab-based and synchrotron X-ray computed tomography substantially alters older accounts of endoskeletal structure in this genus, with important implications for understanding patterns of character evolution deep within the osteichthyan crown. Here we focus on results from two individuals preserved in concretions, one from Gamrie and another from Tynet Burn. The Gamrie specimen preserves both pectoral-fin endoskeletons and a hyomandibular. The scapulocoracoid bears a long, narrow articular surface for the radials. In contrast to previous interpretations, the construction of the fin endoskeleton is broadly similar to that of other early actinopterygians, although the proterygium appears to be imperforate. The hyomandibular is fused with the dermohyal, but assumes proportions more similar to those found in some early sarcopterygians (e.g., *Onychodus*) than those of *Mimipiscis* and *Moythomasia*. Significantly, the Tynet Burn specimen yields a largely complete braincase showing anatomical detail comparable to that known from the Gogo ray fins. Many aspects of the neurocranium are comparable to those of later actinopterygians (e.g., a narrow interorbital septum), but important exceptions include the lack of any dermal ascending processes of the parasphenoid and an unfused ventral floor to the notochordal canal, both of which likely represent plesiomorphic osteichthyan features. Collectively, these new data help clarify primitive conditions within ray-finned fishes, which in turn have important implications for understanding features likely present in the last common ancestor of living osteichthyans.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EVOLUTIONARY STASIS OF NORTH AMERICAN GLYPTODONTS DURING THE GREAT AMERICAN BIOTIC INTERCHANGE

GILLETTE, David D., Museum of Northern Arizona, Flagstaff, AZ, United States; CARRANZA-CASTAÑEDA, Oscar, Centro de Geociencias Universidad Nacional Autonoma de Mexico, Campus Juriquilla, Queretaro, Mexico; WHITE, Richard, International Wildlife Museum, Tucson, AZ, United States; MCCORD, Robert, Arizona Museum of Natural History, Mesa, AZ, United States; THRASHER, Larry, Bureau of Land Management, Safford, AZ, United States

Glyptodonts originated in South America in the Paleogene, diversified through the Neogene, and expanded into North America no later than about 4 million years ago during the Great American Biotic Interchange. Apparently only one genus (*Glyptotherium*) became established in Central America and eventually expanded into Mexico and southern United States. Until recently, three commonly recognized species seemed to fit an anagenetic model of evolution through the Pliocene and Pleistocene in North America: *Glyptotherium texanum* (Blancan), *G. arizonae* (Late Blancan-Irvingtonian), and *G. floridanum* (Rancholabrean). The evolutionary positions of two other species (*G. cylindricum* and *G. mexicanum*) from Mexico were enigmatic due to poor stratigraphic records and incomplete skeletal material for the holotypes. Newly collected glyptodonts from Los Galvenes and Coecillos areas, Guanajuato, in central Mexico, and from the 111 Ranch fauna of southeastern Arizona add to the hypodigm of *G. texanum* and indicate that *G. texanum* and *G. arizonae* are synonymous. The newly recovered specimens include babies, juveniles, and fully grown adults, as large as the largest individuals formerly assigned to *G. arizonae*. All of the characters that seemed to distinguish the two species are now attributable to ontogeny and sexual dimorphism. The species changed little, if at all, over the course of this 2.5 million year interval (Early Blancan, 3.9 mya, to Early Irvingtonian, 1.4 mya). The hypodigm of the late Pleistocene species, *G. floridanum* can be distinguished from that of the expanded hypodigm of *G. texanum* only in minor details of the carapacial armor, which may be related to growth acceleration that changed proportions of the external sculpturing but did not culminate in any recognizable autapomorphies. These observations lead to the hypothesis that the *Glyptotherium texanum* - *G. floridanum* lineage remained practically unchanged for at least four million years. The species definitions of *G. cylindricum* and *G. mexicanum* remain to be reevaluated in this context. The Gulf Coastal Plain was probably the principal center of dispersal for *Glyptotherium*, expanding during sea level retreats, and contracting but never disappearing during advances. Changing climatic conditions and tectonic activity affected habitats and distribution, but there is little evidence that climate change stimulated evolutionary change in the morphology of *Glyptotherium*.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

PALEOPATHOLOGICAL ANALYSIS OF *TAPIRUS* SPP. FROM FLORIDA AND TENNESSEE

GILMORE, Laura S., East Tennessee State University, Johnson City, TN, United States; BREDEHOEFT, Keila E., Hagerman Fossil Beds National Monument, Hagerman, ID, United States

The two largest samples of fossil tapirs known are from the Gray Fossil Site in Gray, Tennessee and Haile 7G in Newberry, Florida. Large numbers of individuals and high numbers of identified specimens (NISP) at these two sites present an unparalleled opportunity to analyze patterns in a fossil sample. Despite the age differences of the two sites, the late Miocene Gray Fossil Site and the early Pliocene (Blancan) Haile 7G have been referred to as sister sites, due to their similar environments and unusually large proportion of tapirs. Three other Florida fossil sites preserving tapirs were also included here to focus on how pathological patterns vary between samples. At the time of this research, there were 167 pathological elements at Gray (*Tapirus polkensis*) and 96 from four fossil sites in Florida: 66 at Haile 7G (*T. lundeliusi*), 21 at the Love Bone Bed (*T. simpsoni*), six at the Leisey Shell Pit (*T. haysii*) and four at Haile 7C (*T. lundeliusi*). The most common pathological elements at Gray are (in order) proximal phalanges, metacarpals and medial phalanges; whereas Florida is dominated by metacarpals, proximal phalanges, cuneiforms and scaphoids. Of all observed pathologies, the vast majority are common osteoarthritis. Results indicate that the tapirs in Florida and Tennessee were both most susceptible to chronic osteoarthritis in the joints of their manus. Given the large amount of osteoarthritis, it is reasonable to assume that many of the tapirs survived to advanced age. Surprisingly, there is a distinct paucity of healed traumatic pathologies, with only eight affected elements at Gray and four in Florida: in fact, only 4.5% of the observed pathologies were traumatic in origin. At Gray, the large number of old individuals and the lack of traumatic damage may be related in part to the relative lack of carnivorans at the site, as well as the scarcity of carnivore damage in general. However, at the Love Bone Bed site, there are numerous carnivoran fossils and this hypothesis is not supported. It may be that the tapirs at this site suffered carnivore attacks that resulted in mostly perimortem bone damage, which is indistinguishable from postmortem damage. Continued excavations at Gray and in Florida, as well as data from other sites with tapir fossils will undoubtedly expand this comparison and will help researchers better understand this fossil taxon's behavior and ecology.

Technical Session XIII (Friday, October 19, 3:15 pm)

EOCENE *DARWINIUS*, *EUROPOLEMUR* AND *NOTHARCTUS* (PRIMATES, ADAPOIDEA): WHAT IS A CLAW, WHAT IS A GROOMING CLAW, AND WHEN DID GROOMING CLAWS EVOLVE?

GINGERICH, Philip D., University of Michigan, Ann Arbor, MI, United States

Living primates are distinguished from tree shrews and other mammals by their grasping hands and feet, which have distal phalanges bearing nails rather than claws. Exceptions include *Daubentonia* and Callitrichidae with claws on all digits except the hallux. Various authors have argued that (1) claws on all digits; (2) nails on all digits; or (3) nails and pedal grooming claws are primitive for primates. Interpretation depends on the taxa included in the order, on phylogenetic relationships (as yet uncertain), and on identification of grooming claws.

Claws are laterally compressed, longitudinally curved, and have pointed distal ends, as do the underlying bony distal phalanges. Nails are broader and flatter with more columnar underlying phalanges. Grooming claws are thought to differ from nails on other digits in being longer and standing at a steep angle to the dorsal surface of the digit as a whole. Toilet claws are not always easy to identify from their underlying bony phalanges.

Micro-CT images were measured for all pedal distal phalanges (PDPs) of *Tupaia* and 25 primate species (14 prosimians, 11 anthropoids). Principal components analysis (PC or PCA) enables clawed PDPs to be distinguished from other distal phalanges. Clawed PDPs are laterally compressed and longitudinally curved, falling in the lower left quadrant of a PC-II vs. PC-III morphospace. PDPs for grooming claws of 14 prosimian species overlap slightly with PDPs for other digits, but generally occupy the lower right quadrant of the morphospace. Addition of Eocene adapoids suggests that *Europolemur* had grooming claws on digit II, and *Notharctus* had grooming claws on digits II and III.

Linear discriminant analysis (LDA) of the same measurements distinguishes most grooming-claw PDPs from non-grooming-claw PDPs. *Europolemur* is again classified as having a grooming claw, but *Notharctus* appears not to have had grooming claws. LDA for all 40 measurements of PDP-I through IV in a foot collectively separates grooming-clawed primates from the others, but here it appears that neither *Europolemur* nor *Notharctus* had a grooming claw. Requisite measurements are not available for *Darwinius*, but it clearly had PDPs similar to those of *Notharctus*.

Ambiguity concerning the presence of grooming claws in Eocene Adapoidea, and the lack of evidence one way or another in Eocene Tarsioidea, mean it is difficult to know whether grooming claws of Lemuroidea and Tarsioidea are homologous, and it is difficult to be certain when grooming claws evolved.

Technical Session I (Wednesday, October 17, 8:45 am)

PNEUMATICITY PATTERNS IN THE SKULL OF *ALIORAMUS ALTAI*, A LONG-SNOUTED TYRANNOSAURID (DINOSAURIA: THEROPODA), FROM THE LATE CRETACEOUS OF MONGOLIA

GOLD, Eugenia, Richard Gilder Graduate School, New York, NY, United States; BRUSATTE, Stephen L., American Museum of Natural History, New York, NY, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States

Alioramus altai is an aberrant tyrannosaurid theropod from the Late Cretaceous of Mongolia, which exhibits a long and gracile skull, slender postcranial skeleton, and smaller size compared to other tyrannosaurids such as the coeval *Tarbosaurus* and *Tyrannosaurus*. The holotype of *A. altai* is an exceptionally preserved juvenile that includes nearly all of the disarticulated cranial bones. Several of these bones exhibit extreme pneumaticity, including internal sinuses associated with the antorbital fenestra, tympanic system, and median pharyngeal system. Because tyrannosaurids are basal coelurosaurs, and because *A. altai* is an unusual long-snouted taxon, a closer examination of its cranial pneumaticity may reveal insight into the origin and evolution of coelurosaurian cranial sinuses on the line to birds, as well as changes in pneumaticity associated with the origin of a novel cranial bauplan. We CT scanned all of the pneumatic bones of the face, palate, and lower jaw of the *A. altai* holotype, which reveal important pneumatic features that are not discernable externally and which help clarify homologies across Theropoda. The maxilla includes the normal suite of antorbital sinuses. The antorbital sinus lies along a vertical passage between the posterior border of the maxillary fenestra and the anterior border of the antorbital fenestra. This extends ventrally to where the roots of the maxillary teeth begin, and then into the main body of the maxilla to reach the posterior margin of the last maxillary tooth. Posteriorly, it is supported by a groove in the ventral process of the maxilla. In addition, the premaxillary sinus extends posteriorly to the anterodorsal margin of the maxillary fenestra and communicates with the antorbital sinus via a small opening near the maxillary fenestra. The quadrate is extensively hollowed by a recess that communicates with the external surface via a series of large foramina on the anterior surface of the bone, between the condyles and the pterygoid flange. There is no communicating foramen on the posterior surface of the quadrate, as in the case in most other coelurosaurs. The quadrate recess extends into the pterygoid flange and the lateral flange for articulation for the quadratojugal. Pneumaticity in the palatine fills the complex shape of this bone and appears to continue into the finger-like medial process, but does not extend into the maxillary process. *Alioramus* possesses many of the characteristic cranial recesses of derived coelurosaurs (including birds), supporting the hypothesis that these features evolved early in theropods. Furthermore, the retention of these recesses indicates that the pattern of theropod cranial pneumaticity may be stable in the face of extreme morphological change, such as snout elongation.

Technical Session I (Wednesday, October 17, 11:30 am)

NEW VERTEBRATES FROM THE LATE CRETACEOUS KALLAMEDU FORMATION, CAUVERY BASIN, SOUTH INDIA, INCLUDING A TROODONTID DINOSAUR, A GONDWANATHERIAN MAMMAL, AND A *SIMOSUCHUS*-LIKE NOTOSUCHIAN CROCODYLIFORM

GOSWAMI, Anjali, University College London, London, United Kingdom; PRASAD, Guntupalli V., University of Delhi, Delhi, India; BENSON, Roger B., University College London, London, United Kingdom; VERMA, Omkar, Indira Gandhi National Open University, New Delhi, India; FLYNN, John J., American Museum of Natural History, New York, NY, United States

Late Cretaceous vertebrate faunas of India are known predominantly from intertrappean deposits in the Deccan volcanic province. A thick sequence of Early Cretaceous to Early Paleocene fossiliferous sediments exposed in the Cauvery Basin of South India has been comparatively poorly explored. Here, we present a preliminary description of a new fauna consisting of vertebrate fossils discovered from the continental Upper Cretaceous (late Maastrichtian) Kallamedu Formation. The Kallamedu Fauna includes ganoid fishes, amphibians, turtles, crocodyliforms, dinosaurs, and mammals, with many taxa suggesting Late Cretaceous biotic links between India and other Gondwanan landmasses. Teeth of abelisaurid dinosaurs and gondwanatherian mammals support pan-Gondwanan distributions for these clades. Of great significance is the first discovery of a *Simosuchus*-like notosuchian crocodile outside of Madagascar. This clove-shaped tooth with multiple homogeneous cusps and a ventrally flaring root are reminiscent of the crown morphology of *Simosuchus clarki*, known from the Upper Cretaceous Maevarano Formation of Madagascar. The single known tooth is tentatively placed within the posterior series of the right dentary, due to the presence of eight cusps and flaring of anterior part of the root similar to that described for some of the dentary teeth of *Simosuchus*. Previous analyses suggested close relationships among Late Cretaceous Indian and Madagascan species across a number of vertebrate groups, including gondwanatherian mammals, nigerophiid snakes, and bothremydid turtles, and this report of the first Indian *Simosuchus*-like notosuchian further strengthens the evidence for close biotic links between India and Madagascar in the Late Cretaceous.

While most of the taxa identified in the Kallamedu Fauna are known from other Gondwanan landmasses, the identification of a troodontid maxillary tooth extends this predominantly Laurasian clade into the Late Cretaceous of India. The single recovered tooth displays a recurved apex, stronger curvature on the anterior margin than the posterior, mesiodistal constriction at the base of the crown, relatively large, apically-inclined denticles that are larger on the posterior carina than the anterior, and well-developed grooves expanding into pits between adjacent denticles. The denticles are not strongly hooked, as in most troodontids, but this is possibly due to abrasion. This discovery of a distinctly Laurasian theropod further complicates paleobiogeographic reconstructions of Late Cretaceous India and supports the presence of a direct or indirect dispersal route between Eurasia and India, potentially via Africa, as has been suggested for eutherian mammals.

Technical Session II (Wednesday, October 17, 11:15 am)

EXCEPTIONAL PRESERVATION AND UNUSUAL FEATURES IN A DISTINCTIVE NEW TARPON-LIKE FISH [ELOPOMORPHA] FROM THE CRETACEOUS OF THE CHATHAM ISLANDS, NEW ZEALAND

GOTTFRIED, Michael D., Michigan State University, East Lansing, MI, United States; FORDYCE, Robert E., University of Otago, Dunedin, New Zealand; LEE, Daphne E., University of Otago, Dunedin, New Zealand; KOEHLER, Richard, University of Otago, Dunedin, New Zealand

We report on a large and nearly complete elopomorph fish from the Cretaceous (possibly Paleogene) of Pitt Island, Chatham Islands, New Zealand. The exquisite specimen, which is three-dimensionally preserved in a volcanic tuff, is the most complete and informative fossil elopomorph reported to date from the Southern Hemisphere. Features supporting elopomorph affinities include the lack of a separate retroarticular ossification on the lower jaw, and a primitively retained median gular. Assignment to the elopiform Family Megalopidae (tarpons) is indicated by the specimen's superior mouth position, large posttemporal fossae, and laterally compressed body covered in large and extensively overlapping cycloid scales. A number of distinctive features, including the elongate body, a high and strongly developed coronoid process on the mandible, an enlarged median gular, a relatively low-profile head, a series of anamestic bones in the cheek region, and the continuation of the lateral line scales onto the base of the caudal fin, indicate that the Pitt Island fish represents a distinctive new taxon within megalopids. One highly unusual feature is a transverse fissure that extends across the skull roof just posterior to the orbits; this structure appears internally continuous on CT-scans and symmetrically disposed, and is therefore interpreted as likely representing a real structure and not an artifact. The overall morphology of the specimen suggests a fish similar in many respects to the extant tarpons *Megalops atlanticus* and *M. cyprinoides* but with a more slender head profile and more attenuated body, and with several unique skeletal features not previously reported on megalopid fishes.

Romer Prize Session (Thursday, October 18, 9:30 am)

ARTICULAR SURFACE MORPHOLOGY AND THE EVOLUTION OF CURSORIALITY IN PALEOGENE UNGULATES: THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSIS OF COMPLEX TOPOLOGIES

GOULD, Francois D., Johns Hopkins School of Medicine, Baltimore, MD, United States

Joint surface morphology reflects joint function as indicated by biomechanics and anatomy. Thus, the quantitative study of articular surfaces is a fruitful avenue of research for inferring functional morphology in fossils. In mammals, qualitative differences in distal femoral shape have been tied to, among others, arboreal and cursorial modes of locomotion. However, complex topology has made quantitative testing of evolutionary hypotheses tied to these observations difficult. In particular, specialization for cursoriality has been suggested as a key factor in the origination of the modern ungulate orders Artiodactyla and Perissodactyla. Studies of comparative anatomy have shown that the paraphyletic group Condylarthra, which is thought to contain the sister taxa to these orders, contained arboreal forms, but some taxa may also have been cursorial. The aims of this study were to test quantitatively the relationship between distal femoral morphology and locomotion, and to use changes in femoral morphology in condylarths and early North American artiodactyls and perissodactyls to examine the changes in locomotion in ungulates through the Paleogene. Using three-dimensional geometric morphometrics I analyzed the shape of the entire distal femoral articular surface. Surface scans were collected from 42 extant mammal genera classified into 5 locomotor categories. Geometric morphometric analysis showed significant differences between arboreal and cursorial taxa across different taxonomic orders (Multivariate Analysis Of Variance on principal component (PC) scores Wilkes λ (2.688, 60)=0.01919, $p<0.001$). Shape variation recovered on the first PC is significantly associated with differences in locomotor mode and supports previous biomechanical and functional anatomical assessments of ecologically different taxa: antero-posterior elongation and extension of the patellar groove in cursorial forms, versus medio-lateral broadening of the condyles in arboreal forms. A discriminant function analysis is highly significant, with percent correct classifications between 80% and 100%. All fossil artiodactyls and perissodactyls are recovered as either cursorial or terrestrial in locomotion, whereas condylarths occur in all locomotor categories, including arboreal and cursorial. Thus the diversification of the modern ungulate orders is not associated with the origin of cursoriality but rather with a reduction in the range of locomotor ecologies. Three dimensional geometric morphometrics of articular surfaces though labor intensive are a powerful quantitative tool for testing qualitative hypotheses of anatomical variation. They are therefore invaluable in studying ecological changes associated with major evolutionary transitions and adaptive radiation.

Technical Session III (Wednesday, October 17, 3:00 pm)

PHALANGEAL MORPHOLOGY OF SUSPENSORY MAMMALS: IMPLICATIONS FOR THE LOCOMOTION OF MALAGASY SUBFOSSIL SLOTH LEMURS (PRIMATES: PALAEOPROPITHECIDAE)

GRANATOSKY, Michael C., Duke University, Durham, NC, United States; MILLER, Charlotte E., Duke University, Durham, NC, United States; LEMELIN, Pierre, University of Alberta, Edmonton, AB, Canada; SCHMITT, Daniel, Duke University, Durham, NC, United States

Based on osteological similarities in the back, arm, and wrist, the subfossil sloth lemurs of Madagascar have been reconstructed as committed inverted quadrupeds similar to extant sloths. However, in contrast to extant sloths and other suspensory species like bats and colugos, sloth lemurs are characterized by what appear to be prehensile hands and feet more typical to those of primates, though few metric studies of phalangeal anatomy exist to support this contention. To investigate the extent to which sloth lemurs may differ in phalangeal morphology compared to primates and other mammals, we compared a broad sample of suspensory and non-suspensory taxa to sloth lemurs--*Paleopropithecus, Mesopropithecus,* and *Babakotia*--using both univariate analyses and principal components analyses (PCA).

Results from the PCA indicate that the intermediate phalanx of non-primate suspensory mammals like sloths, bats, and colugos is longer, has a narrower proximal articular surface, and a dorsoventrally expanded distal trochlea when compared with primates and other non-suspensory mammals. Additionally, phalangeal proportions of non-primate suspensory taxa vary considerably from other species. While primates tend to have longer proximal phalanges and shorter distal phalanges, non-primate suspensory taxa all have long claws on the distal phalanges and relatively longer intermediate phalanges. These differences are most likely to represent a trade-off between passive digital flexion vs. enhanced prehensility. Non-primate suspensory taxa have anatomical features that provide passive, hook-like postures of the hand and foot to support the body against gravity during suspension. Primate hands and feet have none of the features associated with such passive resistance mechanism, but in turn have much greater grasping prowess and dexterity. Sloth lemurs were clearly committed inverted quadrupeds that retained prehensile hands and feet with nails rather than claws, a feature typical of other primates. This anatomical arrangement was potentially energetically costly, requiring muscular rather than passive stabilization and weight support mechanisms. However, the retention of the primate-like grasping extremity would have been advantageous for effective movement between substrates of varying diameters and effective manipulation during food acquisition.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 8:00 am)

SKELETONS IN THE CRETACEOUS CLOSET – AN OVERVIEW OF THE HISTORY OF PALEONTOLOGY IN APPALACHIA

GRANDSTAFF, Barbara S., School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA, United States; PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States

While vertebrate paleontology in North America began during colonial times, the earliest studies were of Pleistocene mammals. Cretaceous vertebrate paleontology in North America was born in New Jersey with Joseph Leidy's 1858 description of a dinosaur skeleton (*Hadrosaurus foulkii*) discovered in Haddonfield NJ in 1830. In 1865 Leidy published an overview of Cretaceous reptiles of the United States; most of the fossils described came from New Jersey marl mines. *Hadrosaurus* was included in this review, as were crocodilians and turtles from New Jersey. *Hadrosaurus* became one of the first dinosaurs to have its skeleton, reconstructed by B. Waterhouse Hawkins, displayed in museums. Cope described the theropod '*Laelaps'* (*Dryptosaurus*) in 1866, also from the New Jersey marls. This dinosaur was the first to be reconstructed in a 'modern' dynamic pose; the famous 'leaping *Laelaps'* of Charles Knight. Coastal waters of Cretaceous New Jersey supported a diverse fauna of fishes and marine reptiles, which were also among the earliest fossils described from North America. Even the infamous 'Bone Wars' feud between Cope and Marsh began in New Jersey when fossils that were coming to Cope for study curiously got diverted to Yale, beginning shortly after the two toured Cope's New Jersey fossil sites.

New Jersey was not the only part of Appalachia producing fossils during the late 19th and early 20th centuries. Cretaceous fossils were described from the Potomac Beds of Maryland and Virginia and from North Carolina (including *Hypsibema crassicauda*, a notorious chimera). Western sections of Appalachia have also been productive. Missouri yielded *Hypsibema missouriense*, a dinosaur found in a well. Alabama has a rich Cretaceous fauna, and the eastern part of Texas (the 'west coast' of Appalachia) has yielded Cretaceous terrestrial and coastal marine fossils.

Vertebrate fossils from Appalachia were well represented in the earliest history of our science in North America. This was not to last: while Cretaceous vertebrate remains continued to be found in the eastern subcontinent the focus of vertebrate paleontology largely shifted to more spectacular finds from the American west in the latter half of the 19th century. Recently, paleontologists have begun to re-explore the rich and diverse vertebrate fauna of Appalachia and its coastal waters. New work in the eastern subcontinent could be said to have begun with discovery of the Ellisdale Site in the early 1980s.

Technical Session III (Wednesday, October 17, 3:30 pm)

INFERRING LEVELS OF ARBOREALITY OF EXTINCT SLOTHS THROUGH A GEOMETRIC MORPHOMETRIC ASSESSMENT OF SCAPULA MORPHOLOGY

GRASS, Andy, University of Iowa, Iowa City, IA, United States

One of the most persistent challenges with studying the fossil record is assessing the behavior of extinct organisms. Oftentimes this can be addressed by identifying correlations between morphology and behavior in a closely related extant taxon, which can then be used to infer similar behaviors from similar morphologies in the extinct taxon. The mammalian scapula is well suited for these purposes, as it has been shown in many groups to have a high correlation between form and function. In primates in particular there is a very distinct difference in scapula morphology between arboreal and terrestrial groups. This is directly relevant to extinct sloths, which are all commonly referred to as "ground sloths," despite that several groups were much smaller and possibly less terrestrial than the archetypal giant ground sloths. Varying levels of arboreality have been demonstrated in these smaller sloths by comparing limb measurements which have been shown to distinguish arboreal and terrestrial primates, as well as modern arboreal and terrestrial anteaters, which are sloths' closest living relatives. A geometric morphometric study was performed to determine if patterns of arboreality could also be parsed out through the scapula morphology of these sloths. Three-dimensional landmarks and sliding semi-landmarks were taken on the scapulae of extant and extinct sloths as well as extant anteaters, and a principal components analysis was performed on the procrustes residuals of these landmarks. The arboreal and terrestrial anteaters have little overlap in morphospace; however the putatively semi-arboreal sloth *Hapalops* tended more towards the giant ground sloths. This could potentially indicate that *Hapalops* was more terrestrial than previously thought. However, the giant ground sloth *Megalonyx* tended towards the area of morphospace occupied by modern tree sloths. Current phylogenetic estimates place *Megalonyx* and *Choloepus*, the modern two toed sloth, in the same family, Megalonychidae. This may reflect that, in sloths at least, scapula morphology is influenced less by adaptation and more by phylogenetic constraint. *Bradypus*, the modern three toed sloth, which is in the monotypic family Bradypodidae, and thus not closely related to *Choloepus*, plotted in the same area of morphospace as *Choloepus*. This may have implications for the supposition of extreme convergent evolution between *Choloepus* and *Bradypus*, and indicate that their similar scapula morphology is instead a result of the retention of similar ancestral forms rather than adaptations to their suspensory lifestyle.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ANALYSIS OF DENTAL MICROWEAR IN THE XENARTHRA: DOES SCANNING ELECTRON MICROSCOPY REVEAL A LINK BETWEEN FEEDING ECOLOGY AND TOOTH SCARRING?

GREEN, Jeremy L., Kent State University at Tuscarawas, New Philadelphia, OH, United States; RESAR, Nicholas A., Kent State University, Kent, OH, United States

Dental microwear has recently been supported as a proxy for feeding ecology in xenarthrans (including tree sloths, armadillos and their extinct relatives). However, the causal relationship between diet and fine-scale tooth wear in this clade has been studied almost exclusively using low-magnification microscopy. Here, we test the hypothesis that dental microwear patterns are significantly different among tree sloths and armadillos by analyzing tooth scars using scanning electron microscopy (SEM). Microwear patterns on 26 teeth from 5 xenarthran taxa were analyzed; each taxon was classified into one of 4 dietary groups: 1. carnivore-omnivores = *Euphractus*; 2. folivores = *Bradypus*; 3. frugivore-folivores = *Choloepus*; 4. insectivores = *Dasypus*. Using SEM, two non-overlapping digital images of microwear were captured for each tooth at 500x magnification. In a blind, randomized design, each image was independently analyzed by both authors using the semi-automated software package, Microwear 4.02. To determine the reproducibility of our results, both intra- and interobserver error in microwear feature recognition was statistically assessed for both observers. Pearson correlation coefficients reveal that datasets from both observers are highly correlated and that both observers recovered the same relative between group differences. Scratch count and scar width variables showed the most discrimination, with insectivores and folivores consistently having the lowest number of scratches and greatest width of scars, whereas frugivore-folivores and carnivore-omnivores recorded the opposite. When dietary groups from the same habitat (i.e., arboreal folivores and frugivore-folivores) are compared, distinct differences in microwear patterns are present, suggesting that microwear records differences in xenarthran feeding ecology. These results represent critical baseline data that can be used to reconstruct paleodiet in extinct ground sloths, glyptodonts, and pampatheres.

Technical Session X (Friday, October 19, 11:30 am)

THE EFFECT OF THE CRETACEOUS ANGIOSPERM RADIATION ON EARLY MAMMAL TAXONOMIC DIVERSITY AND MORPHOLOGICAL DISPARITY

GROSSNICKLE, David, Indiana University, Bloomington, IN, United States

Fossil discoveries over the past 30 years have radically transformed old views of the evolution of Mesozoic mammals. Similarly, recent research on early angiosperm radiation has provided a more detailed account of the roughly contemporaneous diversification of angiosperms and Mesozoic mammals. Though studies have speculated about the possible co-evolution of angiosperms and mammals, there has been no recent quantitative paleontological study on mammals that examines parallel patterns between groups. In this study, three hypotheses were considered: 1) angiosperm radiation had little or no effect on the overall taxonomic and morphologic diversity of Cretaceous mammals; 2) angiosperm radiation led to an increase in the overall diversity of mammals, possibly due to food sources that were new (e.g. fruit), increasing (e.g. seeds), and/or improving (e.g. increased plant matter owing to higher photosynthetic capacity); and 3) angiosperm radiation led to a decrease in mammal diversity, with only herbivorous and insectivorous mammals flourishing, as these groups would have been most likely to profit from the co-evolution and radiation of insects with angiosperms. Diversity curves were created to analyze taxonomic changes, teeth measurements were used as a proxy for body size and disparity, and geometric morphometric analysis of jaws was used to examine changes in morphological and dietary disparity. Results indicate significant morphologic and taxonomic changes in mammals at the time of angiosperm radiation, including a decrease in the number of eutriconodontans and 'symmetrodontans.' The two mammal clades that appear to have been most successful in the Late Cretaceous are the herbivorous multituberculates, which show evidence of morphologic radiation through increased jaw and teeth disparity, and insectivorous therians, which experienced a taxonomic radiation. Body size and morphologic disparity of non-multituberculate mammals, primarily therians, appear to decline with the advent of angiosperms, suggesting the possible occurrence of a morphological "bottleneck" that resulted in a shift towards small insectivores. The results of this study call for more exhaustive research concerning the possibility of mammal-angiosperm-insect co-evolution.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

REFINING HADROSAURID DIVERSITY IN THE SAN JUAN BASIN THROUGH THE REEXAMINATION OF HISTORIC SPECIMENS

GUENTHER, Merrilee F., Elmhurst College, Elmhurst, IL, United States; WOSIK, Mateusz, Elmhurst College, Elmhurst, IL, United States; MCCARTHY, Stephanie, Elmhurst College, Elmhurst, IL, United States

Understanding hadrosaurid diversity in the San Juan Basin can be difficult due, in part, to limitations on the number and quality of specimens. A reexamination of specimens collected in New Mexico in 1922 by Charles H. Sternberg reveals increased taxonomic diversity of hadrosaurids in the San Juan Basin. These specimens include disarticulated cranial and postcranial elements from the Kirtland Formation of McKinley County, New Mexico, approximately 85 miles northeast of Thoreau, New Mexico.

All of the adult cranial and postcranial specimens belong to hadrosaurine taxa. Morphological variation indicates that at least two taxa of hadrosaurines are present in this collection. Cranial material includes dentaries, jugals, prefrontals, and quadrates. Based on the preserved morphology, the cranial elements are referable to the genus *Gryposaurus*. The postcrania exhibit the gracile morphology characteristic of hadrosaurines. The best-preserved postcranial elements are humeri and pubes. The pubes are also referable to *Gryposaurus* as indicated by the profile of the prepubic process of the pubis. Presence of this taxon in the San Juan Basin extends the geographic range of *Gryposaurus* and represents the southern most example of this genus.

This collection also represents individuals from a wide range of growth stages from juvenile to adult. The smallest individuals are represented by fragmentary elements. The juvenile elements consist of postcrania including rib, scapula, and femur, and skull elements, such as a partial quadrate and quadratojugal. The smallest element, a scapula that is 66 mm in length, is comparable in size to those of hatchling hadrosaurs of other genera. The lateral profile of the dorsal margin of this scapula is craniocaudally straight, suggesting that the hatchling represents a basal hadrosauroid taxon. A partial dentary, 53 mm in length, is approximately half the size of the other adult dentaries found, signifying the presence of more advanced juvenile hadrosaurids. At the opposite extreme, are adult elements that represent hadrosaurid individuals that are among the largest known. A large humerus, hadrosaurine based on deltopectoral crest proportions, measures 861 mm in length.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

DENTAL MICROWEAR IN HADROSAURID DINOSAURS FROM THE KAIPAROWITS FORMATION, UTAH

GUNN, Jonathan, The Webb Schools, Claremont, CA, United States; NAZIKIAN, Toshiki, The Webb Schools, Claremont, CA, United States; FARKE, Andrew A., Raymond M. Alf Museum of Paleontology, Claremont, CA, United States

Dental microwear studies, focusing on pits and scratches on the wear-surfaces of teeth, can be used to infer dietary and masticatory patterns in extinct and extant vertebrates. Here, we documented dental microwear in hadrosaurid dinosaurs from the Kaiparowits Formation, Campanian-aged deposits exposed in southern Utah. Previous studies have shown minimal variation in the microwear of hadrosaurids from throughout North America, so we wished to see if the pattern extended to the Kaiparowits Formation. Eighteen shed, isolated teeth were molded and cast, and digital photographs were taken of the occlusal surfaces of the specimens under magnification. High dynamic range (HDR) imaging was used to better visualize microwear features, and these features were then counted digitally. Definitive microwear was found on six of the sampled teeth, and categorized as coarse scratches, fine scratches, and pits. Pits formed 22 percent of the microwear features observed in the teeth, and wear patterns were similar in all specimens from all sites. Furthermore, the wear patterns in the Kaiparowits Formation hadrosaurids are similar to those in previously reported samples from Campanian and Maastrichtian-aged strata elsewhere in North America. This may indicate dietary similarity across the hadrosaurs in these formations, as has been previously suggested.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FIRST RECORDS OF FOSSIL BATS FROM THE DOMINICAN REPUBLIC

GUNNELL, Gregg F., Duke University Lemur Center, Durham, NC, United States; SIMMONS, Nancy B., American Museum of Natural History, New York, NY, United States; ROSENBERGER, Alfred, Brooklyn College (CUNY), Brooklyn, NY, United States; O'NEILL, Hannah K., Brown University, Providence, RI, United States; RIMOLI, Renato, Universidad Autónoma de Santo Domingo, Santo Domingo, Dominican Republic

Fieldwork, conducted in 2011 in conjunction with Brooklyn College (CUNY), was carried out to explore two underwater cave systems in the Dominican Republic. These efforts have produced a number of vertebrate fossil specimens including primates, sloths, snakes, crocodiles and the first evidence of bats from the eastern part of Hispaniola. Divers associated with the Museeo del Hombre Dominicano collected bat fossils at a locality known as Oleg's Bat Cave near Bavaro in the eastern Dominican Republic, and also in the El Dudu cave system in the northern part of the country. The bat fossils recovered, which are almost certainly late Pleistocene to early Holocene in age, consist of isolated, but generally complete, elements including skulls, jaws, and various limb bones. Even though each cave system has only been partially explored, the bat specimens recovered to date are very numerous, numbering into the hundreds of specimens. Eight bat species have been identified thus far including four mormoopids (*Mormoops blainvillii*, *Pteronotus parnellii*, *Pteronotus quadridens*, and *Pteronotus macleayii*) and four phyllostomids (*Brachyphylla nana*, *Erophylla bombifrons*, *Monophyllus redmani*, and *Phyllonycteris poeyi*). All of these species still inhabit Hispaniola today with the exception of *Pteronotus macleayii*, which is known only from Cuba and Jamaica (extant populations) and the Bahamas (Quaternary fossils). The discovery of fossil *P. macleayii* in the eastern Dominican Republic represents a significant range extension for this species and indicates that local extinction events have occurred over the past few thousand years, either in response to climate change or due to anthropogenic factors. In addition, our records from the Dominican Republic represent the first fossils of *Pteronotus parnellii* and *P. quadridens* from the island of Hispaniola, and the first ever record of *Erophylla bombifrons* as a fossil. Two other bat taxa known as fossils from Haiti (the phyllostomids *Macrotus waterhousii* and *Artibeus jamaicensis*) have yet to be found in the cave systems in the Dominican Republic.

Technical Session XVIII (Saturday, October 20, 2:15 pm)

FIRST APPEARANCE OF ENLARGED INNER EARS IN ECHOLOCATING BATS

HABERSETZER, Joerg, Senckenberg Research Institute, Frankfurt, Germany; GUNNELL, Gregg F., Duke Lemur Center, Durham, NC, United States

Tanzanycteris mannardi is represented by a single partial skeleton from the middle Eocene locality of Mahenge in Tanzania. It is among the earliest known fossil bats from Africa and is one of only a very few Paleogene mammals known from south of the Sahara. When originally described it was compared favourably with the primitive European middle Eocene bat *Hassianycteris messelensis* from Messel in Germany but was ultimately placed in its own family, Tanzanycteridae, based on the unique presence of an enlarged cochlea. *T. mannardi* is the only known Eocene bat species with greatly enlarged inner ears. Based on the relatively large size of the cochlea, *T. mannardi* was hypothesized to have possessed a highly sophisticated echolocation system (high duty-cycle echolocation where-in constant frequency emission is employed) which is comparable to that of acoustically extremely specialized extant taxa. In the original study, 2D-microradiography revealed large cavities inside skull as well as sediment representing the approximate size of the former inner ear while most of the bone itself was dissolved. We undertook to re-examine the holotype of *T. mannardi* in order to more precisely measure the 3D-shape of the cochlear endocast and the sparse bony remains of the inner ear and the vestibular organ by means of micro-CT and nano-CT. Our results indicate that, compared with other Eocene and extant bats, the cochlear size of the Tanzanian bat is relatively enormous, comparing especially well with living hipposiderids, rhinolophids and the mormoopid *Pteronotus parnellii*, all of which employ highly sensitive echolocating capabilities. The presence of echolocating abilities utilizing long CF (constant frequency) sounds in a middle Eocene bat from Africa indicates that sophisticated echolocation was developed early in the radiation of bats and that the complex aerial hawking behaviours associated with high duty-cycle echolocation were present in the *Tanzanycteris* lineage. The development of constant frequency echolocation may have been in response to the increased ability of insect prey (in particular moths and other large flying insects) to detect and avoid low duty-cycle bat predators. In addition, high duty-cycle echolocation would have increased the ability of bats to hunt in cluttered and complex habitats in order to increase access to insect prey.

Technical Session XVII (Saturday, October 20, 2:00 pm)

AERODYNAMICS OF THE TAIL IN *MICRORAPTOR* AND THE EVOLUTION OF THEROPOD FLIGHT CONTROL

HABIB, Michael, University of Southern California, Los Angeles, CA, United States; HALL, Justin, University of Southern California, Los Angeles, CA, United States; HONE, David W., University College Dublin, Dublin, Ireland; CHIAPPE, Luis M., Natural History Museum of Los Angeles County, Los Angeles, CA, United States

Microraptoran dinosaurs may have experienced intrinsic difficulties with pitch control because they retained a trunk of typical dromaeosaurid proportions, as opposed to the shortened trunk of ornithurine birds. As a result, any appreciable forward sweep of the wings could bring the center of lift in front of the center of gravity, resulting in a positive pitching moment. Some pitch control could have been provided by the tail fan, however, because the position of the tail fan well behind the center of mass would supply a long moment arm for pitch control. This is not mutually exclusive to other tail uses, such as display or balance during running and climbing.

Specimens of *Microraptor gui* show that a fan of feathers existed near the terminus of the tail. We apply a conservative flat-plate flow analysis to the clearly discernable tail fan of the holotype specimen *Microraptor gui*, and estimate that the tail could plausibly compensate for the equivalent of 100-150g of mass acting in pitch. This would be sufficient to correct for small deviations of the center of gravity from the center of lift. While we expect that the tail would mostly function to reduce positive pitch (nose-up motion), the tail could also be used to dampen negative pitching moments produced during the initial deployment of the hindwings in turning or the dual deployment of the hindwings as airbrakes. We note that the tail was capable of functioning as either a passive pitch stabilizer or an active pitch control device. In active stabilization, a slightly elevated tail position could counter negative pitch while a depressed position could counter positive pitch. The tail could not have provided significant control in yaw or roll, but the forewings and hindwings would have been well suited to providing those control functions.

We suggest that a new and more compelling general model for the evolution of flight in paravians and early birds is emerging. Early in the evolution of theropod flight, major flight control functions were relatively evenly distributed between the forewings and the auxiliary control surfaces – namely, the hindwings and tail. This allowed the comparatively robust hindlimbs and tail of paravians to carry much of the mechanical loading associated with tight maneuvers, launching, and landing. As a result, volant paravians could engage in flight behavior despite possessing overall morphology little changed from the ancestral condition. In more derived members of the avian line, most control function shifted to the forewings, though primary launch power continued to be provided by the hindlimbs. This model explains how animals such as *Microraptor* could fly in cluttered environments with small pectoral muscle fractions and gracile forelimbs.

Technical Session XVII (Saturday, October 20, 1:45 pm)

A NEW MODEL FOR HINDWING FUNCTION IN THE FOUR-WINGED THEROPOD DINOSAUR *MICRORAPTOR GUI*

HALL, Justin, University of Southern California/Natural History Museum of Los Angeles County, Los Angeles, CA, United States; HABIB, Michael, University of Southern California, Los Angeles, CA, United States; HONE, David W., University College Dublin, Dublin, Ireland; CHIAPPE, Luis M., Natural History Museum of Los Angeles County, Los Angeles, CA, United States

The evolution of powered flight in birds remains a contentious issue in vertebrate paleontology. The small dromaeosaurid dinosaur *Microraptor gui* preserves evidence of extensive, lift-generating feathers on each manus and forearm, but also preserves evidence of lift-generating feathers associated with the hindlimbs, effectively forming a pair of "hindwings". Similar morphology has also been described for the hindlimbs of *Pedopenna, Anchiornis* and *Xiaotingia*. Phylogenetic analyses consistently place all of these taxa as paravians and thus close to the origin of birds. Combined with anatomical and functional studies, this indicates that flight evolved at least once within the lineage originating with the common ancestor of birds and dromaeosaurids. Thus, the four-wing design and its inferred flight performance may represent an ancestral four-winged stage in avian flight evolution. Alternatively, the evolution of flight may not have represented a single monophyletic event and there could be multiple abandoned body plans attempting to solve flight performance issues. Under such a case, *M. gui* may represent an alternative solution to aerodynamic issues experienced by early flying theropods.

Prior authors modeled the hindlimb of *M. gui* in a strongly abducted four-winged gliding position that may require an anatomically implausible orientation of the hip socket. We suggest an alternative model in which the hindwings were generally held below the body during steady flight, but deployed unilaterally, or bilaterally, to produce additional roll and yaw during unsteady flight maneuvers, such as turning. In this way, the hindwings could serve as control surfaces, enhancing maneuverability. The effect of a single, laterally deployed hindwing can be calculated for any bank angle. We calculate a 38% decrease in turning radius for a 45 degree bank angle and a 36-179% (20-90 degrees bank angle). Deployment of the hindwings as control surfaces held below the body generates substantial potential locomotor advantage, is supported by aerodynamics and requires no unusual positioning of the hindlimb.

Technical Session VII (Thursday, October 18, 3:30 pm)

TESTING THE INHIBITORY CASCADE MODEL IN MESOZOIC AND CENOZOIC MAMMALIAFORMS

HALLIDAY, Thomas J., University College London, London, United Kingdom; MACKENZIE, Philip, University College London, London, United Kingdom; GOSWAMI, Anjali, University College London, London, United Kingdom

Tooth morphology has been used extensively in the study of mammalian evolution, but models of tooth development have been rarely applied to palaeontological data. The Inhibitory Cascade (IC) model of lower molar development postulates a ratchet system whereby the size of each lower molar is determined by the size of the immediately anterior molar through an inhibitory pathway. Consequences of this model include that the second lower molar (m2) should make up one third of total molar area, and that the sizes of molars should progress sequentially from either large to small, or small to large. By taking length and breadth measurements directly from specimens and from published photographs, tooth areas were estimated for over 65 genera. Sampled taxa represent diverse mammaliaforms, including stem and crown therians, australosphenidans, and more basal taxa, and range from the Jurassic to the present, with particular focus on Cretaceous and Paleogene taxa. The predictions of the IC model were largely upheld across therians and australosphenidans, with some phylogenetic clustering. In 73% of taxa sampled, m2 length is intermediate between that of m1 and m3, while 57% are intermediate when area is used. Furthermore, the mean proportional size of m2 across all taxa was 35% of total area, consistent with the predictions of the IC model. Upper teeth show a much lower proportion (26%) of intermediate-sized second molars, suggesting that a different process may be involved. When the ratio of m2:m1 area is plotted against m3:m1 area, the majority of the taxa fall within or near to the area predicted by the IC model. Earlier and more basal taxa, such as australosphenidans and several Cretaceous stem and crown therians, are clustered around the area indicating equal size in all three molars. Notoungulates, pantodonts and erinaceomorphs fall within or near to the area predicted by the IC model, but other taxa, such as many condylarths, fall well outside of the expected region and are far more disparate. While taxa with some clades show consistent results, phylogenetic clustering is, in general, weak when molar area is analysed. When length is measured rather than area, much stronger phylogenetic clustering emerges, which may be a result of differing molar length-width relationships between groups. The strongest phylogenetic clustering is found when assessing ratios of length between adjacent lower molars, suggesting that a m2/m1 versus m3/m2 plot might provide a strong taxonomic signal and potentially aid in assigning enigmatic fossil taxa to groups, extinct or extant. Overall, these results suggest that the IC model may be plesiomorphic to crown Mammalia, but molar proportions in some taxa depart significantly from expectations.

Romer Prize Session (Thursday, October 18, 9:45 am)

EVIDENCE FOR SUSPENSORY LOCOMOTOR ADAPTATIONS IN A LATE MIOCENE FOSSIL APE BASED ON *IN VIVO*-VALIDATED MODELS OF HIP JOINT ABDUCTION

HAMMOND, Ashley S., University of Missouri, Columbia, MO, United States

Suspensory locomotion plays an important role in hypotheses for the origins of great ape locomotion. When and how suspensory behaviors evolved is currently debated. Early Miocene apes are hypothesized to have been above-branch quadrupeds with suspensory capacities inferred to have originated in the middle to late Miocene, but few data have been available with which to test this hypothesis. Hominoid suspension is thought to require an increased range of hip joint abduction compared to monkey-like above-branch quadrupedal behaviors. If hip joint mobility can be accurately reconstructed from bone morphology, this would provide an opportunity to evaluate locomotor abilities based on hip joint function in fossil apes. Here I present results of *in vivo* and *in silico* measures of hip joint abduction capacity in suspensory (*Symphalangus*, *Hylobates*, *Pongo*, *Gorilla*, *Pan*, *Ateles*) and non-suspensory (cercopithecids, *Cebus*) extant anthropoids. Angular abduction at the hip was measured on anesthetized living primates using a goniometer. Pelves and femora of the same taxa were laser scanned and 3D polygonal models were digitally articulated. Maximum hip abduction was modeled using PolyWorks software using strictly-defined morphological criteria for joint movement. *In silico* and *in vivo* data are strongly correlated, validating the use of digital reconstructions of hip joint mobility. Suspensory taxa have greater ranges of hip abduction than non-suspensory primates using both types of data. When these methods are applied to Miocene apes, results show that the early basal hominoid *Proconsul* had hip abduction similar to non-suspensory quadrupedal anthropoids, whereas the late Miocene crown hominoid *Rudapithecus* displays hip abduction capacity comparable to suspensory extant apes and *Ateles*. This project provides the first evidence for suspensory abilities from the hindlimb of any Miocene ape.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW SPECIMENS OF ELASMOTHERIINI (RHINOCEROTIDAE, PERISSODACTYLA) FROM THE NAMURUNGULE AND NAKALI FORMATIONS (EARLY LATE MIOCENE) OF NORTHERN KENYA

HANDA, Naoto, Kagoshima University, Kagoshima, Japan; NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan; NAKATSUKASA, Masato, Kyoto University, Kyoto, Japan; KUNIMATSU, Yutaka, Kyoto University, Kyoto, Japan

The early Late Miocene Namurungule and Nakali Formations are distributed in northern Kenya. Previously, *Kenyatherium bishopi* is the only elasmotheriin described from the Namurungule and Nakali Formations. The Japan-Kenya joint expedition team has discovered several Rhinocerotidae fossils from these formations. We report new Elasmotheriini fossils from the Namurungule and Nakali Formations.

The specimens from the Namurungule Formation consist of a maxilla with molars (M2 and M3), a mandible with lower p4 to m2 and isolated teeth of upper P4 and upper M3. These specimens were preliminarily identified as Iranotheriinae sp. nov. The specimens from the Nakali Formation include isolated teeth of upper M1 or M2 and upper M3.

These specimens share the following diagnostic characters of the tribe Elasmotheriini: crown cement, constricted protocone of the upper molars and bucco-lingually elongated postfossette of upper P4. These specimens are distinguished from *Kenyatherium bishopi* by lacking characters of the species such as united protocone and hypocone of the molars and developed enamel folding. These specimens are characterized by lingually elongated protoloph and metaloph, undeveloped enamel folding and small crochet. These characters indicate that these specimens resemble following the middle Miocene Elasmotheriini: *Victoriaceros kenyensis* from Maboko of Kenya, and *Huaqingtherium lintungense* from Lintung, Shaanxi, China.

However, the specimens of the Namurungule and Nakali Formations have a small enamel plication in the medisinus of the upper molars. This character is not seen in the upper molars of *V. kenyensis* and *H. lintungense*. Additionally, molar size of these specimens is smaller than those of *V. kenyensis* and *H. lintungense*. Therefore, these specimens belong to a new taxon.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

INVESTIGATING THE IMPACT OF COMPETING INTERPRETATIONS OF PECTORAL GIRDLE PLACEMENT AND APPENDICULAR FUNCTION ON SAUROPOD HEAD HEIGHT

HARTMAN, Scott, skeletaldrawing.com, Madison, WI, United States

Previous attempts to reconstruct the posture and potential range of motion in the cervical series of sauropod dinosaurs have focused on restoring the osteological neutral position (ONP) of the axial column, and attempts to link ONP with the degree of habitual vertebral flexion observed in extant vertebrates. While placement of the pectoral girdle has met with passing discussion, the roll of differing interpretations of appendicular posture has been largely ignored.

To evaluate the impact of competing functional interpretations of the pectoral girdle and appendicular skeleton, a quantitative analysis was conducted on the three most commonly used interpretations of pectoral girdle placement in the literature, and several models of limb kinematics. Testing was carried out on a 3D digital dataset of *Camarasaurus*, as well as dimensionally-accurate skeletal diagrams of *Camarasaurus* and several other neosauropods to increase taxonomic sampling.

Results show that differing interpretations of the angle of the scapula on the body had a minimal impact on the elevation of the presacral column, while the location of the pectoral girdle had a significant impact, with more ventrally and posteriorly located pectoral girdles leading to progressively higher head height.

Published interpretations of forelimb posture in sauropods vary mostly in the orientation of the humerus and the degree of eversion in the elbow. Neither was found to have a significant impact on head height. Hind limb kinematics were found to have a larger impact on head height, as knee and ankle flexure reduced pelvic height, which in turn raised the cervical series. Differences in restoring the pes of sauropods differ markedly, from digitigrade to plantigrade; lowering the foot into a plantigrade stance was found to increase head height.

These findings demonstrate that restoring the ONP of vertebrae is insufficient to accurately estimate head height in sauropods. Competing interpretations of pectoral girdle position and hind limb kinematics can influence the angle of the cervical series significantly, suggesting that a more holistic approach must be taken with regard to sauropod neck posture.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW SPECIES OF CANID FROM THE MALAPA HOMININ SITE, GAUTENG, SOUTH AFRICA

HARTSTONE-ROSE, Adam, Penn State Altoona, Altoona, PA, United States; KUHN, Brian F., Institute for Human Evolution, University of the Witwatersrand, Johannesburg, South Africa; NALLA, Shahed, Institute for Human Evolution, University of the Witwatersrand, Johannesburg, South Africa; WERDELIN, Lars, Department of Palaeozoology, Swedish Museum of Natural History, Stockholm, Sweden; BERGER, Lee R., Institute for Human Evolution, University of the Witwatersrand, Johannesburg, South Africa

The recently discovered hominin bearing site of Malapa (Gauteng South Africa), type locality for *Australopithecus sediba*, has yielded a mammalian fossil assemblage that is remarkable in both its taxonomic breadth and preservational quality. Many of the species that have been identified from this assemblage are represented by multiple elements from single individuals – a rarity for the South African fossil record. Numerous specimens of carnivorans have also been described from the site including both large and small species. Here we examine a smaller sample of specimens that represent the second new species (after *A. sediba*) to emerge from the 1.977 million year old Malapa sample – a new small canid that we attribute to the genus *Vulpes*.

The type specimen, University of the Witwatersrand (UW) 88-812 is a right mandibular fragment that includes part of the alveolus of the p3, the complete p4 and m1, the alveoli of m2 and m3 and the entire distal portion of the mandible. The coronoid, condylar and angular processes as well as mandibular foramen and masticatory muscle insertion scars are well preserved. Another specimen (UW 88-814) is a complete right m2 crown that we believe is from the same individual. Likewise, a complete right rib (UW 88-813) from a small canid was also recovered from the same breccia block. Given the preservational state of Malapa (almost no taphonomic mixing of the sample), this specimen likely came from the same individual.

Relative to a large sample of individuals of modern and fossil *Vulpes* as well as other small canid genera (which can be excluded based on morphology), the new Malapa species of *Vulpes* is defined by the lack of distal accessory cusp on its p4, mesiodistally compressed and high-crowned m1 trigonid, relatively large m2, and relatively small condyle. Overall, this new species is gracile with high-crowned sharp teeth, suggesting, despite its lack of accessory cusps, a tendency toward hypercarnivory or insectivory.

Romer Prize Session (Thursday, October 18, 10:15 am)

DYROSAURID CROCODYLIFORMS ATTAIN PEAK TAXONOMIC DIVERSITY AND CRANIAL MORPHOSPACE DISPARITY IN FRESHWATER FOLLOWING LATE CRETACEOUS LARGE MARINE TETRAPOD EXTINCTION

HASTINGS, Alexander, University of Florida, Gainesville, FL, United States

The Cretaceous-Paleogene (K-Pg) boundary marked the extinction of most large marine tetrapods. While other large marine tetrapods were nearly absent in the following Paleocene, dyrosaurid crocodyliforms have been recovered from marine depositional environments from the Late Cretaceous through the Eocene, when their extinction coincides with the diversification of cetacean mammals. The lack of competition by other large marine tetrapods during the Paleocene may have enabled dyrosaurids to radiate into new habitats and occupy new morphospace. Dyrosaurid fossils from the Paleocene Cerrejón Formation of South America indicate adult individuals occupied entirely freshwater with very different skull morphologies from their saltwater counterparts. Past studies of stable isotopes from dyrosaurids have indicated similar behavior to extant C*rocodylus porosus* which inhabits freshwater as a juvenile then moves to more saline waters with maturity. This suggests the possibility that typically saltwater dyrosaurids inhabited freshwater as adults through paedomorphic modification of ontogeny. The Cerrejón dyrosaurids provide a test for the hypothesis that dyrosaurids diversified into new habitats and occupied new morphospace through paedomorphic modification in a non-marine habitat during the Paleocene. To quantify and compare fresh versus saltwater dyrosaurids, skulls of each dyrosaurid species, for which nearly complete fossils have been recovered (n=10), were analyzed using geometric morphometrics and compared to the same analyses for four extant crocodylian

species (all n≥20). Results of modern morphospace analyses show a significant correlation (all p<0.0001) between Relative Warp 1 (mostly variance in snout length) and size (a proxy for age). This same shift in Relative Warp 1 is seen in dyrosaurids from adult freshwater species to adult saltwater species. This similar shift is consistent with the hypothesis that dyrosaurids diversified in freshwater through retention of juvenile skull morphology. This paedomorphic shift in ontogeny increased diversity and disparity of Dyrosauridae during the Paleocene.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A SNAPSHOT OF THE ANATOMY, LOCOMOTION AND SOCIAL BEHAVIOR OF EARLY MODERN HUMANS AS EVIDENCED BY FOSSIL FOOTPRINTS AT ENGARE SERO, TANZANIA

HATALA, Kevin G., The George Washington University, Washington, DC, United States; RICHMOND, Brian G., The George Washington University, Washington, DC, United States; HARCOURT-SMITH, William E., American Museum of Natural History, New York, NY, United States; LIUTKUS, Cynthia M., Appalachian State University, Boone, NC, United States; ZIMMER, Brian, Appalachian State University, Boone, NC, United States

Fossil human footprints provide a rare but exciting opportunity to directly observe the fossilized behavior of our extinct ancestors. Here we report on a new late Pleistocene fossil human footprint site at Engare Sero, Tanzania. We have uncovered over 350 human footprints at the site, making it the most numerous East African hominin footprint site known to date. The footprint assemblage contains at least 24 distinct trackways and some isolated prints of multiple individuals walking on a surface of wet volcanic ash about 150 m^2 in area over a short period of time (hours to days). This assemblage of fossilized footprints offers a unique window through which we can directly test hypotheses regarding the foot anatomy, gait, and social behavior of early modern humans in the late Pleistocene.

We conducted footprint formation experiments with the habitually unshod Daasanach tribe of northern Kenya, to aid in our interpretation of the Engare Sero fossil prints. We recruited 38 adults (19 male, 19 female) to produce footprints in soft sediment of various moisture levels, at a variety of speeds, including a normal walk, fast walk, jog, and sprint (3 trials at each speed). In our experiments, we found that relative stride length (stride length/footprint length) was a significant predictor of walking velocity (least squares regression, r^2=0.81, p<0.0001). We used this relationship to predict velocities from the Engare Sero footprint trackways, which ranged from about 1 to 2.2 m/s. The orientation of the fossil trackways suggested two groups, one headed northeast and the other southwest. While the six northeast-bound trackways represented a variety of speeds of travel (about 1.25 to 2.2 m/s), over a dozen southwest-bound trackways were likely formed by individuals traveling at very similar speeds (about 1 to 1.25 m/s). The facts that these southwest-bound individuals were moving in a common direction, at almost the same speeds, within a very short window of time, suggest that they may have been traveling together.

If this group were traveling together, then the Engare Sero footprint assemblage may offer the only form of fossil evidence that can be used to directly inform hypotheses about early human group structure. We used resampling statistics and a large (n>2000) data set of modern human foot metrics to calculate the probabilities that each trackway represented foot sizes similar to those of modern men, women, or children. Our statistical results suggest the most probable scenario that the southwest-bound fossil footprint trackways were produced by over a dozen adult females and juveniles, and only one clearly identifiable adult male, who appear to have been traveling together.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ANALYSIS OF THE THEROPOD HALLUX FOR UNRAVELLING THE EVOLUTION OF FOOT FUNCTION

HATTORI, Soki, Nagoya University, Nagoya, Japan

Among the four pedal digits of non-avian theropods, only pedal digit I (hallux) could not reach the ground mainly because of its size relative to other digits. The presence of an opposable hallux is regarded as an important indicator of increasing arboreality because it had a crucial function in perching ability. There are, however, only a few studies of the function of the non-reversed hallux in non-avian theropods, even during cursorial locomotion. Therefore, the purpose of this study is to clarify the form and function of the hallux and foot of non-avian theropods during bipedal locomotion, based on an analysis of both extant birds and non-avian theropods.

In ornithischians, sauropodomorphs and basal theropods, metatarsal I is articulated with the ankle joint like other metatarsals, but this contact is lost in more derived theropods (i.e. neotheropods). I observed several specimens of neotheropods such as *Coelophysis*, *Allosaurus*, *Albertosaurus*, *Khaan*, *Citipati*, *Deinonychus* and *Troodon*. The *Coelophysis* specimens did not prvide information on the detailed structure of the pes because of their state of preservation, but all observable parts of the hallux could be seen to lie on the plantar side of the metatarsus. Metatarsal I in the other taxa has a pointed proximal end, a trochlea surface at its distal end, and deeper lateral collateral ligament fossae than medial ones. In the studied specimens of *Allosaurus* and *Albertosaurus,* this trochlea is well-developed on the flexor surface, but rounded like a ‹ball joint› on the extensor surface, and there is a mediolaterally directed groove adjacent to this rounded joint. In *Khaan* and *Citipati,* extensor or medial views are observable but they seem to have the same features as described above. *Deinonychus* also has a half-rounded trochlea, but the mediolaterally directed groove is invisible. *Troodon* has a more unusually shaped metatarsal I, where the distal end is strongly twisted towards its extensor side.

An articular facet for metatarsal II is located on the lateroplantar surface of the proximal end of metatarsal I: however, the detailed morphology of this facet varies in *Allosaurus*, *Albertosaurus* and *Deinonychus*.

The torsion of metatarsal I, which causes completely reversed hallux and significant grasping ability, is commonly seen as a crucial difference between extant birds and non-avian theropods. However, some features such as deeper lateral collateral ligament fossae and mediolaterally directed grooves are commonly seen in both non-avian theropods and extant birds. Therefore, additional research and comparison of form and function of metatarsal I potentially enables us to understand the unknown function of the hallux in non-avian theropods.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

INTEGRATING DENTAL MICROWEAR TEXTURE ANALYSIS AND GEOCHEMICAL DATA IN AN EXTANT CARNIVORE (*PUMA CONCOLOR*): LESSONS LEARNED FROM MODERN ECOLOGY OF APPLICATION TO PALEOECOLOGICAL STUDIES

HAUPT, Ryan J., Vanderbilt University, Nasvhille, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States

Dental microwear texture analysis (DMTA) and stable isotope geochemistry are powerful tools for understanding the ecology and paleoecology of animals. In particular, the study of carnivores can benefit from integrating data on potential prey resources and relative bone consumption, inferred from stable isotope and DMTA data, respectively. Stable isotope geochemistry ($\delta^{13}C$ and $\delta^{15}N$ data from bone collagen) have shown that Florida panthers (*Puma concolor coryi*) subsist mainly on deer and feral hogs, but will also consume raccoons, nine-banded armadillos, and rabbits. Males were also found to have a more varied diet than females, possibly because of larger home ranges and/or less time spent at kill sites of larger prey. Previous DMTA work on extant carnivores demonstrates the ability to infer relative amounts of durophagy between extant taxa. Thus, we use DMTA of lower carnassial teeth to determine if demographic factors affect carcass utilization. We expect to see differences based on sex, age, and location consistent with previous geochemical data. Our results show a slight negative relationship between anisotrophy (*epLsar*) and average m1 length (R^2=0.23, p=0.067) that approachs significance, indicating that bone avoidance (inferred from greater *epLsar*) occurs in smaller individuals. Furthermore, $\delta^{13}C$ values are positively correlated with anisotropy (*epLsar*) (R^2=0.42, p<0.01), suggesting differences in prey resource utilization in different environments, which was previously suspected based on the tight correlation between $\delta^{13}C$ and $\delta^{15}N$ values. Furthermore, no significant differences were seen between other DMTA characters and geographic location, sex, age, or body size. However, females do have lower mean complexity values than males (3.384 and 4.747, respectively; p=0.052) that are almost statistically significant, indicating greater processing of harder objects by males. These results suggest more complex relationships between demographics and food habits than inferred based on geochemical data. We ultimately conclude that these proxies are complementary, not identical, and can be used in tandem to explore more subtle distinctions and variations in dietary behavior than either proxy could alone. Lastly, when comparing *P. concolor* to other extant carnivores, they are statistically indistinguishable from the African lion *Panthera leo* (in complexity - *Asfc*, *epLsar*, and texture fill volume - *Tfv*) while significantly different from the cheetah *Acinonyx jubatus* (*Asfc* and *epLsar*, p<0.01) and spotted hyena *Crocuta crocuta* (*Asfc* and *Tfv*, p<0.05), consistent with observational data. Collectively, these data provide a necessary baseline understanding of an extant carnivore, allowing for comparisons to extinct carnivorous taxa in deep time.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

TESTING EVOLUTIONARY SIZE TRENDS IN THE OPHIACODONTID (SYNAPSIDA, EUPELYCOSAURIA) SKULL

HAWTHORN, Jessica R., University of Toronto at Mississauga, Mississauga, ON, Canada; REISZ, Robert R., University of Toronto at Mississauga, Mississauga, ON, Canada

Members of the synapsid family Ophiacodontidae provide the earliest record of amniote diversification, and are known from the Middle Pennsylvanian to Early Permian of North America and Europe. There is a clear trend of increasing body size within the family, from the small Middle Pennsylvanian genus *Archaeothyris florensis* to the much larger *Ophiacodon major* from the Early Permian. Increasing skull length relative to trunk length through time has also been reported within Ophiacodontidae, with the latest and largest species thought to have proportionally larger heads. Large heads are unusual among Palaeozoic amniotes, and the dimensions of the elongate, lightly constructed skulls of ophiacodontids differ greatly from contemporaneous eupelycosaurs; however, the apparent emergence of this highly atypical morphological trend has not previously been tested to determine if it is merely an artifact of an overall increase in body size. Elongation of the antorbital region of the skull, another trend reported within ophiacodontids, has also not previously been tested. Total skull length was regressed against presacral vertebral column length, and antorbital skull length is regressed against total skull length using log-transformed data in order to test the hypotheses of increasing skull length relative to trunk length and antorbital elongation, respectively. The residuals from each analysis were plotted against stratigraphic order. The results support allometric antorbital elongation through

time for *Ophiacodon*, but not all ophiacodontids. The trend of increasing relative skull length through time is not supported, though this may be an artifact of the current paucity of specimens with both measureable crania and postcrania positively associated with the same individual. Evaluation of these perceived trends is critical to understanding the taxonomic diversity of ophiacodontids and constructing hypotheses of lifestyle, such as the possible adoption of a secondarily aquatic mode of life, within the family through time.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PHYLOGENETIC AND ONTOGENTIC VARIATIONS OF BONE HISTOLOGY IN THYREOPHORAN OSTEODERMS

HAYASHI, Shoji, University of Bonn, Bonn, Germany; ZHAO, Qi, University of Bristol, Bristol, United Kingdom; WATABE, Mahito, Hayashibara Museum of Natural Sciences, Setouchi, Japan; CARPENTER, Kenneth, Prehistoric Museum, Utah State University - College of Eastern Utah, Price, UT, United States; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Within vertebrate evolution, only thyreophorans have evolved huge and bizarrely shaped osteoderms. Their function and extreme size evolution remain controversial; possible functions include defense, display, species recognition, and thermoregulation. In this study, we explored ontogenetic and phylogenetic changes in thyreophoran osteoderm histology to shed light on the evolutionary history and functional implications of osteoderms in thyreophorans. Late juvenile ankylosaurs (*Pinacosaurus*) lack large postcranial osteoderms, with the exception of the cervical half-rings and small bony ossicles. This developmental delay of osteoderm formation with respect to the body skeleton is similar to living reptiles. Contrary to this, a juvenile *Stegosaurus* (Denver Museum of Natural History and Science 33359) already has a well-developed dorsal plate. Additionally, a histological comparison between the body skeleton and osteoderms of a growth series of *Stegosaurus* shows that the osteoderms continue to grow well after skeletal maturity has been reached. In terms of evolutionary heterochrony, these observations indicate predisplacement and hypermorphosis in stegosaur osteoderm evolution. Ontogenetic variations of thyreophoran osteoderms are observed in their cortical histology. The thickness of collagen fiber bundles in ankylosaur osteoderms and cortical bone of *Stegosaurus* spikes increases from juvenile to adult. Similar histological variations are also observed throughout their phylogeny. In ankylosaurs, derived taxa exhibit more extensively developed collagen fiber bundles with respect to the primitive taxa, and in stegosaurs, thick cortical bones of spikes are seen in derived taxa, but are lacking in any primitive taxa. All thyreophoran osteoderms are comprised of metaplastic bone, but important histological differences exist between derived ankylosaur and stegosaur osteoderms. In ankylosaurs, the structural and histological features of large osteoderms (cranial osteoderms, cervical half-rings, spikes, and clubs) are similar to those of small osteoderms embedded in the skin in that both have thin compact bone surrounding thick cancellous bone and abundant collagen fibers. In contrast, the spike-shaped osteoderms of derived stegosaurs have a uniform structure that differs markedly from the plates in having thick cortical bone. Both spikes and plates lack abundant, thick collagen fiber bundles. This suggests that stegosaur spikes and ankylosaur osteoderms both were reinforced but by different strategies and for different purposes, i.e., protection against penetration on one hand and inflicting wounds on the other. Stegosaur plates, on the other hand, have a weaker structure due to their spongious structure and their function was more likely for species recognition, display, and/or thermoregulation.

Technical Session I (Wednesday, October 17, 11:15 am)

AN OVIRAPTORID ADULT-EGG ASSOCIATION AND THE ORIGIN OF AVIALAN REPRODUCTIVE STRATEGIES

HE, Tao, Zhejiang Museum of Natural History, Hangzhou, China; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; JACKSON, Frankie D., Montana State University, Bozeman, MT, United States; JIN, Xingsheng, Zhejiang Museum of Natural History, Hangzhou, China; POUST, Ashley W., Department of Integrative Biology and University of California Museum of Paleontology, Berkeley, CA, United States

Although avian reproduction is unique among living animals, some aspects derive from their non-avian theropod ancestry. Here we describe a new oviraptorid specimen from the Upper Cretaceous Nanxiong Formation of Jiangxi, China. This partial skeleton with two closely associated eggs provides some insight into the theropod-avian transition in reproduction. The adult comprises the posterior half of the skeleton (from the mid-sacral region), fully articulated except for slight dorsal displacement of the caudal series relative to the sacrum and outward displacement of caudal gastralia. High caudal vertebrae count (>26), tall, triangular neural spines, and unfused metatarsals place the specimen within Oviraptorinae rather than Ingeniinae. Caudal sutures remain open, indicating that like most non-avian dinosaurs and other reptiles (but unlike crown avians) oviraptorids began reproduction before complete neurocentral closure. Gross inspection of cross-sections of the right femur and left tibia show no evidence of medullary bone. One of the long, asymmetric eggs (19.3 x 7.2 cm) lies behind the sacrum, below caudals 4-7. Ornamentation consists of linear ridges aligned with the long axis. The second egg sits between the ischia adjacent to the left side with its blunt end apparently directed caudally. The 1.0 mm-thick eggshell consists of two calcite layers, separated by a distinct and irregular boundary. Although the eggs are of similar shell thicknesses the mammillary to continuous layer ratios vary significantly. The eggs belong to Elongatoolithidae, but overlapping sizes and shell thicknesses within this oofamily complicate more definitive assignment. Consistent with unlaid eggs, there is no evidence of embryonic bone. The eggs' arrangement relative to the adult parallels the occurrence of young external to and partially exiting adult ichthyosaurs. Similar extrusion of young has been observed in drowned pregnant cattle, suggesting that the eggs were fully or partially extruded post-mortem due to the build up of decay-related gases internally. The displaced gastralia concur with an extended or exploded abdomen. The narrow fit of the egg in the pelvic canal argues against the hypothesis that theropods laid eggs in bound pairs. The blunt-end out arrangement of the internal egg differs from the typical oviposition alignment found in most extant birds. The presence of two equally developed eggs supports monoautochronic ovulation as hypothesized for Maniraptora on the basis of within-clutch egg pairing in *Troodon* and oviraptorids. This iterative style of laying may have allowed production of larger eggs relative to adult body mass.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:00 am)

PALEOGENE SQUAMATES FROM THE NORTHERN NEOTROPICS: ECOLOGICAL IMPLICATIONS AND BIOGEOGRAPHIC HISTORIES

HEAD, Jason J., Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; RINCON, Aldo F., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; MORENO-BERNAL, Jorge W., Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Ancon, Panama

The modern northern Neotropics possesses some of the highest diversity among extant squamates, but the sparse fossil record from this region has previously limited the ability to reconstruct their evolutionary histories. New discoveries from the early Paleogene of northern South America reveal biogeographic patterns and paleoecology of modern clades. Squamates have been recovered as components of vertebrate faunas from the late Paleocene Cerrejón Formation and late Paleocene- early Eocene Bogotá Formation of Colombia. The Cerrejón Formation represents large-scale fluvial deposits with associated rainforest flora and herpetofauna. The squamate record consists of snakes, including multiple individuals of the giant aquatic boid *Titanoboa cerrejonensis* and a single, poorly preserved precloacal vertebra assigned to Anilioidea on the basis of extreme reduction of the neural spine, broadly concave dorsal margin of the neural arch and comparatively narrow zygosphene. The presence of a fossorial to leaf-litter specialist provides the first the first terrestrial component to the reptile record and indicates geographic proximity of the aquatic record to rainforest habitats within the Cerrejón Formation. The Muchelo Creek locality in the Bogotá Formation is dated to just before the Early Eocene Climatic Optimum (EECO). It represents smaller-scale fluvial deposition, and preserves a diverse squamate fauna consisting of iguanians, including the fossil record of hoplocercines, and boine, caenophidian, and ungaliophiine snakes. Modern members of these clades include arboreal taxa, and the Bogotá squamate record represents a forest herpetofauna. Extant tropical forest squamates undergo thermal stress at high ambient temperatures, and inferred thermal tolerances of the Bogotá squamate record may constrain temperature estimates at the beginning of the equatorial EECO.

The Colombian squamate record indicates that the continental-scale biogeographic zonation of the modern northern Neotropics was established no later than the middle Eocene. Both the Bogotá and Cerrejón formations include representatives of extant clades that are either endemic or predominately South America ("anilioids") or whose Central American distributions are limited or represent more recent immigration from South America (hoplocercines, boines). These records additionally indicate that the biogeographic events that initially assembled Neotropical squamate faunas, including New World immigration of iguanians and first occurrence of South American boines, were likely late Mesozoic in age.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PHYLOGENETIC POSITION OF *PROCERVULUS* (CERVIDAE, ARTIODACTYLA, MAMMALIA) AND IMPLICATIONS OF CHARACTER EVOLUTION IN CERVIDS

HECKEBERG, Nicola S., Bavarian State Collections of Palaeontology and Geology & Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität München & Department of Zoology, University of Cambridge, Munich, Germany; RÖSSNER, Gertrud E., Bavarian State Collections of Palaeontology and Geology & Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität München & Geobio-Center, Ludwig-Maximilians-Universität München, Munich, Germany; ASHER, Robert J., Department of Zoology, University of Cambridge, Cambridge, United Kingdom; WÖRHEIDE, Gert, Bavarian State Collections of Palaeontology and Geology & Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität München & Geobio-Center, Ludwig-Maximilians-Universität München, Munich, Germany

Representatives of cervids are recorded for the first time from the early Miocene. A number of successive, adaptive radiations led to the diversity seen in the fossil record and the extant fauna, where cervids form the second most diverse family of large living mammals. Despite their widespread and common occurrence, much remains to be discovered concerning their phylogenetic history. Particularly interesting is the relationship of the early stem cervids to crown taxa of the family.

Previous studies dealing with cervid phylogeny generally focused on subsets of data, i. e. using molecular data or morphological data only, including only fossils or only living cervids. This work compiles for the first time morphological data, consisting of 150 craniodental characters, and molecular data from fossil and living artiodactyls focusing on cervids. Molecular data include some or all of the mitochondrial genome and the nuclear

gene SRY (sex-determining region on the Y chromosome) (source: GenBank) for 40 living species and cytochrome b for the extinct *Megaloceros giganteus*.

These data were combined in a supermatrix and phylogenetic analyses were undertaken under three different optimisation criteria, Maximum Parsimony (PAUP), Bayesian Inference (MrBayes) and Maximum Likelihood (RAxML), all of which converged on a consistent result. According to the analyses, the early Miocene *Procervulus* is sister taxon to Cervinae, Muntiacinae and Capreolinae and more closely related to the Muntiacinae than to the other two subfamilies.

This result proves the already known development from a relatively primitive two to three-tined antler in *Procervulus* to much more complex antlers on one hand and secondary development to simpler antlers on the other hand in living cervids, and also provides more insight to cranial and dental character evolution. For example, the angulus mandibulae is strongly elongated in *Procervulus* and the processus coronoideus is upright, both indicating differences in the mandibular muscle attachment compared to modern cervids. An elongation of the skull and especially the snout can be observed in the course of evolution. *Procervulus* possessed upper molars, which are wider than long, and bear lingual and sometimes even labial cingula. The long, upright pedicles are situated directly above and on the rim of the relatively big orbits, differing from the more inclined and further posteromedially positioned pedicles in living cervids. All these observations suggest an adaptation to a different environment and diet than extant cervids are adapted to.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE CURRENT KNOWLEDGE OF TRIASSIC VERTEBRATE ASSEMBLAGES OF THE DEEP RIVER BASIN (NEWARK SUPERGROUP: CHATHAM GROUP), NORTH CAROLINA, BASED ON RECENT DISCOVERIES

HECKERT, Andrew B., Dept. Geology, Appalachian State University, Boone, NC, United States; SCHNEIDER, Vincent P., North Carolina Museum of Natural Sciences, Raleigh, NC, United States; MITCHELL, Jonathan S., University of Chicago, Chicago, IL, United States; SLOAD, Eric J., Dept. Geology, Appalachian State University, Boone, NC, United States; OLSEN, Paul E., Lamont Doherty Earth Observatory, Columbia University, Palisades, NY, United States

Recent discoveries and the application of microvertebrate techniques, particularly screenwashing, at artificial outcrops (quarries) have substantially increased the known diversity of fossil vertebrates in the Deep River Basin of North Carolina. New discoveries come from all three sub-basins (Wadesboro, Sanford, and Durham) and from multiple stratigraphic horizons. The Pekin Formation in the Sanford sub-basin yields semionotids, coelacanthids, temnospondyls, dicynodonts, the traversodont cynodont *Boreogomphodon*, and numerous archosaurs (phytosaurs, a rauisuchian, *Lucasuchus* and two new taxa of aetosaurs, and a new crocodylomorph). Fossils from the overlying Cumnock Formation in the Wadesboro sub-basin include redfieldiids, lungfish, metoposaurid temnospondyls, and three phytosaur skulls, two with associated skeletons. The Cumnock Formation in the Sanford sub-basin yields the richest and most diverse assemblages, including redfieldiids (*Cionichthys* and *Synorichthys*), semionotids, the coelacanth *Diplurus*, the lungfish *Arganodus*, temnospondyls, the enigmatic amniote *Colognathus*, lepidosaurs, phytosaurs (including the type of *Rutidon carolinensis* Emmons), a rauisuchian, the venomous archosauriform *Uatchitodon schneideri*, *Revueltosaurus olseni*, *Boreogomphodon*, and the dromatheriid cynodonts *Dromatherium sylvestre* Emmons and *Microcondon tenuirostris* Emmons. The Sanford Formation assemblage is limited to traversodontids and a rauisuchian tooth. The stratigraphically problematic “Lithofacies Association II” of the Durham sub-basin yields additional lungfish and an exceedingly rare record (for the Newark Supergroup) of a hybodont (aff. *Lissodus*) in addition to the published assemblage of a temnospondyl, the rauisuchian *Postosuchus allisonae*, crocodylomorph *Dromicosuchus grallator*, aetosaur *Aetosaurus*, a dicynodont, and the cynodont *Plinthogomphodon herpetairus*.

These assemblages reveal sites with both more fully aquatic (sharks, lungfish) and typically terrestrial (derived archosauromorph) taxa. The lungfish and sharks are both closely related to taxa known from western North America, Africa, and Europe, and are only found as extremely small fossils. In linear dimensions the lungfish toothplates are approximately half the size (and thus less than ¼ the occlusal surface) of broadly contemporaneous toothplates from the American southwest, and far smaller than otherwise similar toothplates from Upper Triassic strata in Morocco. Although a few lungfish toothplates still possess unworn tubercles, indicative of juvenile morphology, others are more worn and plausibly could represent a dwarfed, endemic species. Aetosaurs, *Postosuchus*, sphenosuchians, and revueltosaurs are all fully terrestrial animals that are comparatively rare in other Newark Supergroup basins.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

MYOLOGICAL RECONSTRUCTION OF THE BASAL CERATOPSIANS, *PSITTACOSAURUS* AND *PROTOCERATOPS*: UNDERSTANDING MUSCLE RELOCATION RELEVANT TO POSTURE

HEDRICK, Brandon P., University of Pennsylvania, Philadelphia, PA, United States; DODSON, Peter, University of Pennsylvania, Philadelphia, PA, United States

Ornithischian dinosaurs are plesiomorphically bipedal, with quadrupedality evolving independently in each of the major clades (Marginocephalia, Ornithopoda, Thyreophora). Though all quadrupedal dinosaurs evolved quadrupedality secondarily, only ceratopsians and thyreophorans have evidence of semi-sprawling forelimb posture, whereas sauropods and ornithopods developed columnar forelimb posture. Traditionally, dinosaurian gait and posture has been examined through kinetic motion of joints and the length and orientation of muscle moment arms. A recent study used myology in order to understand stance of the bipedal basal ornithischian, *Lesothosaurus*. This was done to evaluate the basal ornithischian condition for muscle attachment. In order to understand successively more derived muscular patterns in early marginocephalians and the evolution of the semi-sprawling forelimb posture in derived ceratopsians, we reconstruct the musculature of the facultatively bipedal basal ceratopsian, *Psittacosaurus* and the more derived obligatorily quadrupedal basal ceratopsian, *Protoceratops*. Direct comparisons of two closely related taxa that represent completely different postures allow insight into this important stance transition. Changes in bone morphology and muscle scarring (signifying origins and insertions of major muscles) in *Psittacosaurus* and *Protoceratops* reveal relocation, reduction, or hypertrophy in major muscles. For example, the coracoid of *Psittacosaurus* has a pronounced eminence for the origin of the m. biceps brachii. The corresponding region in *Protoceratops* is flat. Thus the biceps was a more significant muscle in *Psittacosaurus*. *Protoceratops* has a long, defined ridge near the scapular origin of m. triceps brachii, whereas *Psittacosaurus* lacks muscle scars. The olecranon is incipient in *Psittacosaurus* compared to the large rugose olecranon of *Protoceratops*. The reduction of the m. biceps brachii and hypertrophy of the m. triceps brachii from *Psittacosaurus* and *Protoceratops* is an example of myological trends towards larger stabilization muscles of the forelimb in quadrupeds. However, such significant changes are not seen in the hindlimb.

Muscle reconstructions based on the extant phylogenetic bracket are compared to previous muscle reconstructions of other archosaurs with reference to phylogeny and posture. This study demonstrates that myological reconstructions are an effective method for evaluating functional changes, such as stance, across an evolutionary lineage. It also documents that the forelimb module undergoes significant hypertrophy and reduction of specific muscles across the lineage whereas the hindlimb module does not. These changes are crucial to the stance transition in basal Ceratopsia.

Romer Prize Session (Thursday, October 18, 10:30 am)

FROM EXTANT TO EXTINCT: LOCOMOTOR ONTOGENY AND THE EVOLUTION OF AVIAN FLIGHT

HEERS, Ashley M., University of Montana, Missoula, MT, United States

Transitional fossils are the record of evolutionary transformations, key to deciphering the origins of major clades and organismal diversification. Bringing these fossils ‘to life’ to better understand evolutionary transitions involves reconstructing the function(s) of their anatomical features, by investigating how comparable features function in living organisms. Yet, extant adult forms and extinct fossils are often very different and thus difficult to compare. Here, I use theropod dinosaurs and their avian descendants to show how postnatal developmental transformations can help elucidate evolutionary transitions. Though juveniles are not often discussed in extinct-extant comparisons, developing birds share a number of similarities with the extinct theropods whose transitional skeletons and protowings record the origin of avian flight. Many immature birds rely on dinosaur-like, transitional skeletons and protowings to navigate three-dimensional habitats and reach refugia. Though not yet capable of flight, these juveniles use their incipient wings and underdeveloped skeletons for intermediate locomotor behaviors like wing-assisted incline running or ‘steaming’ over water, where wings and legs are used cooperatively. Developing birds can thus elucidate potential locomotor capabilities of extinct theropods with similar anatomies, by actualizing form-function relationships through behaviors that bridge obligately bipedal to flight-capable transitions. To document feather and skeletal ontogeny in the precocial chukar (*Alectoris chukar*), I (i) used a propeller apparatus to measure aerodynamic forces generated by dried wings over a range of ages and Reynolds numbers, and (ii) used high resolution computed tomography scans and biplanar x-ray videos (X-ray Reconstruction of Moving Morphology) of different aged birds to quantify three-dimensional skeletal kinematics during various behaviors. My results show that juveniles and adults with highly disparate anatomies employ very similar skeletal kinematics, possibly due to differences in aerodynamic force production by protowings versus wings. Locomotor performance improves through ontogeny, but even young birds generate useful aerodynamic forces. This suggests that extinct theropods might also have been capable of more bird-like wingstrokes and greater aerodynamic force production than implied by their transitional morphologies. Developing birds depend on dinosaur-like, transitional skeletons and protowings for a variety of intermediate flapping behaviors, and though we are only beginning to explore locomotor ontogeny, juveniles that actualize the functional capacities of transitional anatomies may provide multifaceted and unique insight into life’s history.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE BIOMECHANICAL IMPLICATIONS OF CRYSTALLITE ORIENTATION IN CROCODILIAN TOOTH ENAMEL

HENDRICKS, Stephen M., Department of Geology, Bowling Green State University, Bowling Green, OH, United States; YACOBUCCI, Margaret M., Department of Geology, Bowling Green State University, Bowling Green, OH, United States

Enamel crystallites respond to stress in a preferred direction relative to their orientation, and therefore these orientations may be useful in making functional interpretations in both extant and extinct vertebrates. We examine the utility of crocodilian enamel in making biomechanical interpretations by testing the hypothesis that reptilian enamel acts only as a surface coating and does not exhibit any response to stress, as has been suggested. Enamel

lacking a mechanical signal would exhibit either randomly oriented crystallites with regard to the outer enamel surface (OES) or homogeneity in crystallite orientation, since there would be no selective advantage to having differing orientation on different tooth surfaces. In order to evaluate these assumptions, eight shed teeth from seven extant crocodilian taxa were longitudinally sectioned and examined using a scanning electron microscope (SEM); images were taken using QuartzPCI. The images were analyzed using ImageJ to record crystallite orientation relative to the OES or enamel-dentine junction (EDJ) and statistical analyses were completed using PAST statistical software, analyzing raw angle measures and deviation from 90 degrees (calculated by subtracting measurements from 90 and taking the standard deviation). Apical enamel shows significantly different crystallite orientations from lateral enamel (defined as enamel along the labial and lingual tooth surfaces) in six of the seven taxa using the raw angle measures (Mann-Whitney U-test, $p<0.0014$); tests using deviance from 90 degrees returned high levels of significance (Mann-Whitney U-test, $p<5E-4$) in all seven taxa. The statistical program R was used to generate a random series of angles from 0 to 90 to simulate random crystallite orientation; comparison to deviance from 90 demonstrated significant values (Mann-Whitney U-test, $p<5E-22$) in all taxa. The hypothesis that crocodilian enamel does not exhibit a response to stress placed upon teeth is rejected; different orientations are seen in the apex where the tooth first encounters the prey item. In addition, the apex encounters the prey in a different orientation than does the lateral surface of the tooth, which may help to explain the results. However, there is no clear relationship between orientation and either trophic niche or cranial morphology. Given the unspecified nature of locations within the jaw for our specimens, detailed interspecific comparisons were inapplicable for this investigation. In order to resolve functional adaptations in crocodilian teeth, a larger dataset and continued examination is needed; we believe such work may lead to new strategies for inferring the biology of ancient vertebrates.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

THE NONAVIAN THEROPOD QUADRATE: SYSTEMATICS USEFULNESS, MAJOR TRENDS AND PHYLOGENETIC MORPHOMETRICS ANALYSIS

HENDRICKX, Christophe, Universidade Nova de Lisboa, Lourinhã, Portugal; ARAÚJO, Ricardo, Southern Methodist University, Dallas, TX, United States; MATEUS, Octávio, Universidade Nova de Lisboa, Lourinhã, Portugal

The quadrate in nonavian theropods is incredibly diverse morphologically; however this morphological disparity has been underestimated for taxonomic purposes. The quadrate topological homologies and anatomy, as well as the terminology, among nonavian theropod clades are reviewed. In order to evaluate the phylogenetic potential and investigate the evolutionary transformations of the quadrate, we conducted a Catalano-Goloboff phylogenetic morphometric analysis using 3 morphometric characters, a total of 28 landmarks coded for 23 taxa, as well as a cladistic analysis using 115 discrete quadrate-related characters coded for 43 taxa. The cladistic analysis provides a fully resolved tree mirroring the current classification of nonavian theropods. The quadrate morphology by its own provides a wealth of data with strong phylogenetic signal. Several unambiguous synapomorphies support nonavian theropod relationships and the resulting consensus tree allows inference of major trends in the evolution of this bone. Important synapomorphies include: for Abelisauridae, a lateral ramus extending to the ectocondyle; for Tetanurae, the absence of the lateral process; for Spinosauridae, a medial curvature of the ventral part of the pterygoid ramus occurring just above the mandibular articulation; for Neotetanurae, an anterior margin of the pterygoid flange formed by a roughly parabolic margin; and for Tyrannosauroidea, a semi-oval pterygoid flange shape in medial view. The Catalano-Goloboff phylogenetic morphometric analysis reveals two main morphotypes of the mandibular articulation of the quadrate linked to function. The first morphotype, characterized by an anteroposteriorly broad mandibular articulation with two ovoid/subcircular condyles roughly subequal in size, is found in Ceratosauria, Tyrannosauroidea and Oviraptorosauria. This morphotype allows a very weak displacement of the mandible laterally. The second morphotype is characterized by an elongate and anteroposteriorly narrow mandibular articulation and a long and parabolic/sigmoid ectocondyle. Present in Megalosauroidea, Carcharodontosauridae and Dromaeosauridae, this morphotype permits the lower jaw rami to be displaced laterally when the mouth opened.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST REPORT OF AN ANURAN FROM THE FOSSIL BUTTE MEMBER (EARLY EOCENE, WASATCHIAN) OF THE GREEN RIVER FORMATION, WYOMING

HENRICI, Amy C., Carnegie Museum of Natural History, Pittsburgh, PA, United States; BAEZ, Ana M., CONICET, Buenos Aires, Argentina; GRANDE, Lance, Field Museum of Natural History, Chicago, IL, United States

The Green River Formation was primarily deposited in three lakes, Lake Uinta, Lake Gosiute, and Fossil Lake, during the Eocene. Although the formation is famous for the numerous exceptionally well-preserved fossils that it has produced, the remains of anurans are extremely rare with only three currently known specimens. One is an unidentified specimen preserved as a mostly carbonized skin imprint from the Wasatchian-Bridgerian Parachute Creek Member deposits of Lake Uinta. The second consists of an impression of a nearly complete, articulated skeleton of the pelobatid, *Eopelobates* sp., from the Bridgerian Laney Member deposits of Lake Gosiute. The third, and focus of this presentation, is a nearly complete, articulated skeleton of a new genus and species from the Wasatchian Fossil Butte Member deposits of Fossil Lake.

The new anuran was recovered from a whitish, laminated, calcimicrite limestone as part (FMNH PR2384) and counterpart (held in a private collection). Most of the nearly complete and articulated skeleton is retained on the part where it is exposed in dorsal aspect. The counterpart is heavily restored and contains only a few pieces of original bone and very poor impression of the skull. The specimen is very small, with a snout-vent-length (measured from tip of snout to end of pelvic girdle) of 19.3 mm, which could indicate an immature ontogenetic age. An ossified columella and sphenethmoid are present, however, which indicates that the frog is postmetamorphic because these bones, when present, ossify after metamorphosis is completed. It is most likely a young adult, because the carpal bones are ossified but the distal tarsal bones, which generally ossify late, are not.

This anuran possesses an interesting mix of characters that initially did not readily ally it with any currently known anuran family. A phylogenetic analysis that incorporated representative costatans, anomocoelans, and neobatrachians was undertaken to determine its relationships. Results of this analysis places the Green River frog within Anomocoela, as the sister taxon to *Pelodytes*. This clade is the sister taxon to the remainder of the anomocoelans. The clade Anomocoela is the sister taxon of Neobatrachia, with *Hadromophryne natalensis* basal to this clade.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PRELIMINARY FAUNAL ANALYSIS OF THE DONGGUTUO SITE, NIHEWAN BASIN, CHINA

HENSLEY-MARSCHAND, Blaire, Indiana University, Bloomington, IN, United States

Donggutuo is a 1.1 million year old archaeological site in the Nihewan Basin of China located approximately 100 miles west of Beijing. The Nihewan Basin area is of great importance in human evolution because it recorded the behaviors of early hominids as they migrated out of Africa and into this new geographic area over one million years ago. The presence of over 10,000 stone tools at Donggutuo attests to the presence of *Homo erectus* in the Nihewan Basin, but as of yet there have been no *H. erectus* specimens found in this area. Joint US-Chinese teams excavated this site in 1991, 1992, and 2000-2001, and it was the first site in China to record precise provenience data during excavation. A thorough analysis of the material was conducted in an effort to establish an agent of accumulation for this site and to test paleoenvironmental reconstruction hypotheses for this area. The current analysis consists of 2162 specimens from all three recorded field seasons. Surface damage indicates carnivore involvement in the accumulation of this site, but there is an indication of hominid involvement as well in the form of both cutmarks and hammerstone percussion marks. Therefore, this faunal analysis establishes a direct connection between these stone tools made by early hominids and the accumulated fauna. In an effort to supplement paleoenvironmental reconstructions of the Nihewan Basin, specimens have been identified to the most specific taxonomic level possible. Despite a large amount of unidentifiable specimens (20.21%) and unidentifiable long bone fragments (29.32%), the analysis of identifiable specimens thus far indicates a high frequency of Equidae in addition to Elephantidae, Rhinocerotidae, and Bovidae. The high proportion of Equidae may suggest a generally open environment during the time of deposition while *H. erectus* was moving into this new geographic area. However, further identification of the faunal specimens is required for a more specific paleoenvironmental reconstruction.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:15 am)

BONY ATTACHMENTS OF FLIGHT FEATHERS IN NEORNITHINE BIRDS: ANATOMY, HISTOLOGY AND FUNCTIONAL VARIATION

HIERONYMUS, Tobin L., NEOMED, Rootstown, OH, United States; SIMONS, Erin L., Midwestern University, Glendale, AZ, United States

Attachments of the major forelimb feathers (remiges) of paravians are sometimes associated with bony features on the ulna, metacarpus, and phalanges, variously referred to as quill knobs or remigial papillae. These bony features provide a link between the fossilizing skeleton and the morphology of the soft-tissue wing, but their anatomical and functional relationships are currently poorly understood. We examined the fine-scale anatomy and ecological context of remigial papillae in a broad sample of extant neornithine birds. Soft tissue relationships of remex-related bony features were determined in a range of neoavian taxa by a standard battery of anatomical techniques, including dissection, microCT, and plastic-embedded hard tissue histological sectioning. Preliminary results from this part of the analysis include a new description of the anatomy, histology, and osteohistology of remigial ligament attachments to the ulna, the minor metacarpal, and the phalanges of the major digit. The histological results indicate grossly visible bony correlates for feather attachment, some of which have previously been overlooked. Phylogenetic and functional relationships of these bony features were examined by redundancy analysis (RDA), a form of constrained ordination that allows functional and behavioral information to be explicitly included in the definition of a morphospace. For this analysis, principal coordinate (PCO) scores of categorical variables describing bony features for 87 extant neornithine birds were included in a multiple multivariate regression, with log body mass and the significant PCO scores of a phylogenetic distance matrix as covariates. Variation due to phylogeny was partialled out, and the resulting regression against body mass formed the basis of an RDA ordination space. This preliminary RDA suggests that whereas the prominence of a second, smaller set of ventral remigial papillae on the ulna may be weakly related to body size, variation in the other bony features related to feather attachment is largely independent of mass. Wing shape may be a more important determinant of feather-related bony features,

with the following obervations: (1) proportionally elongate ulnae appear to be related to prominent caudal ulnar papillae; (2) rounded wing tips show a similar pattern for the ulna with the inclusion of carpometacarpal papillae; and (3) pointed wing tips seem to co-occur more often with prominent digital fossae. The distribution of bony correlates for feather attachment in neornithine wings may be due to a trade-off between primary and secondary feathers in their contribution to the second moment of area of the wing, and thus the force generated in flapping flight. Bony correlates of feather attachment provide an additional line of evidence, alongside intramembral indices and limb cross-sectional properties, that may be used to infer the shape and function of forelimb feathers in extinct paravians.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MINERALIZATION OF MAMMOTH MOLARS

HIGGINS, Pennilyn, University of Rochester, Rochester, NY, United States; POTAPOVA, Olga, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; AGENBROAD, Larry, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States

Isotopic analysis of the tusks of mammoths and elephants (and their relatives) has been used extensively to understand behaviors and preferences of these enormous beasts, as well as their time of death. From this work, the mineralization patterns of tusks is well understood, and a great deal has been learned about extinct species of proboscideans. There are scenarios in which it could be advantageous to use molars instead of tusks, however. Molars possess enamel, which is arguably less prone to diagenetic alteration. Because enamel is less likely to be altered, one can more confidently analyze substituted carbonate in the enamel matrix, which is not only a simpler process, but also provides carbon isotopic data that can be related to diet. However, to effectively utilize isotopic data from mammoth or elephant molar tooth enamel, one must first understand the timing and pattern of mineralization in the tooth. Very little research has been done in this regard, with only a few, widely different, estimates for how long a whole tooth may take to mineralize and a little bit of information on the microstructures of elephant tooth enamel. Mammoth and elephant teeth are unique as they are constructed from a series of vertical plates. The plates are stacked together and worn, such that on the occlusal surface of the tooth is a repeating series of cementum, enamel, dentine, enamel, and back to cementum for as many plates as there are in the tooth. The roots are fused between adjacent plates. This fusion appears to occur after the bulk of the tooth has mineralized. We have conducted isotopic analysis to answer the following questions: 1) What is the overall pattern of mineralization for the plates? Does mineralization occur one plate at a time, from front to back, following the “conveyer belt” pattern of the tooth emergence/replacement that is characteristic for elephants? Or do all the plates mineralize simultaneously, from occlusal surface to root, as is the case for most mammals? Or is the pattern something in between these two potential end-members? 3) How long does it take for an entire molar or an individual plate to mineralize? 2) At what point do the roots fuse, and do they fuse synchronously or in some sequence? Serial isotopic analysis of five individual plates from a single right upper molar from a mammoth from the Mammoth Site in Hot Springs South Dakota shows that all plates most likely mineralize simultaneously from occlusal surface toward the root. The complete mineralization seems to take about one year. Fusion of the roots, however, is not simultaneous. Fusion begins sometime after the plates are essentially fully formed, and appears to begin at the front of the tooth and move toward the back, again, over the course of about one year.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:30 am)

DEPOSITIONAL ENVIRONMENT AND REWORKING HISTORY OF THE SEVERN (BOWIE, MD) AND BLADEN (ELIZABETHTOWN, NC) FORMATIONS: TAPHONOMIC AND SEDIMENTOLOGICAL CHARACTERISTICS OF TWO LATE CRETACEOUS LAG DEPOSITS

HIPPENSTEEL, Scott P., University of North Carolina at Charlotte, Charlotte, NC, United States; GARCIA, William J., University of North Carolina at Charlotte, Charlotte, NC, United States

The Severn Formation of Maryland (Campanian) and the Bladen Formation of North Carolina (Maastrichtian), while not strictly contemporaneous, are important Late Cretaceous vertebrate localities that have produced an abundant and diverse assemblage of terrestrial and marine fossils. The fossils collected for this study came from the Elizabethtown Landfill Annex site (Bladen Formation) and from outcrops along a small unnamed tributary of the Patuxent River in Prince George’s County Maryland (Severn Formation). Both formations have been described as shallow/marginal-marine lag deposits; nevertheless, sedimentological and taphonomic analyses suggest they differ with respect to hydrodynamic energy, water depth, and reworking history.

To compare the taphonomic condition of the chondrichthyan teeth at each locality more than 2,500 teeth were evaluated with respect to smoothing, chipping, and fracturing of the tooth crown, root, and shoulders/cuspet(s). The taphonomic condition of the teeth was poorer at the Elizabethtown site, with a majority of the fossils in a broken, abraded, or worn state. At the Maryland location nearly 10% of the specimens remained in a pristine condition, suggesting minimal transport or reworking. The North Carolina locality also contains a larger proportion of coarse and very coarse sand (>50%) with scattered small pebbles, while the Maryland deposit contained primarily fine to medium sands. Finally, the presence of scavenging forms (e.g. *Squalicorax* spp.) at both locations suggests a shallow-water nearshore depositional environment and the higher ratio of marine reptile teeth (e.g. mosasaur) to marginal-marine reptile teeth (e.g. crocodylian) in the Severn Formation suggests a depositional environment further from shore.

The Bladen Formation, exposed at the Elizabethtown Landfill Annex site, represents a marginal-marine or deltaic lag deposit with input of numerous terrestrial vertebrate fossils, including dinosaur teeth. In contrast, while the Severn Formation contains scattered terrestrial forms, it appears to be a transgressive shelf lag deposit. These descriptions are in general agreement with previous reports on the Severn (nearshore continental shelf with input of distal terrestrial forms) and Bladen (fluvially-dominated estuarine with input of proximal terrestrial forms and distal marine forms).

Preparators’ Session (Thursday, October 18, 8:30 am)

INTRODUCING C.O.D.I. (THE COMPREHENSIVE OLDUVAI DATABASE INITIATIVE): AN ELECTRONIC REPOSITORY OF TERRESTRIAL VERTEBRATE FOSSILS FROM THE PLIO-PLEISTOCENE OF OLDUVAI GORGE, TANZANIA

HLUSKO, Leslea J., University of California Berkeley, Berkeley, CA, United States; NJAU, Jackson K., Indiana University, Bloomington, IN, United States

Olduvai Gorge was first brought to the attention of paleontologists in 1913 and has since provided tremendous insight to the last two million years of vertebrate evolution in East Africa. Thousands of fossils have been recovered from this site over the almost 100 years of field work, including numerous type specimens and records of first and last appearance dates. However, due to the long history and multiple investigators, the material is scattered across numerous museums, personal collections, and countries with no comprehensive database of the material. We have developed the Comprehensive Olduvai Database Initiative with the goal of creating an electronic repository of information about these fossils that includes bibliographic information, photographs, element identification, stratigraphic context, and current repository. As of April 2012, 20 monographs and other scientific publications dating from 1934 – 1990 had been entered into the database (approximately 3,700 specimens). Data entry from published work and visits to museums holding collections are underway, including the inventory of fossils held returned to the National Museum of Tanzania, Dar Es Salaam, from the Kenyan National Museums in 2011. With the launch of the CODI website at www.olduvai-paleo.org we have initiated the second phase of the project. This relies on scientific crowd-sourcing--to draw on the knowledge of other vertebrate paleontologists to identify unpublished or underpublished material. In our presentation we will introduce the audience to the on-line database, demonstrate some of its unique features, and request assistance recovering information about fossil material from Olduvai Gorge, calling for the scientific community at-large to work collaboratively to record this information before it is lost to the passage of time.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

SILICA INGESTION IN GRAZING *BISON* AND ARIDITY: IMPLICATIONS FOR MICROWEAR ANALYSIS

HOFFMAN, Jonathan M., University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States

Microwear tooth analysis is used to interpret the diet and ecology of herbivorous mammals. However, microscopic wear (e.g., scratches and pits) has been attributed to both diet (i.e., plant type) and abiotic sources (i.e., exogenous grit or soil), complicating interpretations. Additionally, it is unclear whether environmental factors, such as aridity, affect levels of abiotic silica consumption and ultimately microscopic wear. To strengthen the interpretive power of microwear analysis, we have assessed the relationship between local aridity, silica consumption by grazers, and microwear features.

Loss-on-ignition analyses were conducted to measure the ingested silica content (as a proxy for abiotic silica consumption) in fecal samples from two populations of American bison (*Bison bison*), which represent environmental extremes in relation to aridity. The Tallgrass Prairie National Preserve is a temperate grassland in southeastern Kansas with a mean annual precipitation (MAP) of 1080 mm. By contrast, the Henry Mountains Wilderness of southeastern Utah is a cold desert that experiences much drier conditions (MAP = 204 mm). Fresh fecal samples were collected during the dry season for each locality. Additionally, bison teeth previously collected from each site were molded and cast for microwear analysis to test for correlations with aridity and silica consumption.

If local aridity affects abiotic silica ingestion (e.g., grazers in arid areas consume more soil/sand than grazers in wetter areas), then we would expect to see a significant difference in the mean fecal silica content of the two bison populations. However, we discovered no significant difference between the mean fecal silica content of the two bison populations (21.57% and 22.44% inorganic by dry weight for the Henry Mountains and Tallgrass Prairie populations, respectively), indicating no correlation between aridity and silica consumption. These results suggest that local aridity does not impact abiotic silica consumption by grazers and this environmental factor does not influence microwear. Microwear analyses of bison teeth from both sites will elucidate this relationship further, lending insight into how microwear features are affected by environmental conditions. A better understanding of the factors affecting microwear in ungulates will ensure more meaningful interpretations in future ecological and paleoecological studies using this method.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

TAXA AS HYPOTHESES

HOLBROOK, Luke T., Rowan University, Glassboro, NJ, United States; GEISLER, Jonathan, New York College of Osteopathic Medicine, Old Westbury, NY, United States

Phylogenetic taxonomy and nomenclature have reduced ambiguity in how names are applied, but taxonomic names are still divorced from the hypothesis testing of phylogenetic analysis. Instead, phylogenetic taxonomy and the Phylocode in particular encourage nomenclature to act as a set of stable rules that allows a suprapecific taxon to be applied to essentially any conceivable phylogenetic hypothesis. This contrasts with what is often the actual practice of taxonomists, where taxonomic names are used to communicate specific patterns of phylogenetic relationships. These patterns are always hypotheses, though they may be well supported by character evidence. Therefore, we argue that a taxonomic name should indicate a specific hypothesis of phylogenetic relationships that is distinct from other hypotheses, which are identified by other taxonomic names. As a consequence of this view, taxonomic definitions must be explicit and specific, such that the specifiers for taxonomic definitions cover not only taxa to be included, but also taxa to be excluded, and also must spell out their contingency on the validity of other taxonomic concepts. Under this approach, priority becomes secondary to monophyly in choosing among mutually exclusive names. For taxa that were named prior to the advent of phylogenetic taxonomy and are entrenched in the systematic literature, we suggest they be redefined when necessary to be monophyletic. The new definitions should follow the intentions of the original author in terms of which taxa are critical for inclusion and exclusion. This view of taxonomy minimizes synonymy, provides a clearer picture of the scientific purpose and application of taxonomy and nomenclature, and lends itself to practical digital applications of taxonomy.

Technical Session IV (Wednesday, October 17, 1:45 pm)

MORPHOLOGY AND DIVERSITY OF THE MANDIBULAR SYMPHYSIS OF ARCHOSAUROMORPHS

HOLLIDAY, Casey M., University of Missouri, Columbia, MO, United States; NESBITT, Sterling J., University of Washington, Seattle, WA, United States

Archosauromorphs radiated into numerous trophic niches during the Mesozoic, many of which were accommodated by particular suites of cranial adaptations and feeding behaviors. The mandibular symphysis, the joint linking the mandibles, is a poorly understood cranial joint which offers significant insight into skull function and feeding ecology. Using comparative data from extant amniotes, we investigated the skeletal anatomy and osteological correlates of relevant soft tissues in a survey of archosauromorph mandibular symphyses. Characters describing degree of interdigitation, morphology of Meckel's cartilage, and general symphyseal structure were identified using observational and imaging techniques. The evolution of these features was mapped using a current phylogeny of archosauriforms with the addition of non-archosauriform archosauromorphs. Extinct taxa with the simple Class I condition (e.g., proterochampsids, "rauisuchians"), rugose Class II (aetosaurs, protosuchians, silesaurids), and interdigitating Class III symphyses (e.g., phytosaurs, crocodyliforms) and finally fused Class IV (avians) and Class V (ornithischians) build the joints in expected ways, though they differ in contributions of bony elements and Meckel's cartilage. Optimization of the different classes of symphyses across a archosauromorph clades indicate that major iterative transitions from plesiomorphic Class I to derived, rigid Class II-V symphyses occurred along the lines to phytosaurs, aetosaurs, a subset of poposauroids, crocodyliformes, pterosaurs, ornithischians, and birds. These transitions in symphyseal morphology correlate with changes in dentition (type of tooth and heterodonty), the origins of beaks, and potentially inferred diet indicating symphyses are informative characters in understanding the evolution of archosauromorph cranial evolution.

Technical Session VI (Thursday, October 18, 2:30 pm)

LIASSIC DAWN: PHYLETIC DIVERGENCE ANALYSIS SUPPORTS EARLY TO MIDDLE JURASSIC ESTABLISHMENT OF PRIMARY DINOSAURIAN DIVERSITY

HOLTZ, Jr., Thomas R., Dept. of Geology, University of Maryland, College Park, MD, United States

Recent analyses by a number of workers have yielded a significant increase in our understanding of the standing taxonomic diversity (i.e., number of taxa present per unit time) of Mesozoic Dinosauria, and these measures have been compared to changing environmental parameters (including paleogeographic and atmospheric transformations) in an attempt to study the factors which contributed to dinosaurian success. This analysis is complementary to these other efforts, examining not only standing diversity but estimates of phyletic divergence patterns within this clade.

A set of new species-level supertrees for Dinosauromorpha has been assembled, taking advantage of the substantial numbers and scope of recent phylogenetic analyses. Unnamed fragmentary specimens are incorporated into these topologies if they represent stratigraphic and/or biogeographic range extensions of the clade in question, and are placed on the tree at the most recent possible branching time so as to reduce the duration of ghost lineages. Alternative topologies are constructed to reflect presently unresolved issues within Theropoda and Sauropoda. Standing diversity and phyletic divergence counts are counted in 5 Myr intervals over the whole of the Mesozoic: these counts are based on both standard cladistic divergence models and on alternative anagenetic alternatives (in which congeneric sister taxa with non-overlapping known stratigraphic ranges and which inhabited the same or adjacent depositional basins are counted as a single lineage with no divergence event.)

These data are then compared to geochronology and to various paleoenvironmental factors. Time bins of the late Early and Middle Jurassic epochs stand out statistically as the primary intervals for diversification: subsequent divergences represent elaborations within major lineages established at this earlier phase. Diversification patterns do not seem to be correlated with changing oxygen or carbon dioxide levels. Weak statistical support was found for correlation between increased levels of diversification of dinosaurs and increased sea level and decreased degree of contiguousness of depositional basins. Lagerstätten effects strongly influence estimates of divergences for eumaniraptoran (= deinonychosaur + avialan) clades, but not for other dinosaurs.

Expansion of these analyses to explore patterns of phyletic divergence in other terrestrial tetrapod clades (e.g., Mammaliaformes, Crurotarsi, Pterosauria) could be used to examine if comparable trends exist in these groups.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DENTAL MICROWEAR IN THE MAASTRICHTIAN MOSASAUR *CARINODENS BELGICUS*

HOLWERDA, Femke M., Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Portugal & Museu da Lourinhã, Lisbon, Portugal; BEATTY, Brian L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; SCHULP, Anne S., Natuurhistorisch Museum Maastricht & VU University Amsterdam, Maastricht, Netherlands

Teeth of the small durophagous mosasaur *Carinodens belgicus* are known from the Maastrichtian of the North- and South-Atlantic, and the Tethyan realm. Its peculiar dentition inspired debate and speculation on its dietary niche ever since its first description almost a century ago. New discoveries in recent years allowed for a more detailed evaluation of its food preferences. Biting performance of *Carinodens* has been modeled in a previous study, which helped bracket the durophagous diet options within reach of this taxon; stable isotope analysis of tooth enamel suggests a shallow marine/nearshore foraging. In this contribution, we studied the dentition of *Carinodens* for microwear patterns on the apical and lateral enamel wear facets so as to further (and independently) evaluate the possible feeding behavior and diet of this animal.

The study focused on five well-preserved isolated teeth from the type Maastrichtian. Macroscopically, wear was observed on the apex and on the mesiodistal side; microwear was observed using SEM at several magnifications. Scratches were largely bimodal in size and categorised as fine and coarse, and pits were simply counted. Scratch orientation was measured along the mesiodistal axis. Coarse scratches were found to be the most common feature and pits the least common. Scratch orientation was primarily along the mesiodistal plane or in the labiolingual plane with an angle of ~130°.

In general, these microwear features can most likely be explained by either mastication or abrasion by sediments or food. As scratch width only indicates the minimum width of the abrading particle, the material causing the wear here could have ranged from silica-based sands to larger abrasives. However, in this case, abrasion by sediments might not explain this wear, because the type Maastrichtian sediments are predominantly carbonate; quartz siliclastics are virtually absent. Therefore it is more likely that hard food particles, such as benthic organisms with hard exoskeletons, caused the wear on the enamel of *Carinodens*. One might speculate whether these were the intended diet of *Carinodens* or rather an unavoidable result of feeding on benthic macroalgae; however, the carnivorous nature of related taxa as well as the stable isotope signal as recorded in the teeth leave predation on larger benthic prey items the most likely explanation.

The mesiodistal and labiolingual direction of the microwear scratches might suggest that *Carinodens* showed more complexity in the use of its teeth than simple grasping, and that a gripping and pulling motion during feeding akin to that employed by modern varanids may have been the cause.

Technical Session XVIII (Saturday, October 20, 3:15 pm)

THE OLDEST PSEUDORHYNCOCYONIDS: THEIR BEARING ON RELATIONSHIPS OF THIS EUROPEAN STEM PLACENTAL FAMILY

HOOKER, Jerry, Natural History Museum, London, United Kingdom

Members of the family Pseudorhyncocyonidae are recorded only from France and Germany, where they are rare in faunas ranging from the middle of the Early Eocene to nearly the end of the epoch. With few exceptions, preservation types are polarized between assemblages with only one or two isolated teeth and that from Messel, with complete flattened skeletons, but whose teeth are difficult to observe. Although pseudorhyncocyonids are considered to be sister group to the Leptictidae, primitive members are almost unknown and consequently details of their relationships have been difficult to establish. New material in the form of isolated teeth representing numerous loci, belonging to two species from the earliest Eocene of the UK, go some way to bridging morphological gaps and resolving these relationships. In particular, similarities between one of the new species and the putative lepticid ?*Palaeictops levei* from the Paris Basin Late Paleocene suggest close affinity and thus a further downward range extension for the family Pseudorhyncocyonidae. The character states that generated an earlier dismissal of such a relationship are mainly primitive. Other groups recently considered closely related to leptictids are palaeanodonts and pantolestans. Cladistic analysis of all available pseudorhyncocyonids and of primitive members of these

other three groups, using dental characters, has been conducted. Most results produce a monophyletic Pseudorhyncocyonidae, including *'P'. levei* and *Diaphyodectes*, which were previously regarded as European leptictids. Palaeanodonts nest within Leptictidae, whilst pantolestans are unstable in position, relating either to Leptictidae + Palaeanodonta or to Pseudorhyncocyonidae. The pattern of relationships suggests European endemism for the Pseudorhyncocyonidae from early in the Paleocene and a probable North American origin.

Technical Session VIII (Thursday, October 18, 2:00 pm)

FAUNAL HETEROGENEITY IN BARSTOVIAN MAMMALS OF THE NORTHWEST: WHAT DOES FAUNAL DIVERSITY TELL US ABOUT TECTONICS AND HABITAT DIVERSITY?

HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States; MAGUIRE, Kaitlin C., University of California, Berkeley, Berkeley, CA, United States; MCLAUGHLIN, Win N., University of Oregon, Eugene, OR, United States

The Middle Miocene contains the greatest diversity of North American mammals since the Eocene, and possibly the greatest in the history of mammals. This period has drawn extensive interest in studies of ecological evolution, of the role of climate in the generation of diversity, and of the impact of immigration events on diversity. Many of these studies, however, have focused on the tectonically quiescent Great Plains. Efforts to understand the role of tectonic activity in diversity generation have come to differing conclusions about whether the diversity of the Great Basin is greater than the Great Plains in the Middle Miocene, confounded somewhat by differences in publication bias and sampling and in the methods applied to correcting for these biases. Our collecting and taxonomic efforts in the fossil record of Oregon have improved the completeness and consistency of sampling and taxonomy across many localities with highly divergent publication histories, so we have a superior sample with which to address the diversity of mammals in Oregon at a variety of scales. We compare all the Barstovian sites in Oregon and Northern Nevada using presence-absence and relative abundance data to determine the diversity patterns within and between collecting areas. In looking at the differences among sites, we find that the faunal heterogeneity in the Barstovian of Oregon is remarkably high, almost certainly greater (perhaps substantially so) than that found in the same time period in the Great Plains. This diversity seems to represent habitat heterogeneity in Oregon in the Middle Miocene, rather than simple isolation and local adaptation. The diversity of supported habitats is to be expected in a tectonically and topographically complex landscape, but finding fossil evidence in support of this expectation shows us the quality of the ecological samples available in this well-preserved time period. This habitat heterogeneity is visible even within a single lithostratigraphic unit, as illustrated by the diverse faunal affinities of mammals from the Mascall Formation. This result makes sense in light of the suggestions of earlier workers that the diversity of mammals in the Mid-Miocene is maintained in part by a remarkable diversity of habitats during the Barstovian.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

STURGEON DORSAL OSTEODERM ONTOGENY: A TRANSFORMATIONAL MODEL FOR MARGINOCEPHALIAN SQUAMOSAL ORNAMENTS

HORNER, Vanessa S., Ohio State University, Columbus, OH, United States; HORNER, John R., Museum of the Rockies, Bozeman, MT, United States

The squamosal and parietal border ornaments of *Triceratops* (episquamosals and epiparietals) and *Pachycephalosaurus* (squamosal spikes and nodes) are hypothesized to undergo marked changes during ontogeny that includes a period of expansion and elongation proceeded by a period of reduction and shape change. A late-stage morphological shape change of a mineralized ornamental structure is highly unusual, and has led to recent arguments suggesting *Stygimoloch* to be an unlikely ontogenetic phase of *Pachycephalosaurus*. To evaluate the possibility of such a transformation, we undertook a survey of vertebrate taxa in search of osseous ornamental structures that both expanded and reduced in height or length during ontogeny. One candidate was found, the midline dorsal osteoderms of sturgeons (Acipenseridae), reported to grow dorsoventrally to sharp, pointed structures in juveniles, and then flatten dorsoventrally and widen as the animals reach maturity. Osteohistologic studies were undertaken of a series of sturgeon (the extant taxon *Scaphirhynchus platorynchus* and an extinct taxon, Acipenseridae indeterminate from the Late Cretaceous Hell Creek Formation) dorsal osteoderms to determine the process involved in height reduction. The results indicate that osteoderm transformation in the sturgeon is similar to the processes hypothesized to alter the marginocephalian ornaments even though the overall microstructure of these ornaments are quite different. As hypothesized for the marginocephalian ornaments, size reduction of sturgeon dorsal osteoderm ridges coincide with a phase of osteoclastic resorption, revealed by a scalloped texture on the external surfaces near the apex of the ornaments. These scallops match the size of osteoclast cells. As osteoclasts removed mineralized tissues from the ornament apex the tissues were apparently redistributed around the periphery of the base, essentially giving the structures a flattened appearance. This study shows that although ontogenetic ornamental height reduction is unusual, it is not unknown. As hypothesized for the marginocephalians, the ornament height reduction phase in sturgeons most likely visually signals the onset of maturity.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW PERMIAN AND TRIASSIC VERTEBRATES FROM TURKEY (SE ANATOLIA)

HOSGOR, Izzet, TransAtlantic Exploration Med. Int. Pty. Ltd. - Viking Int. Ltd., Ankara, Turkey; FORTUNY, Josep, Institut Català de Paleontologia, Cerdanyola del Valles, Spain

Permian and Triassic vertebrates from Turkey are poorly known. From the Middle-Late Permian actinopterygians and tetrapod footprints were previously reported whereas chondrichthyes and actinopterigians are known from the Lower Triassic. Herein, we report new findings from southeastern Anatolia. Recent fieldwork in this area has provide new vertebrate remains from the Middle-Late Permian of the Tanin Group and Early Triassic of the Çigli Group, including the first occurrence of temnospondyls in Turkey. From the Tanin Group a semi-articulated specimen is here referred to Branchiosauridae, and probably represents a new taxon. The skull proportions and the high degree of ossification of the postcranial elements are indicative of an adult specimen. This clade is well known from the Early Permian of Central Europe and Sardinia. In Siberia, the genus *Tungussogyrinus* was described in Late Permian-Early Triassic sediments but it its affinity with Branchiosauridae is controversial. The finding of a new taxon of Branchiosauridae in the Middle-Late Permian of SE Turkey has important paleobiogeographical implications, revealing a greater distribution for branchiosaurids, and will help to understand the evolutionary history of the group.

From the Early Triassic of the Çigli Group, several teeth were recovered, mostly assignable to actinopterigians, whereas a single tooth belongs to a hybodontiform shark (Chondrichthyes). An additional dermal bone with external ornamentation is referred to an indeterminate stereospondyl temnspondyl.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

FIRST OCCURRENCES OF FELIDAE AND CANIDAE (MAMMALIA: CARNIVORA) FROM THE CHITING FORMATION (PLEISTOCENE) OF SOUTHWESTERN TAIWAN

HU, Huai-Pin, South Dakota School of Mines and Technology, Rapid City, SD, United States; PAGNAC, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, United States; MARTIN, James, South Dakota School of Mines and Technology, Rapid City, SD, United States; WU, Ming-Chee, National Cheng Kung University, Tainan, Taiwan (Republic of China); FANG, Jiann-Neng, National Taiwan Museum, Taipei, Taiwan (Republic of China)

Taiwan contains abundant, diverse, and unique Pleistocene paleofaunas that have been virtually undescribed outside of the Taiwanese, Chinese and Japanese literature. Pleistocene fossils are derived from two main sources. The "Penghu Fauna" consists of remains dredged from the Penghu Channel in the Strait of Taiwan. The "Chochen Fauna" is a diverse assemblage of mammals collected at various exposures in the city of Tainan, southern Taiwan. Mammalian constituents include the families Felidae, Canidae, Rhinoceratidae, Suidae, Cervidae, Bovidae, and the orders Primates and Rodentia. Absolute dating of the Chiting Formation sediments has yet to be accomplished. Specimen NTM I04005, a partial cranium of a large pantherine felid, closely related to *Panthera tigris*, housed at the National Taiwan Museum, was recovered from the middle Pleistocene Chiting Formation near Chochen, Tainan City, Taiwan. This specimen allows for the most complete comprehensive description of a large felid specimen from Taiwan, and is one of the most complete Pleistocene specimens from southeastern China. Specimen NTM I04005 is characterized by overall cranial size intermediate between that of the earliest Pleistocene species *Panthera zdanskyi* and modern *P. tigris,* thereby confirming previous interpretations suggesting an increase in size within *Panthera* throughout the Pleistocene. Additional diagnostic features include massive zygomatic arches with pronounced, laterally extended mandibular fossa, an extremely well developed sagittal crest with a thickened anterior flare, and a slender braincase and occiput. The specimen TCTM OL 0002, housed at the Tainan City T'sai-Liao Museum, consists of an incomplete portion of the dorsal skull of *Nyctereutes*. The braincase and part of the orbital and rostral regions are preserved, including the frontals, parietals, occipitals and portions of the maxillaries. The ventral portion of the braincase is broken. The mediolateral narrowing of the orbital region, the elongate braincase, the posterior flaring and vertical posterior surface of the occipital region, and the split sagittal crest are typical of *Nyctereutes*. These carnivores no longer exist in Taiwan, and their Pleistocene record in southern China is surprisingly limited in comparison to their common appearance in northern China.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

***EQUUS* SPECIES RICHNESS IN THE RANCHOLABREAN OF THE SOUTHEASTERN U.S. COASTAL PLAIN: A QUANTITATIVE ANALYSIS OF ISOLATED CHEEK TEETH**

HULBERT Jr., Richard C., Florida Museum of Natural History, Gainesville, FL, United States

Fossils of *Equus* are very abundant in Pleistocene deposits in the southeastern USA, but consist primarily of isolated teeth and postcranial skeletal elements, not the complete skulls and mandibles favored by equid systematists. Previous workers, using relatively small samples, recognized at least two and more often three sympatric species of *Equus* of differing body and tooth size throughout this region during the Rancholabrean land mammal age. To answer the most basic systematic question, how many species were present

in this region during the Rancholabrean, standard measurements were taken on over 2000 cheek teeth. Univariate and multivariate statistical analyses were used to determine if either the two- or three-species hypotheses was supported, or if an alternative hypothesis best explained the results. Each of the 12 cheek teeth (P2–M3 and p2–m3) was analyzed separately. Each sample was divided into four wear-stage categories by the amount of remaining crown height on each tooth relative to unworn specimens, with boundaries at 75, 50, and 25 percent of unworn crown height. The results of the analyses support the presence of only a single morphospecies of *Equus* in Florida and the coastal regions of Georgia and South Carolina (FL/GA/SC) during the Rancholabrean. In this region, the coefficient of variation (CV) for tooth lengths and widths for the 12 samples range between 6 and 9, while the CVs decrease to 4–8 when the samples are partitioned into wear stages. These, along with the observed ranges of these variables, are of similar magnitude as those found in well-established extant and fossil species of *Equus*. With few exceptions, teeth from Louisiana and Mississippi represent a morphologically similar, but much larger taxon (by about 25%) than the one found in FL/GA/SC. Samples from the intervening area in Alabama, southwestern Georgia, and western Florida remain to be analyzed to determine if there is an east to west size gradient, or a sharp boundary of demarcation between the populations of *Equus* in the two regions. Further work on other systematically important elements, especially metapodials, will test this novel single-species hypothesis for FL/GA/SC Rancholabrean *Equus*. Based on dental characters, such as protocone shape and relative length, shape of the metaconid-metastylid complex, and depth of the ectoflexid, the FL/GA/SC taxon belongs to the caballine species-group (i.e., *Equus caballus* and close relatives). These results are in broad agreement with studies of ancient DNA that a single, geographically highly variable species of caballine *Equus* ranged across the Americas and Eurasia in the late Pleistocene.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 10:15 am)

EVOLUTIONARY DYNAMICS OF LARGE BODY SIZE IN NON-AVIAN DINOSAURS

HUNT, Gene, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; FITZJOHN, Richard, University of British Columbia, Vancouver, BC, Canada; CARRANO, Matthew T., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States

With body masses spanning at least five orders of magnitude, non-avian dinosaurs have only recently attracted the attention of scientists interested in the dynamics of body size evolution. Using femoral length as a proxy for overall body size in dinosaurs, we apply several statistical models to explore its evolution in a phylogenetic context. Targeted comparisons among models can be used to shed light on aspects of body-size evolution, and here we focus on two issues: (1) the pervasiveness of directional trends, and (2) the presence of detectable upper limits for body size. Directionality was assessed by comparing the fit of the non-directional model of Brownian motion (BM) to a scenario of BM with an underlying trend. Results indicate support for a trend of increasing body size (= "Cope's rule") in some, but not all dinosaur clades. To assess the macroevolutionary evidence for an upper limit to dinosaur body size we compared fit of the BM model to that of BM in the presence of reflecting boundaries that forbid body sizes larger than a specified value. This latter model was fit using a novel likelihood function, and its improvement in fit relative to BM was judged using a likelihood ratio test with the null distribution generated by simulation. These analyses have found strong evidence for an upper limit to body sizes in theropods but not sauropods or ornithopods.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 10:15 am)

ORIGIN OF THE GREATER ANTILLEAN PRIMATE FAUNA

HUNT, Kevin D., Indiana University, Bloomington, IN, United States; KAY, Richard F., Duke University, Durham, NC, United States

The timing of arrival and means of dispersal of primates in the Greater Antilles has been the subject of continued debate, mirroring the same debates for other taxa of vertebrates. Some suggest that there was a single ancient (Oligocene-Early Miocene) vicariant arrival of primates, sloths, and rodents from South America. Others argue for an alternative scenario calling for multiple cross-water dispersal events of some or all of these taxa, not necessarily at the same time. Recovery of new cranial, dental, and postcranial specimens of *Antillothrix* together with added data from other Antillean taxa *Paralouatta* and *Xenothrix* prompts a revised phylogenetic analysis to explore these different models. A 'GAARlandia' vicariance model proposes arrival by 32 million years ago. Molecular models of extant platyrrhine cladogenesis suggest that the oldest crown platyrrhine lived between 21 and 24 Ma. So, if Antillean primates cluster as stem platyrrhine taxa, the vicariance model would be supported. Alternatively, if different taxa link with one or another of three crown platyrrhine clades (Atelidae, Pitheciidae, and Cebidae) overwater dispersal would be a more likely scenario. Our phylogenetic analysis suggests first, that the extinct Antillean taxa belong to the crown clade and, second, that they are not a monophyletic group. These finding lend support to the hypothesis that primate reached the Antilles by overwater dispersal and subsequently dispersed between the islands either overwater or by vicariance.

Technical Session IX (Friday, October 19, 11:45 am)

HOW DID BOUNDING AND GALLOPING GAITS EVOLVE IN CROCODYLOMORPHA?

HUTCHINSON, John R., Royal Veterinary College, Hatfield, United Kingdom

Some Crocodylia use asymmetrical gaits, including bounding and galloping, at near-maximal speeds. It is often hypothesized that these gaits evolved within stem Crocodylomorpha, evidenced by their typically small body size, long limbs, terrestriality and changes in axial morphology (e.g. 'paravertebral shield' and procoely). A size constraint on the usage of asymmetrical gaits has also been assumed, but few data exist on what sizes of crocodiles do use these gaits and there has been no quantitative test of how size might mechanistically limit this usage.

To address the latter questions and move toward reconstructing the evolution of asymmetrical gaits in Crocodylomorpha, experimental data (50-100 Hz video) were collected from 189 steady state locomotor cycles of 32 individuals from 15 species of Crocodylia to quantify locomotor behaviours across a wide speed range (0.15-4.4 ms^{-1}). Size-normalized speed, duty factor (% time feet on ground), relative stride frequency and length were measured for each individual cycle and statistically compared among individuals using a linear mixed model with individual, species, major clade, body mass and gait as factors. Additionally, log-transformed anatomical data for each of the 78 limb muscles of 18 individuals (0.13-278 kg) from 6 species underwent regression analysis (including phylogenetically independent contrasts) to quantify size-related changes in the capacity of limb muscles (e.g. physiological areas calculated from muscle mass, pennation and fascicle length) to support asymmetrical gait usage.

Gait results show that Alligatoroidea do not use asymmetrical gaits, for reasons yet unknown, whereas extant Crocodyloidea experience a size-related loss (under 2-4m length). The polarity of the evolution of asymmetrical gaits depends on the position of Gavialoidea within Crocodylia but fossil outgroups are also pivotal. Yet without a clear signal of which anatomical traits indicate asymmetrical gait abilities in extinct (or poorly known extant) Crocodylomorpha, this is problematic.

Scaling analysis of alligatoroid vs. crocodyloid limb muscles demonstrates that neither clade has unusual or significantly different allometry (except in a few muscles such as elbow flexors) that might support the usage of faster, asymmetrical gaits. Hence it is possible that vertebral mechanisms are key to the evolution of extreme gaits in Crocodylomorpha, although other limb-based mechanisms such as muscle moment arms or physiology have not been fully tested. Until such mechanisms are more firmly established or rejected, it remains uncertain when and how asymmetrical gaits evolved in the crocodile lineage or what, if any, role body size played in that transition.

Technical Session X (Friday, October 19, 9:15 am)

BODY SIZE EVOLUTION IN PERMO-TRIASSIC EUTHERIODONTS AND THE EFFECTS OF THE END-PERMIAN MASS EXTINCTION

HUTTENLOCKER, Adam, University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States; BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa

The "Lilliput effect," a temporary decrease in body sizes of daughter lineages observed in post-extinction communities, may be a pervasive feature of mass extinctions. Such reductions have been identified following the end-Permian extinction (ca. 252 Ma) in Triassic marine invertebrates and anecdotally in South African temnospondyls and nonmammalian therapsids. Here, we quantify patterns of body size evolution in Permian to early-Middle Triassic eutheriodonts, an ecologically varied therapsid clade that outnumbered contemporary dicynodont herbivores in terms of species richness during the earliest Triassic and eventually gave rise to mammals. We address the question: Were there significant body size decreases in Eutheriodontia and its subclades following the end-Permian extinction? Basal skull length (BSL) as well as femur and humerus midshaft diameter were used as proxies for relative body size. Preliminary analysis on measurements from more than 343 eutheriodont specimens suggests large maximum body sizes (BSL > 300 mm) and increasing size disparity in Late Permian *Cistecephalus* and *Dicynodon* assemblage zones, followed by a decrease in cranial size disparity with smaller maximum and median sizes in the Triassic *Lystrosaurus* Assemblage Zone. Our findings corroborate earlier results on BSL in the Permo-Triassic (P-Tr) therocephalian genus *Moschorhinus,* which suggested significant within-lineage cranial size reductions in a P-Tr survivor lineage. More general patterns corroborate significant decreases in BSL and limb bone dimensions in eutheriodonts as a whole. Finally, to account for the effects of longer term phylogenetic trends, it is necessary to recognize potential phylogenetic constraints on observed body size patterns. In other words, are apparent body size trends stochastic or "driven" and, if driven, are they explainable by extrinsic processes (e.g., selective pressures) acting on body size distributions during the P-Tr transition? We explore statistical approaches including (1) regression on dissimilarity matrices (Mantel tests) and (2) model-based tree randomization procedures in order to identify the extent to which size distributions are explainable by phylogenetic distance and tree structure. Our null prediction is that size shifts are stochastic and largely reflect tree structure (i.e., closely related clades should be more similar in size than phylogenetically disparate clades). However, initial results from Mantel tests indicate that size disparity correlates poorly with pairwise phylogenetic distance within the therocephalian subclade. Alternatively, if extrinsic factors accelerated rates of life history evolution across clades, then observed size distributions should show significant anti-signal in earliest Triassic clades.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EGGSHELLS AS SEDIMENT: A FLUME STUDY TO DETERMINE THE APPLICABILITY OF SEDIMENT-TRANSPORT EQUATIONS TO EGGSHELLS

IMAI, Takuya, Montana State University, Bozeman, MT, United States; EVANS, Thomas, Montana State University, Bozeman, MT, United States; CAHOON, Joel, Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States

Discriminating *in situ* from transported eggshell assemblages furthers our understanding of nesting behaviors, time-averaging, and spatial-mixing. Previous research proposed that one could assess the transport of skeletal assemblages by comparing the clast size of associated sediment with the quartz equivalent diameters of represented fossil bones. If bones and matrix sediment share similar transport properties, they may have experienced synchronous deposition. This work explores the applicability of this approach to eggshells and their fossil assemblages. We used three models based on empirically derived sediment-transport equations to estimate flow competence for eggshell deposition, and the performance of each model was tested using repetitive laboratory flume trials. Values of critical bed shear stress at deposition (τ_{bc}) of chicken eggshell fragments representing 1/4 to 1/2 of the whole shell were estimated using three models. Model 1 estimates τ_{bc} from eggshell volume, model 2 from eggshell density, and model 3 from eggshell settling velocity. These same fragments were released in a laboratory flume with a smooth synthetic bed and bulk flow velocity decreasing downstream (gradually varied flow). The flow depth at deposition was recorded for each fragment. After calculating τ_{bc} values using the flow depth, they were compared to the τ_{bc} values estimated by the models. In addition, based on the measured τ_{bc}, we estimated the size of clastic grains expected to be synchronously deposited with our eggshells. Estimated τ_{bc} values varied from those observed by 11-91%, and models 1 and 2 (11-35% negative error) outperformed model 3 (71-91% negative error). The performance of models 1 and 2 improved with increasing fragment size. The results indicate that existing sediment-transport equations using shell volume and density can provide reasonable estimates of the flow competence at deposition for 1/4 to 1/2 chicken eggshells. Thus, these equations support assessment of eggshell transport by comparing estimated flow competence between matrix sediment and eggshells at least over the size range employed in this study. The measured τ_{bc} values (90-111 g/cm·s^2) indicate that coarse quartz sand or larger may be synchronously deposited with eggshells resembling our eggshell samples. Although these methods may be applicable to fossil eggshell assemblages, further tests under natural conditions are necessary to evaluate whether they are valid analytical tools for field research.

Technical Session IX (Friday, October 19, 9:45 am)

THE EVOLUTION OF EARLY CROCODYLOMORPH DISPARITY AND LOCOMOTOR STYLES: NEW EVIDENCE FROM THE LATEST TRIASSIC OF NEW MEXICO

IRMIS, Randall B., Natural History Museum of Utah and Dept of Geology & Geophysics, University of Utah, Salt Lake City, UT, United States; NESBITT, Sterling J., Department of Biology, University of Washington, Seattle, WA, United States

Crocodylomorphs are the only pseudosuchian lineage that survived the end-Triassic extinction. The bauplan of most early Mesozoic non-crocodyliform crocodylomorphs included an upright stance, small body size (<100 kg), and are interpreted to have been generalist faunivores. Consequently, early crocodylomorphs are often stereotyped as all conforming to these characteristics, defining a single ecological role that did not vary significantly from the Late Triassic to Late Jurassic (duration of ~100 million years). Yet, some fragmentary fossils (e.g., *Redondavenator* and *Phyllodontosuchus*) hint at a greater ecological disparity among early crocodylomorphs. Here, we report a largely articulated skeleton of a new crocodylomorph taxon from the latest Triassic (?Rhaetian) *Coelophysis* Quarry of Ghost Ranch, northern New Mexico. The specimen consists of the posterior portion of the skull, articulated hindlimbs and forelimbs, pelvis, parts of the vertebral column, and associated osteoderms. Though this new taxon displays typical cursorial features and small body size (femur length = 7 cm), its limbs are remarkably elongate and gracile. Although lengthening of the femur and tibia are responsible for hindlimb elongation (relative to other crocodylomorphs), the new taxon is unique among known tetrapods (fossil or extant) in lengthening its forelimb by elongation of the proximal carpals, the radiale and ulnare, so that they are as long as the radius and ulna. Crocodylomorpha is diagnosed by a slight elongation of these two elements, but the relative length of these elements in the new taxon is extreme, at least twice that of any other crocodylomorph; these proportions are unambiguous because both forelimbs are articulated. This suggests a specialized ecological role for the new form, differing substantially from a generalized small faunivore ecology. The Late Jurassic taxon *Hallopus victor* is the only species that has remotely similar forelimb proportions, but it is not clear if other character states support a close relationship with the new taxon. These new data demonstrate that early crocodylomorph disparity was significantly higher than previously thought, and that crocodylomorphs diversified into a variety of ecological roles prior to the end-Triassic extinction, resulting in specialized lineages that continued well into the Jurassic.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FUNCTION OF THE SYMPHYSEAL TOOTH WHORLS OF *EDESTUS*

ITANO, Wayne M., University of Colorado Museum of Natural History, Boulder, CO, United States

The function of the paired upper and lower symphyseal tooth whorls of the Carboniferous chondrichthyan genus *Edestus* is obscure. A *Pristis* (sawfish) rostrum-like function to disable small prey with a slashing motion, suggested by others, seems inefficient with the teeth arranged as they are. Grasping or cutting prey between the paired tooth whorls with a pincer- or scissor-like action would be hindered by the curvature of the whorls, which prevents the occlusion of more than a few teeth. This is particularly evident for *Edestus newtoni,* where the tooth whorls form nearly a half circle. The anterior teeth would be nonfunctional, but would exact a cost in added mass and drag. The serrated edges of *Edestus* teeth seem adapted to slicing flesh, so as to disable prey and possibly to slice it into pieces. I propose that such a slicing action was carried out with a vertical motion of the head, with jaws fixed relative to each other, and not with a scissor-like action, as usually assumed. A comparison can be made with the cookiecutter shark, *Isistius brasiliensis,* which uses its lower teeth to cut pieces of flesh from the flanks of much larger prey, but with a circular, rather than a linear, motion of its head. *E. minor* and *E. heinrichi* differ from *E. newtoni* in having less curved tooth whorls. This could have been an adaptation to allow them to reduce swimming drag by closing their jaws, but to effectively slash prey with their jaws open. The prey must have been massive, so as not to have been pushed out of the way rather than sliced, and soft, at least for *E. minor* and *E. heinrichi,* since little or no wear is observed on the teeth of these species. The prey might have been large, soft-bodied invertebrates, such as large jellyfish or nonshelled cephalopods, or something without a modern analog. The large, presumed upper, tooth whorls of *E. heinrichi* and *E. giganteus* (probably a junior synonym of *E. heinrichi*) seem more massive than needed to hold the teeth. The large mass might have been used to increase the force of a downward slashing motion, with the assistance of gravity. The type specimen of *E. newtoni,* which was reexamined for this study, shows moderate wear to the serrations of the older teeth, presumably due to use in feeding, and significant damage to the posterior edges of two adjacent teeth. The origin of the damage is not known (and might even be postmortem breakage), but if it were caused by occlusion with the opposing dentition of the same individual, other scratches would be expected

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

CHONDRICHTHYANS FROM THE MIDDLE PERMIAN OF RUSSIA

IVANOV, Alexander, St.Petersburg University, St.Petersburg, Russian Federation

The Middle Permian chondrichthyans are poorly known in Russia but a new collection from the Kazanian deposits of the East European Platform and Cis-Urals demonstrates a taxomonic diversity of sharks. The isolated teeth of ctenacanthiform *Glikmanius occidentalis* and lonchidiid "*Lissodus*", and fin spines and teeth of a new sphenacanthid were found in the Kazanian localities of the Vym River Basin, Komi Republic. The teeth of symmoriiform *Stethacanthus altonensis* and anachronistid *Cooleyella amazonensis*, polyacrodontid teeth including a new genus, and various chondrichthyan scales have been recovered from the borehole in the Vladimir Region, from the Chimbulak quarry in the Kirov Region, from the Kotlovka locality at the Kama River in the Perm Region, and from the Pechische locality at the Volga River in the Tatarstan Republic. A block containing a fragment of jaw cartilage, teeth, and scales from one individual of the new sphenacanthid also occurs at the Pechische site. The impression of a hybodontiform caudal fin skeleton was reported from the Kargaly quarry in the Orenburg Region. The occurrence of *Cooleyella amazonensis* in the Middle Permian (Roadian) on the west side of the Guadalupe Mountains, West Texas supports a relation between the Delaware Basin and the Kazanian Basin during the Middle Permian previously suggested based on brachiopod data. The diversity of chondrichthyan assemblages in the East European Platform and Urals decreased from the Early to Late Permian. The most diverse assemblage from the Artinskian of the Urals includes various symmoriiforms, ctenacanthiforms, jalodontid, sphenacanthids, anachronistids, synechodontiform, edestids, petalodontiforms, orodontiforms, and cochliodontiforms. The sphenacanthids, polyacrodontids, anachronistids are common in the Kazanian assemblage. The Late Permian (Tatarian) assemblage of Russia is represented by the abuandant sphenacanthids and polyacrodontids, rare ctenacanthiform and menaspids.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

CONTROL OF HAZARDOUS PARTICULATE EXPOSURE DURING FOSSIL PREPARATION THROUGH THE USE OF LOCAL EXHAUST SYSTEMS

JABO, Steven J., Smithsonian Institution, Washington, DC, United States; KROEHLER, Peter A., Smithsonian Institution, Washington, DC, United States; MAKOS, Kathryn A., Smithsonian Institution, Washington, DC, United States; PETERS, David M., Smithsonian Institution, Washington, DC, United States

Preparation of fossils for scientific study involves a variety of chemical and physical methods to remove the rock matrix surrounding the specimen. The matrix may contain several elements, depending on its geological source, that pose potential health hazards to the preparator from inhalation of airborne particulates generated during physical preparation. The elements of most concern to health (due to carcinogenicity and progressive pulmonary diseases) include respirable-sized particles of crystalline-free silica, asbestos fibers, and radioactive particles. A local exhaust ventilation (LEV) system was installed in the National Museum of Natural History's Vertebrate Paleontological Preparation Lab to reduce staff exposures. The LEV consisted of six capture (snorkel-type) hoods on flexible ducts,

connected to hard ductwork leading to a combination High-Efficiency Particulate Air filtered cyclone plus bag house dust collector. The flexible LEV hoods are easily positioned over the rock matrix work area for efficient removal of preparation generated particles and vapors from associated chemicals. Analysis of personal exposure (breathing zone air) samples collected during various representative tasks associated with the preparation of vertebrate paleontological specimens indicated that use of the LEV both reduced and controlled staff exposures to silica-containing dust to within permissible exposure limits established by the U.S. Occupational Safety and Health Administration. Redesign of the ductwork is needed to reduce excessive sound pressure levels, which currently necessitate hearing protection for comfort over prolonged work periods. The use of respirators is not required when using this LEV system, although staff is still enrolled in the Institution's respiratory protection program for use when working in field conditions or at other sites without the benefit of local exhaust.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

AVIAN EGGS FROM THE EOCENE CHADRON FORMATION, NEBRASKA, AND WILLWOOD FORMATION, WYOMING

JACKSON, Frankie D., Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; CORSINI, Joseph A., Eastern Oregon University, La Grande, OR, United States

Fossil avian eggs from the Paleogene of North America are rare. We describe specimens from the lower Eocene Willwood Formation of Wyoming and the upper Eocene Chadron Formation of western Nebraska. Both egg types differ from previously described specimens and therefore represent new oospecies. Four of five egg fragments from the Willwood Formation contain avian embryonic remains. The largest fragment measures 3.0 cm long x 3.7 cm wide, which represents a minimum size for this egg type. The 600 µm-thick eggshell consists of mammillary, continuous, and external layers. The mammillary layer varies laterally from 130-160 µm in thickness, with an abrupt transition to the overlying 380 µm-thick continuous layer. A 67 µm-thick blocky external layer overlies the continuous layer. Prisms are partially or completely obscured by squamatic texture in the continuous layer. Relatively abundant, straight and narrow pores terminate in funnel-shaped openings at the shell surface. The degree of bone ossification and presence of cratered eggshell nuclei suggest that death occurred at a relatively late stage of embryonic development. The Chadron Formation egg measures 60 mm x 44 mm. The 890 µm-thick eggshell consists of a 225 µm-thick mammillary layer, 615 µm-thick continuous layer, and a 50 µm-thick external layer. Calcite cleavage planes intersect at acute angles, producing a "splayed" appearance within the mammillary and continuous layers. Prisms of the continuous layer fan outward toward the outer eggshell surface, terminating in undulating surface ornamentation. The eggshell exhibits an abrupt transition between layers and irregularly developed squamatic texture. The microstructure of the Willwood eggshell resembles that of some modern birds such as Demisolle Crane (*Anthropoides virgo*) and Wild Duck (*Anas platyrhynchos*). In contrast, the Chadron eggshell differs from most modern eggs, and more closely resembles that of some Cretaceous non-avian theropod eggs. Shared features include irregular squamatic texture, crystal splaying, and ornamentation. Additionally, the Chadron eggshell exhibits twice the water vapor conductance predicted for an avian egg of comparable mass. These similarities may result from the presence of archaic avian groups in the Eocene and/or convergent evolution of eggshell structure and nesting behaviors with non-avian theropods.

Technical Session II (Wednesday, October 17, 9:45 am)

DERMAL BONE IN EARLY TETRAPODS: A PALEOPHYSIOLOGICAL HYPOTHESIS OF ADAPTATION FOR TERRESTRIAL ACIDOSIS

JANIS, Christine M., Brown University, Providence, RI, United States; DEVLIN, Kelly, Brown University, Providence, RI, United States; WARREN, Daniel E., Saint Louis University, Saint Louis, MO, United States; WITZMANN, Florian, Museum für Naturkunde, Berlin, Germany

The dermal bone sculpture of early, basal tetrapods of the PermoCarboniferous is unlike the bone surface of any living vertebrate, and its function has long been obscure, although a high degree of vascularization is indicative of a physiological function. Physiological studies on extant vertebrates (turtles, alligators and frogs) show that dermal bone and other calcified tissues can aid in regulating acid-base balance in response to hypercapnia (excess metabolic blood carbon dioxide) and lactate acidosis, during exercise and while submerged in water. Buffering of acidosis is thus clearly important in tetrapods under conditions when they cannot use rapid rates of lung ventilation (as is seen with the use of ribs in amniotes) to expel metabolic carbon dioxide.

We propose a similar buffering function for these sculptured dermal bones in early tetrapods. Unlike the condition in modern reptiles, which experience hypercapnia when submerged, early tetrapods would have experienced hypercapnia on emergence onto land, due to inefficient means of eliminating carbon dioxide via the primitive tetrapod buccal pumping mode of lung ventilation. Lactate acidosis would also be likely on land due to the relatively greater costs of terrestrial locomotion. Unlike modern amphibians, which also employ buccal pumping, most early tetrapods would have been too large to rely on cutaneous carbon dioxide loss, and are unlikely to have had the specialized lissamphibian thin skin. Note that modern frogs may encounter terrestrial acidosis which they buffer with calcium from their endolymphatic lime sacs.

A prediction of this hypothesis is that greater levels of dermal bone sculpturing would correlate with habitat, being more prominent in terrestrial forms. We show that pronounced dermal sculpture is largely confined to the more terrestrial early tetrapods, with the exception of some highly specialized flattened aquatic forms (e.g., plagiosaurs) that may have experienced hypercapnia in deep water environments. Dermal sculpture is reduced or lost in stem amniotes that likely had the more efficient lung ventilation mode of costal aspiration, and in small-sized stem amphibians that would have been able to use the skin for gas exchange. We conclude that the early tetrapod sculptured dermal bone was an initial adaptation for terrestrial existence via the buffering of resultant acidosis; its loss reflects the acquisition of more efficient means of carbon dioxide loss in extant tetrapods and their ancestors.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEARLY COMPLETE TURTLE (TESTUDINES: EUCRYPTODIRE) FROM THE UPPER JURASSIC OF CENTRAL GERMANY, AND ITS PALEOECOLOGY

JANSEN, Maren, Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany; KLEIN, Nicole, Steinmann-Institut für Geologie, Mineralogie und Paläontologie, University Bonn, Bonn, Germany

Late Jurassic turtles from Western Europe are frequent finds in sediments representing fluviatile to lagoonal and marine environments. However, those turtles show a mixture of basal and derived characters, which makes it difficult to interpret their habitat preferences and life style. The overall morphological description of the Upper Jurassic fossil turtles of the Langenberg Quarry, Oker, Lower Saxony, Germany, gives further insight into the paleoecology, as well as the distribution of known taxa, and indicates a possible endemic Late Jurassic turtle fauna of Oker. Two skulls, a nearly complete, articulated specimen, as well as isolated shell plates and postcranial bones could be assigned to Plesiochelyidae, Thalassemydidae, as well as one previously undescribed eucryptodire taxon. The small but nearly complete specimen (FV 853), still *in situ* in sediment matrix, was scanned using computer tomography, morphologically described in detail, and compared with extinct and extant turtles. The combination of basal characters, such as the development of the pygal region, with derived characters, such as the lesser ossified bridge region between carapace and plastron, define the specimen as derived relative to *Plesiochelys*. However, a definite assignment is difficult, due to the ontogenetic stage of FV 853. Several characters define FV 853 as juvenile: the small size (7.28 cm carapace length) of the specimen, the grade of ossification of the skull elements and preserved limbs, as well as the large lateral carapacial fontanelles that surround the costals. Furthermore, the sculpturing of the vertebral scutes, which was previously seen as either a character shared only by pleurosternid taxa or an unrelated juvenile feature, can now be confirmed as a juvenile character for both pleurosternid taxa and eucryptodire taxa. Aside from these juvenile characters, FV 853 shows clear aquatic adaptations. Forelimb ratios of the specimen and various other Mesozoic eucryptodire turtle taxa were compared to an existing study of selected extant cryptodires, which had shown that these ratios reflect habitat preferences independent from ontogenetic stages. The specimen plots together with freshwater turtles and more moderately to fully aquatic turtles, indicating it inhabited the nearshore to offshore area of the costal region. Since the locality is interpreted as representing a shallow marine environment in a coastal region with periodic regressions and transgressions, it is reasonable to expect a higher degree of aquatic adaptation during transgressive periods. Other Mesozoic turtles of Western Europe with similar morphologies and supposed lifestyles support this conclusion.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 12:00 pm)

FOSSIL VERTEBRATES FROM NEOTROPICAL LATITUTES: A VAST RECORD WAITING TO BE DISCOVERED

JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Panama, Panama

The tropical region of South America (Neotropic) is a vast place, ~8 million of km^2, similar in area to USA, and plays a major role on global climate, carbon and fresh-water budgets, and global weathering rates. It also contains the highest biodiversity on Earth, of both plants and animals. The history of the Neotropic is essential for understanding the evolution of the tropical ecosystem. How this high diversity was achieved, how it has been maintained, and how it has responded and will respond to major environmental crises still remain central questions in ecology and evolutionary biology. Compared to its massive size, there have been very few studies focused on understanding the evolution of its climate and biota. However, the lack of studies is not the product of poorly preserved fossils but rather a paucity of researchers working in tropical latitudes. In the last decade, we have been working in seven different Neotropical localities (both Panama and Colombia), including the lower Cretaceous of Zapatoca, the Maastrichtian coal mines of Guaduas, the Paleocene coal mines of Cerrejon, the late Paleocene-early Eocene Bogota formation, the late Oligocene-early Pliocene of Panama, the Middle Miocene La Venta, and the Miocene-Pliocene Castilletes formation. The overall vertebrate fossil record indicates 1) Tropical mean annual temperature (MAT) is not stable. Estimates using both a snake paleothermometer in Cerrejon and biomarkers (TEX86) indicate that MAT during the late Paleocene was ~29 Celsius, 1.5 Celsius higher than modern tropical temperatures. 2) MAT during the Early Eocene reached ~32-33 Celsius, and yet neither the mammal fauna/flora of Bogota formation shows a collapse as some global climatic models had predicted. 3) Cerrejon Paleocene faunas are characterized by massive sizes including snakes, turtles, crocodiles and lung-fishes. 4) Despite years of searching, no Paleocene mammal has been found yet. 5) Xerophytic and savanna landscape dominates the northern region of the Neotropics today, however, that was not the case until ~3-5 My ago. Faunas from Castilletes indicates a much more humid environment, suggesting a massive transformation of the neotropical landscape during the Pliocene. 6) A weak interchange between South American and North American

mammalian faunas started at ~10 My, followed by a strong interchange pulse during the latest Pliocene-early Pleistocene. In contrast, the rich fossil record of Panama indicates an active interchange of turtles, crocodiles and *Boa* as early as ~22 My. The fossil record of the Neotropic is vastly unexplored. Decades of paleontological exploration are still ahead of us, but the rewards will be immense as the tropics are a constant source of evolutionary innovation.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

AN ARMADILLO AND A LEG: INFERRING BEHAVIORAL DIFFERENCES OF *DASYPUS BELLUS* AND *DASYPUS NOVEMCINCTUS* FROM MORPHOLOGY OF THE CALCANEUS

JASINSKI, Steven E., East Tennessee State University, Johnson City, TN, United States; WALLACE, Steven C., East Tennessee State University, Johnson City, TN, United States

Dasypus bellus (beautiful armadillo; Xenarthra), assuming *it* is within *Dasypus*, is from the Pleistocene of North America (Rancholabrean NALMA) and has often been considered identical to the extant *D. novemcinctus* osteologically when disregarding size. Consequently, many behavioral interpretations for the former have been derived from the latter. By comparing the calcanea of these two dasypodids, distinct osteological differences were observed including a mediolaterally-expanded astragular facet region, an anteriorly-elongated calcaneal head, and a ventrally-elongated calcaneal foot in *D. novemcinctus*. Such characters were not allometric and are believed to correlate to distinct behavioral differences. We suggest that *D. novemcinctus* maintains a more fossorial lifestyle due to its expanded facet areas, while the larger *D. bellus* was likely more terrestrial, with little digging behavior. Such a disparity in lifestyle could not only explain the osteological differences present, but also why fossils of *D. bellus* have been recovered farther north, particularly northeast, than the present range of *D. novemcinctus*. A larger, more terrestrial animal could cover longer distances during periods of warm or mild weather and become acclimated to cold weather more efficiently. The osteological variances, however, are only a preliminary look into possible differences between these dasypodids. If *D. bellus* did behave differently than *D. novemcinctus*, interpretations based on fossils of *Dasypus*, and the fossil identities themselves, may need to be re-evaluated to find how these two taxa are related behaviorally, geographically and temporally. Previous conclusions that *D. novemcinctus* and *D. bellus* were behaviorally and ecologically the same are possibly incorrect based on our data, and should be re-assessed. This study adds further support to the growing trend of using caution when making inferences about extinct taxa based on extant relatives.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW QUATERNARY VERTEBRATE RECORDS FROM CAVE DEPOSITS IN JASPER NATIONAL PARK, ALBERTA, CANADA

JASS, Christopher, Royal Alberta Museum, Edmonton, AB, Canada; HORNE, Greg, Parks Canada, Jasper, AB, Canada; CRITCHLEY, Dave, Northern Alberta Institute of Technology, Edmonton, AB, Canada

Sedimentary cave deposits in western Canada are an important source of Quaternary vertebrate remains. They are especially important because they often preserve remains of small vertebrates that are rarely recovered from other depositional settings (e.g., sand and gravel deposits). Recent paleontological reconnaissance and fieldwork at three cave localities in Jasper National Park is improving our understanding of late Quaternary faunas in western portions of Alberta. Two of the localities, Disaster Point Cave and Procrastination Pot, are situated in close proximity to one another in the Front Ranges of the Canadian Rocky Mountains. The third locality, Ice Trap Cave, is situated above tree-line in a remote region of the Canadian Rocky Mountains.

On-going reconnaissance at Procrastination Pot and Ice Trap Cave indicate that both sites preserve paleontological remains that further contribute to our understanding of post-glacial biotas in mountainous regions of western Canada. Identified surface remains preserved inside Procrastination Pot include *Ursus*, cf. *Ovis*, and cf. *Marmota*. Chiropteran remains are abundant at Procrastination Pot and the cave currently acts as a hibernaculum. Ice Trap Cave preserves soft tissue remains of marmots (*Marmota* sp.) in addition to deposits of rodent dung. Rodent dung collected near the surface of organic deposits at Ice Trap Cave was radiocarbon dated to 9600 ± 40 yr BP.

Excavation of fossiliferous sediments at Disaster Point Cave took place in 2010 and focused on an area known as the Terminal Dig. Recovered mammals include carnivorans (*Mustela*), rodents (Arvicolinae, Muridae, Sciuridae, cf. Heteromyidae), and shrews (*Sorex*). Amphibians (anurans, salamanders) comprise a significant portion of the recovered fauna. AMS radiocarbon dates of 1700 ± 30 yr BP and 2650 ± 30 yr BP on charcoal collected from stratified sediments suggest a late Holocene age for the fauna from the Terminal Dig. A slightly older AMS radiocarbon date (6090 ± 40 yr BP) on bone collagen from a pelvis of *Ursus americanus*, provides the current known maximum age for fauna preserved in the cave.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

BIODIVERSITY AND STRATIGRAPHIC DISTRIBUTION OF THE FIRST LATE LADINIAN (MIDDLE TRIASSIC) MARINE VERTEBRATE FAUNA — XINGYI FAUNA FROM SOUTH CHINA

JI, Cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; SHANG, Weiliang, Xingyi National Geological Park, Xingyi, China; DIAO, Guangwan, Xingyi National Geological Park, Xingyi, China; MOTANI, Ryosuke, Department of Geology, Davis, CA, United States; TINTORI, Andrea, Dipartimento di Scienze della Terra “A. Desio”, Università degli Studi di Milano, Milano, Italy

The Xingyi Fauna is the first well preserved marine reptile fauna reported from the late Ladinian to date. Eight valid marine reptile taxa have hitherto been reported, including the thalattosaur *Anshunsaurus wushaensis*, sauropterygians *Glyphoderma kangi, Nothosaurus youngi*, *Lariosaurus xingyiensis*, *Keichousaurus hui* and *Yunguisaurus liae*, and protorosaurs *Macrocnemus* cf. *M. fuyuanensis* and *Tanystropheus* cf. *T. longobardicus*. However, most specimens lack exact stratigraphic and geographic data.

A scientific excavation has been carried out since August of 2011 at the Nimaigu Village of Wusha District, Xingyi City, Guizhou Province and has yielded over 300 reptilian remains in the 28 layerss (layer 26 to layer 53) of the 5.2m – 5.9m thick beds out of the 96m-thick Zhuganpo Member of the Falang Formation. The Xingyi Fauna is mainly represented by *Keichousaurus* with a continuous occurrence between layers 26 and 44. Research on the ammonoids above the fossil layer suggested a latest Ladinian age. The new findings included two ichthyosaurs (*Guizhouichthyosaurus* and *Qianichthyosaurus*) and thalattosaurs that were collected from the upper bed of the fossiliferous level (layer 42 to layer 53), revealing close affinity to the younger Guanling Biota (Carnian, Late Triassic). Contrarily, the sauropterygian material only appears in the lower bed of the fossiliferous level including nothosaurs (layer 30), pistosaurs (layer 36) and *Keichousaurus* (layer 26 to layer 44), which are typical Middle Triassic members. Therefore, it is possible that Xingyi Fauna displays a transition of marine reptile faunas and will provide new information on the reconstruction of the paleoecology and paleoenvironment.

Within the Xingyi Fauna, the durophagous member (*Glyphoderma*) only represents up to 1 out of 10 species while the ratio is 5 out of 15 in the Panxian-Luoping Fauna and 5 out of 9 in the Guanling Biota. The biodiversity of the Xingyi Fauna is highly in accordance with the recent hypothesis on the positive correlation between taxonomic abundance of durophages and sea level change possibly resulted from the remarkable sea level drop during the late Ladinian.

Technical Sesssion XII (Friday, October 19, 1:45 pm)

TWO NEW EARLY TRIASSIC MARINE REPTILES FROM CHAOHU, ANHUI PROVINCE, SOUTH CHINA

JIANG, Da-Yong, Department of Geology and Geological Museum, Peking University, Beijing, China; MOTANI, Ryosuke, Department of Geology, University of California, Davis, CA, United States; TINTORI, Andrea, Dipartimento di Scienze della Terra, Università degli Studi di Milano, Milano, Italy; RIEPPEL, Olivier, Department of Geology, The Field Museum, Chicago, IL, United States; SUN, Zuo-Yu, Department of Geology and Geological Museum, Peking University, Beijing, China

Records of marine reptiles from the Lower Triassic, when they first emerged following the short-term stagnancy after the end Permian mass extinction, are rare, with only a single taxon usually being found from one locality, such as the ichthyopterygian *Utatsusaurus* from Miyagi of Japan and *Chaohusaurus* from Anhui of South China. However, the records of Early Triassic sauropterygians from South China and other localities have been ambiguous.

During the excavation at Majiashan in Chaohu, AnhuiProvincein May of 2011, we found two new marine reptiles, co-occurring with the ichthyopterygian *Chaohusaurus* from the Middle-Upper Member of the Nanlinghu Formation, with age of the Spathian of the Olenekian (Early Triassic). Sixty complete skeletons of *Chaohusaurus* were excavated from beds 621, 628, 633 and 638, some of which are preserved three-dimensionally in nodules. From bed 598, lower than the typical *Chaohusaurus* layers, we found an articulated postcranial skeleton of sauropterygian, which is the first definite Early Triassic sauropterygian with exact stratigraphic data within the Spathian. This skeleton is preserved in ventral view, with the last three cervical vertebrae and 19 dorsal, 3 sacral and more than 18 caudal vertebrae. The transverse processes of dorsal vertebrae are not distinctively elongated. The cervical centra are keeled ventrally whereas cervical ribs are double-headed and carry a free anterior process. The dorsal ribs are single headed and the clavicles rest on the anteromedial aspect of the scapula. The humerus is curved. These features allow assignment of the new taxon among sauropterygians. The interclavicle has no posterior stem, and the scapula is of typical eosauropterygian shape, with a broad and ventrally expanded glenoidal portion that is separated from a narrow posterodorsal blade, but the coracoid is round and plate-like without a waist. This feature is different from all the other known eosauropterygian but is similar to placodonts.

The other new taxon was from bed 719, stratigraphically higher than the main fossil levels of *Chaohusaurus*. It is about 1.4 m long, with a small skull that is different from all known marine reptiles known so far. The presence of the upper temporal fenestra suggests that it is a diapsid. The two new taxa suggest that multiple clades of marine reptiles co-existed earlier than previously believed, during or before the middle Spathian.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

HAINOSAURUS VERSUS _TYLOSAURUS_: IS THE FORMER DISTINCT FROM THE LATTER?

JIMENEZ-HUIDOBRO, Paulina, University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada

The tylosaurine mosasaur genus *Hainosaurus* was originally described from upper Campanian to Maastrichtian aged deposits in Belgium. Nearly 25 years ago, a new species, *H. pembinensis* (upper Campanian, Manitoba, Canada) was assigned to the genus, despite the fact that all other North American species of tylosaurine mosasaur had been assigned to the genus *Tylosaurus.* Recently, a new species of North American tylosaurine was also assigned to *Hainosaurus neumilleri*. Redescription and revision of materials of *H. pembinensis* resulted in its generic reassignment to *Tylosaurus*. Examination of the materials of available Belgian hainosaurs reveals that the diagnostic characters cited in original descriptions, and subsequent treatments, do not support generic distinctions between *Hainosaurus* and *Tylosaurus*. *Hainosaurus neumilleri* has not yet been examined by us, but if the genus is a junior synonym of *Tylosaurus*, as we propose, than the relevant question concerning *H. neumilleri* is its species level distinction within *Tylosaurus*. Key characters considered to support generic distinction include the position of the pineal foramen, the shape of the maxilla/premaxilla suture, and characteristics of teeth and quadrate. Our observations of these diagnostic characters do not support such distinctions. For example, we recognize variability in the position of the pineal opening within the genus *Tylosaurus* (*e.g. T. kansasensis, T. nepaeolicus, T. pembinensis and T. proriger*) that is identical to the claims made for *Hainosaurus*. The maxilla/premaxilla suture seam is sinuous (zig-zagged), and the quadrate presents a prominent internal suprastapedial process, both features being reported in genus *Tylosaurus*, as well. The remaining Northern and Southern Hemisphere tylosaurines have all been assigned to the genus *Taniwhasaurus* and are generically distinct from either *Hainosaurus* and *Tylosaurus.*

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SHARKS FROM THE GERALDINE BONEBED, LOWER PERMIAN OF TEXAS

JOHNSON, Gary D., Southern Methodist University, Dallas, TX, United States

The Geraldine Bonebed was discovered by A. S. Romer in 1932. It eventually yielded a large number of mostly complete skeletons of four tetrapod taxa, for which it is famous, and also a diverse flora as well as other vertebrates. It occurs in the Nocona Formation, Wichita Group, Sakmarian age. With the help of Bill May (Norman, Oklahoma), bulk samples of matrix were screen-washed and sorted to produce a variety of vertebrate microfossils, including sharks (SMU 69641, 76693-76714, 76717), especially xenacanths. The non-xenacanth sharks are rare and include a petalodont tooth (*Janassa*?), *Helodus* sp. (2 teeth), and four partial hybodont teeth (probably representing 3 species). These are all considerably more common higher in the Wichita Group. Among the xenacanths are two typically small *Xenacanthus* sp. occipital spine fragments, two *Orthacanthus* sp. occipital spine fragments (one small, one very small) and hundreds of *Orthacanthus* teeth. *Orthacanthus texensis* teeth are much more common (1723, including germinal and deformed teeth) than *O. platypternus* teeth (75). Measurements (anteromedial-posterolateral length vs. labial-lingual width of the base as seen in aboral view) of random samples of these teeth yielded the following results: for *O. texensis* (n = 141), mean length = 3.15 mm, mean width = 3.49 mm, with a range of 1.12-9.80 mm (length) and 1.18-11.27 mm (width); for *O. platypternus* (n = 35), mean length = 2.63 mm, mean width = 1.90 mm, with a range of 0.84-5.39 mm (length) and 0.72-4.49 mm (width). A linear regression analysis of these data (width on length, with 95% confidence intervals) resulted in a slope of 1.11 ± 0.04 and y-intercept of −0.03 ± 0.13 mm for *O. texensis* and a slope of 0.68 ± 0.08 and y-intercept of 0.10 ± 0.23 mm for *O. platypternus*. Both data sets are comparable to those higher in the Wichita Group for these species. With one possible exception (the exact locality cannot be confirmed), *O. texensis* and *O. platypternus*are not known to occur below the Nocona Formation in Texas, nor are they anywhere older than Sakmarian age.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A FUNCTIONAL INTERPRETATION OF THE CRANIAL SUTURE MORPHOLOGY IN _CAPTORHINUS AGUTI_ (REPTILIA)

JONES, Marc E., UCL, University College London, London, United Kingdom; ZIKMUND, Tomas, Queen Mary's School of Medicine & Dentistry, London, United Kingdom

Permian captorhinomorphs were geographically widespread and showed diversity in body size, skull shape, and dental apparatus. *Captorhinus aguti* is one of the best known representatives having been described in detail from both complete skulls and isolated elements. However, the detailed structure of certain cranial joints (e.g. lacrimal-prefrontal) remains poorly known and the functional implications of the overall joint arrangement has not been fully explored. We surveyed a range of cranial material from Fort Sill, Oklahoma, USA, (Arroyo Formation) referred to *Captorhinus aguti* using binocular microscopy, micro Computed Tomography (CT), and Scanning Electron Microscopy to examine the cranial joints in greater detail. Many of the peripheral cranial joints involve broad overlaps occasionally terminating in serrated edges whereas other joints involve more complex interdigitations such as those closer to or along the midline. The lacrimal-prefrontal joint has been considered of particular interest to the functional morphology of early amniotes because of its location above the dental arcade and in front of the orbit. When the constituent elements of *Captorhonus* are found in isolation the corresponding facets are invariably damaged. However, a mico CT computer model of an articulated lacrimal and prefrontal demonstrates that in this taxon the joint is more complex than previously appreciated and may have served a key role in accommodating stresses transmitted from the dental arcade to the facial bones. It involves several interdigitating plates of bone which are particularly large in the medial part of the joint. A dorsal view of the lacrimal facet shows that the plates are orientated as if to radiate from a point equal to the posterolateral corner of the nasal cavity. Any micromovement within the joint must have occurred in the dorsoventral plane (in parallel to the long axis of the plates) or these plates would be vulnerable to breakage. The successive overlaps would provide a large surface area for collagen fibres running between the facet surfaces. These would resist or dampen movement in a dorsoventral direction. A compressive loading of this kind is likely to arise during feeding when the maxillary dentition meets resistance. Comparisons with testudines and lepidosaurs show a greater overall similarity to the joint complexity of testudines, an observation that may have implications relating to skull fenestration and muscle arrangement.

Technical Session XVII (Saturday, October 20, 2:15 pm)

TURNING IN THEROPODS

KAMBIC, Robert E., Brown University, Providence, RI, United States; GATESY, Stephen M., Brown University, Providence, RI, United States

In extant animals, maneuvering plays a crucial role in navigating complex terrain, finding food, or escaping predators; extinct theropods were likely no exception. Despite its importance, maneuvering's complexity and intermittent nature have resulted in little study compared to steady locomotion.

In this study, we used the helmeted guineafowl, (*Numida meleagris*) to study one type of maneuvering: turning to face a new direction while standing. We used biplanar cineradiography and radiopaque bone markers to acquire high-resolution six degree of freedom segment kinematics. Observed turns rely primarily on long axis rotation of the femur or tibiotarsus to reposition the foot mediolaterally. At the hip, the antitrochanter likely limits abduction while the bicondylar shape of the knee prevents abduction/adduction. Limiting this degree of freedom requires the use of long axis rotation.

Further analysis of the guineafowl hindlimb should help provide the link between joint shape and soft tissue anatomy and range of motion. For instance, relatively thin condyles and long collateral ligaments at the knee may signal large long axis range of motion. We hypothesize that almost full reliance on long axis rotation is an avian feature while extinct theropods with more erect posture used a combination of abduction/adduction and long axis rotation at the hip. Abduction/adduction at the hip is hypothesized to decrease in importance on the line from primitive archosaurs to birds.

Data such as these provide the functional and mechanical perspective needed to infer the behavior of extinct theropods.

Technical Session X (Friday, October 19, 9:30 am)

PERMIAN ORIGINS OF THE POST-EXTINCTION THERAPSID RECOVERY FAUNA

KAMMERER, Christian F., Museum für Naturkunde, Berlin, Germany; FRÖBISCH, Jörg, Museum für Naturkunde, Berlin, Germany; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; SMITH, Roger M., Iziko, the South African Museum, Cape Town, South Africa

The Permo-Triassic mass extinction caused total reorganization of the terrestrial vertebrate fauna, with therapsids experiencing nearly complete turnover. The Early Triassic therapsid recovery fauna characterizes a brief interval dominated by highly autapomorphic clades like Lystrosauridae. Previous hypotheses for the origin of the therapsid recovery fauna supposed that these clades either originated post-extinction or invaded fossiliferous basins from elsewhere in Pangea. Though some species must have originated post-extinction, new discoveries and reexamination of poorly-known taxa reveal that the typical clades of the recovery fauna extend well into the Late Permian. These results contradict the prevailing view of acute extinction followed by rapid recovery—Early Triassic records represent lineage survival across the boundary rather than post-extinction radiation. Four dicynodont clades are known in the Triassic: lystrosaurid and kannemeyeriiform dicynodontoids and kingoriid and myosaurid emydopoids. Previous research has demonstrated that two species of the quintessential therapsid disaster taxon *Lystrosaurus*, traditionally considered an index fossil for the start of the Triassic, appear in the terminal Permian. These species already exhibit the extreme *Lystrosaurus* cranial morphology, however—our research reveals an expanded Lystrosauridae stretching back to at least the *Cistecephalus* Assemblage Zone: *Euptychognathus* from Tanzania and undescribed taxa from Zambia and South Africa. These undescribed taxa are very similar to *Lystrosaurus* but with a narrow intertemporal bar, helping to bridge the morphological divide between other dicynodontoids and the *Lystrosaurus* lineage. In Emydopoidea, the recent discovery of Early Triassic *Kombuisia* has filled the former Permian-to-Middle Triassic kingoriid ghost lineage. Additionally, new material of the enigmatic dicynodont *Emydorhinus* from near the Permo-Triassic boundary reveals that this taxon forms the sister-group of the Early Triassic *Myosaurus*. Within theriodonts, akidnognathid and baurioid therocephalians include genera that cross the extinction boundary. In cynodonts, phylogenetic study of the rare Permian taxon *Nanictosaurus* supports its placement as an epicynodont, dragging this predominantly Triassic group back beyond the boundary. These records show that, at least in southern Africa, the therapsid clades making up the post-extinction recovery fauna were already present but rare in the terminal Permian. Autapomorphic morphological features of these

clades predate the extinction and thus cannot be extinction responses. Most elements of the recovery fauna do not survive beyond the Early Triassic—antecedents of the post-recovery fauna (eucynodonts, kannemeyeriiforms) remain elusive.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ARTIFICIAL CHEWING WITH REAL TEETH

KARME, Aleksis, University of Helsinki, Helsinki, Finland; KALLONEN, Aki, University of Helsinki, Helsinki, Finland; GALAMBOSI, Szabolcs, University of Helsinki, Helsinki, Finland; ENGSTRÖM, Pauli, University of Helsinki, Helsinki, Finland; FORTELIUS, Mikael, University of Helsinki, Helsinki, Finland

In remarkable contrast to the widespread use of tooth wear in paleodiet and paleoenvironment reconstruction there has been very little experimental study of the causes of different tooth wear types. We have therefore built an artificial chewing apparatus for simulating wear on real teeth under controlled circumstances of mechanical mastication. The core design principle of the machine is repeated, full-occlusion single stroke movement. The majority of the device design was done with CAD-modeling, and the needed parts were then milled from stainless steel. The electric motor and power source were selected to be easily obtainable and affordable. An in-house designed water-cooling system for the motor was built to facilitate long-term testing and allow high number of chewing cycle repetitions. Full adjustment of the occlusion and chewing force are available for experiments. The setup is reasonably sized, weighing in total less than 5 kg, which in addition to the affordability of the component parts should allow easy and flexible use.

Teeth worn with the chewing machine were first cut straight and polished to a flat and even "occlusal" surface for the initial experiments. Horse teeth were selected for their hypsodonty and compact structure, with enamel, dentine and cement almost uniformly distributed along the tooth's height. Mastication was performed with and without abrasive substances. Mastication without abrasive substances was done in a pure water medium, whereas a viscous glycerin-based liquid was used to keep the particles in suspension when abrasive substances were introduced.

Teeth were subjected to over 200 000 chews during a time span of 60 hours. Results were estimated visually and quantitatively using 3D-scan data. Elevation, slope, aspect and facet development were quantified and estimated from the worn surface using GIS techniques. In pure attrition, tooth against tooth, facet development and differential wear to dentine, cement and enamel was observed, whereas in abrasion results were dominated by the added particles, which induced rounded wear surfaces and clear overwriting striations.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

LATE OLIGOCENE BEAVER (CASTORIDAE, RODENTIA) FROM WESTERN JAPAN

KATO, Takafumi, Kurashiki University of Science and the Arts, Kurashiki, Japan

The late Oligocene to early Miocene rodents found in Nagasaki Prefecture, Kyushu, Japan, have been identified as belonging to the following 3 taxa: (1) *Steneofiber* sp. from the late Oligocene Sasebo Group, (2) *Youngofiber* sp., and (3) *Diatomys shantungensis* from the early Miocene Nojima Group. These Miocene species are considered endemic taxa distributed in China and Japan. In contrast, *Steneofiber* is a European genus that is not known to be from the Late Oligocene in China.

Recently, additional specimens of *Steneofiber* were found in the basal part of the Fukui Formation of the Sasebo Group of Sasebo City, Nagasaki Prefecture. The fossiliferous layer is approximately 1 m thick, containing pebbly transgressive lag deposit unconformably overlying the coal-bearing non-marine shale and sandstone of the Sechibaru Formation of the Sasebo Group. The new material of *Steneofiber* is represented by seven isolated cheek teeth and seven incisors probably belonging to the same species, associated with fragmentary skeletal remains of anthracotheres, rhinocerotids, and tortoises.

The materials exhibit the following features: semi-hypsodont teeth completely devoid of cement, relatively simple enamel pattern with uncomplicated fossettes, round and broad fossettes and flexi, parastria absent on P4, long and curved mesoflexus (or mesofossette) almost reaching the posterior end of the crown, short and broad hypoflexus, and an additional fossette between the parafossette and the mesoflexus. These dental characters are similar to the late Oligocene species *S. dehmi* but are different from the simpler enamel pattern. These specimens might be a new species of *Steneofiber*.

During the late Oligocene and early Miocene periods, the number of Castoridae genera and species increased and became widespread in the Northern Hemisphere. The occurrence of Japanese Oligo-Miocene beavers probably reflects this episode.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A PALEOECOLOGICAL ANALYSIS OF LATE PLEISTOCENE CERVID REMAINS FROM GUY WILSON CAVE, SOUTHERN APPALACHIANS, TENNESSEE

KAUFMAN, Amanda K., East Tennessee State University, Johnson City, TN, United States; SCHUBERT, Blaine W., East Tennessee State University, Johnson City, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States

The paleoecology of late Pleistocene cervids at Guy Wilson Cave is based on 1) systematic identification of cervid material, 2) taphonomic analysis with a focus on carnivore utilization and 3) carbon isotope proxies from modern and fossil cervids and fossil herbivore tooth enamel ($\delta^{13}C$). Systematic identification reveals that there are four to five cervid taxa in the cave fauna based on dental remains: *Odocoileus* cf. *O. virginianus*, *Rangifer tarandus*, cf. *Cervus*, and *Cervalces/Alces.* Taxonomic separation of *Cervalces* and *Alces* was not possible given the fossil material, and no dental characters were found to separate the two living species of *Odocoileus*. Taphonomic analysis of gnawing and tooth markings shows alterations consistent with a canid predator, and the overall pattern suggests full-heavy utilization and possible scavenging activity. A likely candidate for this modification is the dire wolf, *Canis dirus*, and the cave appears to have served as a den. Isotopic analysis of the community shows that taxa were feeding in a dominantly C_3 environment, as all $\delta^{13}C$ values are less than -8‰; values of *Odocoileus* (-13‰ to -15.8‰) and *Tapirus* (-13.6‰ to -15.4‰) also suggest a relatively dense canopied temperate forest. Even horses have isotopic values (-11‰ and -12.1‰) consistent with the consumption of primarily C_3 vegetation, potentially C_3 trees/shrubs or C_3 grasses. Extant *Odocoileus* from Sullivan County, TN has $\delta^{13}C$ values (-13.2‰ to -17.2‰) that are not significantly different from Guy Wilson Cave *Odocoileus*, suggesting that dietary niches in these deer may have been consistent from the late Pleistocene to today in this region. Although the maintenance of similar dietary niches from glacial to interglacial periods is in contrast to what occurs in Florida, a relatively stable forested environment in the Appalachians may be responsible for similar dietary niches in *Odocoileus* over time.

Technical Session VIII (Thursday, October 18, 3:00 pm)

THE PALEOENVIRONMENT AND PALEOECOLOGY OF THE COASTAL MIOCENE SANTA CRUZ FORMATION (LATE EARLY MIOCENE, ARGENTINA)

KAY, Richard F., Duke University, Durham, NC, United States; VIZCAÍNO, Sergio F., Museo de La Plata, La Plata, Argentina; BARGO, M. S., Museo de La Plata, La Plata, Argentina

The paleoenviroment and paleoecology of the Santa Cruz Formation (SCF) is summarized, combining the data from 10 field seasons with a new examination of the community structure of the vertebrate fauna using modern analogs. Emphasis is placed on the SCF outcrops along the coastal Atlantic between about 50.3° and 51.6° S and their faunas (Santacrucian SALMA). SCF Fossil Levels (FL) 1–7 south of the Río Coyle range between ~17.4 to 17.5 Ma and are considered analogous to a single modern fauna of limited geographic and temporal scope. As paleolatitude during Santacrucian times was the same as that of today, FL 1–7 was extratropical and had highly seasonal day lengths. The Andes had not risen to a sufficient altitude to block westerly winds and moisture from reaching the Atlantic coast, nor had the Middle Miocene global climatic cooling begun. Several taxa recovered at FL 1–7 or in nearby penecontemporaneous levels (e.g. palm trees, the frog *Calyptocephalella*, the lizard *Tupinambis*, the anteater *Protamandua*, and the primate *Homunculus*) strongly indicate that the climate of FL 1–7 was much warmer and wetter than today. The overall mammalian species richness and niche composition, expressed as percentages of arboreal or scansorial, frugivorous, and grazing, suggest that overall rainfall was in the range of 1000 to 1500 mm per annum. Occurrence of trees and forest-dwelling birds and mammals (porcupines, spiny rats, sloths, scansorial marsupials, and monkeys) supports this conclusion. The occurrence of calcareous root casts in paleosols indicates high seasonality in rainfall with cool wet winters and dry warm summers. Grasses were also present, and a number of vertebrate taxa (giant terrestrial birds, many notoungulates, glyptodonts, and armadillos) appear to have been adapted to open environments. Sedimentologic, ichnology, floral, and faunal elements taken together suggests a landscape for FL 1–7 consisting of a mosaic of open temperate humid and semi-arid forests, with ponds in some areas and seasonal flooding in others, no doubt promoting the formation of marshlands with a mixture of grasses and forbes.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

STYLUS SHARPENING INSTRUMENT FOR FOSSIL PREPARATION

KAZUMI, Wada, Museum of Nature and Human Activities, Sand, Hyogo, Japan, Sanda, Japan; IKEDA, Tadahiro, Museum of Nature and Human Activities, Sanda, Hyogo, Japan, Sanda, Japan; SAEGUSA, Haruo, Museum of Nature and Human Activities, Sanda, Hyogo, Japan, Sanda, Japan; SHINYA, Akiko, The Field Museum, Chicago, IL, United States

Air scribes and pin vises fitted with carbide needles are commonly used to prepare vertebrate fossils but the stylus-point becomes dull or breaks over time. Styli are traditionally sharpened manually with a hand-held or a desk top rotary tool fitted with a diamond grinding disc. These manual sharpening processes are imprecise and the resulting point of the newly sharpened stylus is off-center. This can cause inaccuracy and inefficiency in the preparation of fossils. To overcome the imprecision of manual sharpening processes, a stylus sharpening instrument can be custom built from locally available and inexpensive parts. The instrument is composed of two assemblies each with a variable speed hand-drill motor mounted on a base board. Three stylus shaft holders that are aligned and fixed to the base board hold a stylus in a stable position. The positions of holders are adjustable depending on the length of styli. The first motor rotates the stylus through an O-ring belt connecting the motor's main shaft to a rubber pulley which is attached to the stylus. Different sized pulleys are used according to the stylus' diameter. The second motor powers a grinding disc, and this grinding assembly is attached to the base board with a swivel mount that allows the operator to pivot the assembly freely. The grinding assembly has two operator handles to enable the operator to sharpen the stylus to a desired angle. Preparators in the Dinosaur Laboratory of Museum of Nature and Human Activities use a 3/4 inch 400 grit double-sided diamond cut-off wheel

for sharpening styli, but grinding discs of various grit size and diameter can also be mounted on this assembly. The motors are powered by rechargeable batteries so that the instrument is portable in the laboratory and at excavation sites. A plexiglass cover is mounted over the grinding parts for safety. This instrument allows preparators to easily and safely sharpen styli with precise, centered points.

Preparators' Session (Thursday, October 18, 8:00 am)

FEATHERING DINOSAURS

KEILLOR, Tyler, University of Chicago, Chicago, IL, United States

Recent fossil discoveries have amplified our knowledge of varied dinosaur integument. Preserved scales, filaments and feathers have supplied a wealth of reference that artists endeavor to incorporate into reconstructions of new specimens. A variety of techniques have been employed to create sculptural flesh-models with unusual integumentary coverings. Coats of fibers and feathers can be sculpted in relief, creating hard models of these soft features. Alternately, feathers, hair, flocking, and other delicate mixed media such as acetate sheets and nylon monofilament can be used to create the coverings for a life reconstruction. A survey of the methods and materials currently used by a variety of artists and technicians will be presented.

Technical Session XIV (Saturday, October 20, 11:30 am)

A NEW LOWER TRIASSIC ICHTHYOPTERYGIAN FAUNA FROM FOSSIL HILL, NEVADA

KELLEY, Neil P., University of California, Davis, Davis, CA, United States; MOTANI, Ryosuke, University of California, Davis, Davis, CA, United States; EMBREE, Patrick G., Orangevale, CA, United States

Beginning with discoveries in the 19th Century, Nevada has been an important source of Triassic ichthyopterygian fossils. However, to date it was not known whether ichthyopterygians were present in the region in the Early Triassic, during the earliest phase of ichthyopterygian evolution. We investigated Lower Triassic rocks at the famous Fossil Hill locality in Pershing County, Nevada and identified a previously unrecognized ichthyopterygian fauna. The Anisian (Middle Triassic) Fossil Hill Member of the Prida Formation in the Humboldt Mountain Range, and stratigraphically equivalent horizons in the Favret Formation in the adjacent Augusta Mountain Range, are characterized by a rich marine reptile fauna comprising the ichthyosaur genera *Cymbospondylus*, *Mixosaurus* and *Phalarodon* together with the sauropterygian *Augustasaurus* and the enigmatic reptile *Omphalosaurus* as well as fish, ammonites and other invertebrates. Recently, fragmentary ichthyopterygian fossils have been discovered in the lowest levels of the Prida Formation at the historic Fossil Hill locality. These levels are Spathian (Lower Triassic) in age based on invertebrate index fossils and sit stratigraphically below the diverse Anisian assemblage of the Fossil Hill Member and above microbialite dominated facies typical of the "delayed recovery interval" that characterizes the earliest Triassic. Although all specimens collected to date are fragmentary, distinctive tooth morphologies indicate that multiple species of ichthyosaur were present and permit comparison to known Lower Triassic ichthyopterygian taxa. The presence of an *Utatsusaurus*-like form, and a *Chaohusaurus*/*Grippia*-like form suggests faunal similarity with Lower Triassic assemblages from Canada and to a lesser extent, Spitsbergen, Japan and China. Taken together, these comparably aged localities indicate biotic dispersal of relatively small-bodied ichthyopteryians across northern Panthalassa during the earliest known phase of their evolution, shortly after the recovery of marine ecosystems from the end-Permian mass extinction. Further work in this and other Lower Triassic localities will provide important opportunities to better understand early ichthyopterygian evolution and potentially pinpoint the stratigraphic, paleogeographic and paleoecological context of their origin.

Technical Session IV (Wednesday, October 17, 2:15 pm)

NEW EVIDENCE ON THE PTEROID ARTICULATION AND ORIENTATION IN PTEROSAURS

KELLNER, Alexander W., Laboratory of Systematics and Taphonomy of Fossil Vertebrates, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; COSTA, Fabiana R., Laboratory of Systematics and Taphonomy of Fossil Vertebrates, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; RODRIGUES, Taissa, Departamento de Medicina Veterinária; Universidade Federal do Espírito Santo, Alegre, Brazil

The pteroid is a long, rod-like element whose position, function and orientation have been much debated without reaching a consensus. These debates are focused mostly on whether or not this bone supports the propatagium by being directed forward during flight in an anterior orientation or being medially oriented in a more parallel position to the edge of the wing. These hypotheses are mainly based on indirect anatomical evidence and aerodynamic models of performance. The first hypothesis leads to a broad forewing acting as a leading edge flap, suggesting a higher aerodynamic efficiency, while the second one implies a narrower forewing. Paramount to this question is the articulation of the pteroid to the carpus that has been the subject of debate. A long-held view suggests that this bone articulates with the distal fovea of the preaxial carpal. An opposing interpretation argues that the pteroid was articulated to the lateral side of the preaxial carpal, with a small sesamoid filling out the fovea carpalis. An alternative proposal followed, in which the pteroid would actually articulate with the proximal syncarpals, but this remained controversial and was not universally accepted. The main problem is that this bone is normally found disarticulated and displaced from its natural anatomical position. New exquisitely preserved specimens from the Romualdo Formation (Albian) of Brazil can settle this question. Some show a distinct articulation surface on the dorsal region of the proximal syncarpal, close to the articular facet for the radius. This feature is observed in both anhanguerids and tapejarids and is the strongest candidate for the articulation of the pteroid. Among the most interesting material is a specimen that represents the almost complete wings of an anhanguerid individual and possesses the pteroid directly in articulation with the proximal syncarpal. As the proximal carpals are fused into a proximal syncarpal in osteologically mature specimens, this position constrains the pteroid to a more medial orientation regarding the edge of the wing, avoiding subjecting this bone to heavy loads if it would have been projected anteriorly.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

IS MODAL BODY SIZE AN EVOLUTIONARY ATTRACTOR? *ANOLIS* AS A CASE STUDY

KEMP, Melissa E., Stanford University, Stanford, CA, United States; HADLY, Elizabeth A., Stanford University, Stanford, CA, United States

Many explanations for patterns of body size diversification exist; principal among them is the idea of modal body size acting as an evolutionary attractor. The speciose lizard genus *Anolis* serves as an exemplary system to test this hypothesis and investigate whether the biotic environment affects the ability of taxa to converge on modal body size. We focus on anoles restricted to the Lesser Antilles that have a modal body size corresponding to the purportedly optimal solitary status, in addition to two other size classes that are found when species co-occur. We use phylogenetic independent contrasts to reconstruct body size for ancestral lineages and infer directionality of size evolution. While the distributions of these three size classes are significantly different from one another, we find that the Lesser Antillean anoles are not evolving towards the modal body size even when we account for competition. However, body size appears to be constrained by the modal size even though large lineages get larger and small lineages get smaller. These data suggest an important role for competition in driving macroevolutionary trends in body size, in addition to other forces operating at higher taxonomic levels.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A GEOMETRIC AND KINEMATIC BACKBONE MODEL OF THE CHEETAH, ACINONYX JUBATUS, AND ITS APPLICATION TO UNDERSTANDING THE SPINAL KINETICS OF MIRACINONYX TRUMANI

KENNEDY, Natalia K., University of California, Los Angeles, Los Angeles, CA, United States; BHATT, Roopak, University of California, Los Angeles, Los Angeles, CA, United States

Cheetahs are the fastest land animals, partly due to their spinal flexbility. Surprisingly, there has never been a detailed study of the musculoskeletal anatomy and function of its vertebral column despite the obvious contributions it makes to cheetah speed through extreme flexion and extension. Using anatomical data, radiographs, and 3-D laser scanning, a geometric and kinematic computer model of the vertebral column of the cheetah was produced. This model allows a clearer understanding of the spinal flexibility of the cheetah, as well as which specific areas are fundamental in providing the vertebral column flexibility necessary for fast running.

Based on 3-D scans of fossils, the model will be modified to investigate the flexibility of the spine of an extinct North American cheetah-like cat, *Miracinonyx trumani*. It will demonstrate whether there are short, specific areas of the vertebral column that serve as indicators of overall spinal flexibility. If so, this would allow paleontologists to infer the spinal flexibility, and by extension speed and paleoecology, of extinct felids with only a few vertebrae. This technique will allow for more information to be gleaned from those incomplete specimens than was previously possible.

Technical Session XVI (Saturday, October 20, 11:30 am)

ISOTOPIC DIETARY SIGNALS IN MURINE RODENTS FROM THE NEOGENE SIWALIK GROUP LAGS LARGE MAMMALS BY ONE MILLION YEARS

KIMURA, Yuri, Southern Methodist University, Dallas, TX, United States; UNO, Kevin T., University of Utah, Salt Lake City, UT, United States; CERLING, Thure E., University of Utah, Salt Lake City, UT, United States; PATNAIK, Rajeev, Panjab Universiy, Panjab, India

The Neogene Siwalik formations of northern Pakistan and India comprise a long depositional sequence of fluvial deposits and contain vertebrate fossils ranging in age from 18 to less than 1 Ma. Carbon isotopes of soil carbonates and large mammal teeth from this interval document an ecological shift from C_3-dominated woodlands to C_4-dominated grasslands between 8.5 and 6.0 Ma. Here we compile carbon isotope data of true mice and rat (Murinae) teeth, using laser ablation GC-IRMS, from northern Pakistan (13.8 Ma to 6.5 Ma), northern India (2.5 to 2 Ma), and Recent species of both regions. This study relates carbon isotope ratios with morphological traits in murine molars. Because Siwalik murine diversity primarily resulted from in-situ evolution in northern Pakistan rather than immigration, we tested the hypothesis that murines shifted dietary niche in response to a change in food source in a pattern similar to that of large mammals. Alternatively, the small home range of mice may have enabled them to persist in fragmented patches of desirable vegetation during the transition from a C_3 to a C_4 ecosystem. In this case, an expected dietary shift indicated by isotopes would be delayed in comparison to large mammals.

Carbon isotope data obtained from more than 70 lower first molars were associated with dental measurements. Preliminary results show: (1) the carbon isotope record of murines differs from that of large mammals in that the carbon isotope values become abruptly more positive with a broader range at 7.4 Ma, whereas large mammals began the shift at 8.5 Ma, (2) larger murine species generally have more positive carbon isotope values than smaller species between 9.2 and 6. 5 Ma, (3) the difference in isotope means of pre-defined taxa at a given locality are statistically significant at 8.2 Ma and increase in value at 7.4 Ma. They indicate that differences in diet in Siwalik murines can be recognized by 9.2 Ma, but that the major shift attributed to C4 vegetation occurs later in murines than in large mammals. In addition, the pattern of isotopic change in murines is more similar to that seen in Siwalik paleosols than in large mammals, suggesting that like paleosols, which reflect overlying vegetation, the small home range of murines results in more precise resolution of past ecological conditions than large mammals.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PHYLOGENETIC PLACEMENT OF *PANTHERA ATROX* BASED ON CRANIALMANDIBULAR CHARACTERS

KING, Leigha M., East Tennessee State University, Johnson City, TN, United States; WALLACE, Steven C., East Tennessee State University, Johnson City, TN, United States

Over the past twenty years both morphological and molecular phylogenies have been proposed for extant and extinct members of the family Felidae. However, there remain several discrepancies, particularly within the genus *Panthera*, likely due to the very recent diversification within the family. One example that has received recent attention is the phylogenetic placement of *P. atrox.* These inconsistencies suggest the need for further analysis and perhaps even different methodology to truly understand pantherine evolution. Consequently, morphologic characters from the skull and dentary were analyzed within *Panthera* (including all extant, and one extinct, taxa) to gain a better understanding of pantherine phylogeny. To increase confidence in the results, multiple specimens of each taxon were analyzed and scored. Extant taxa included: *P. leo* (African lion)*, P. tigris* (tiger)*, P. onca* (jaguar)*, P. pardus* (leopard)*, Uncia uncia* (snow leopard), and *Neofelis nebulosa* (clouded leopard). The latter two taxa are considered pantherine, though not in the genus *Panthera*, due to their consistent placement in various phylogenetic trees as falling just outside the *Panthera* group. Four outgroups were used; *Crocuta crocuta, Metailurus* ssp*., Proailurus lemanensis,* and *Pseudaelurus validus*. From each phylogeny created, despite the outgroup, apparent grouping between *Panthera leo, P. tigris,* and *P. atrox* was present. Therefore, *P. atrox* is likely more closely related to the African lion and the tiger than the jaguar, in contrast to what has been recently suggested. Moreover, gross morphological similarities between *P. atrox* and *P. onca* are likely the result of convergent hunting styles and/or prey selection, rather than phylogenetic affinity.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A COMPARISON OF THE MICROVERTEBRATE FOSSILS FROM THE GARDEN PARK FOSSIL AREA IN COLORADO AND THE LITTLE HOUSTON QUARRY NEAR SUNDANCE, WYOMING (BOTH LATE JURASSIC, MORRISON FORMATION)

KING, Lorin R., Western Nebraska Community College, Scottsbluff, NE, United States; FOSTER, John R., Museum of Western Colorado, Grand Junction, CO, United States; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States

The Garden Park Fossil Area and the Little Houston Quarry have yielded abundant large dinosaurs, including a relatively "typical" Morrison Formation fauna consisting of the theropod *Allosaurus* and sauropods such as *Camarasaurus*, *Apatosaurus* and *Diplodocus*. The Garden Park quarries (Jennings and Johnson Locality, Cleveland Quarry, Small Quarry and Green Acres Locality) have also produced some identifiable, albeit fragmented, small vertebrate remains. The rare, smaller non-dinosaurian vertebrates include pterosaurs, turtles, crocodyliforms, and lungfish fossils, as well as specimens of the mammals *Docodon* and *Amblotherium*, plus the sphenodontian *Eilenodon*. These are represented mainly by disarticulated to fragmentary limb bones, vertebrae, osteoderms, and teeth. There is a scarcity of fish in the Garden Park Fossil Area (except at the Small Quarry) which could suggest that standing water was sometimes infrequent, but the abundance of plant material and invertebrate material suggests an often wet substrate and likely a high local water table. The small vertebrates preserved at the Little Houston Quarry include actinopterygian fish, lungfish, frogs, salamanders, turtles, sphenodontians, lizards, *Cteniogenys*, crocodilians, and the mammals *Docodon*, *Psalodon*, and an indeterminate dryolestid. At Garden Park, like most Morrison Formation fossil quarries in the western United States, small vertebrate specimens are not as common as the larger dinosaurian material, but at the Little Houston Quarry the total number of bones and minimum numbers individuals of small vertebrates is higher than that of dinosaurs. Importantly, even at Garden Park, the microvertebrate fossils, while not frequently recovered and relatively non-diagnostic, still record a greater diversity of taxa (at higher taxonomic levels) than do the more frequently collected large dinosaur elements.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

INFERRING LOCOMOTOR CAPABILITIES OF THE EXTINCT TERROR BIRD *GASTORNIS* USING GEOMETRIC MORPHOMETRICS

KIRCHNER-SMITH, Mackenzie E., Indiana University Bloomington, Bloomington, IN, United States

Gastornis was a large flightless bird that lived in the lush Eocene forests of North America and Europe, a member of the family Gastornithidae. These so-called "terror birds" are part of the order Anseriformes, whose living members include ducks, geese and swans. Terrestrial locomotion was an important part of their survival, and estimating their locomotor capabilities is an important part of understanding their ecology because of their terrestrial adaptations. Using geometric morphometric analysis I compared the shape of the distal end of the tarsometatarsus of 11 species of modern day birds ranging from flightless and terrestrial to aerial. Landmarks were taken, three each, around the metatarsal trochlea II, III and IV, one at the point where the metatarsal trochlea III ends, and one on either side of the peak of curvature towards the proximal end. I Procrustes superimposed the landmarks and subjected them to a principle components analysis. The results illustrate differences in shape between the functional groups, with distinct groupings found in the shape of this bone for truly aerial, truly terrestrial, and birds that are often aerial but spend a considerable amount of time wading or walking. The more flat and fused distal ends indicate birds relying on flight, and the more wide spread and separated indicates it is likely terrestrially adapted; this change in shape is what describes the principle component 1. When the data set for *Gastornis* was added to this plot, it fell close to the large terrestrial birds such as emu and rhea. Based on these data an estimated running speed may be obtained by regressing the principal component scores against the known maximum running speeds of the modern large flightless birds.

Technical Session XIII (Friday, October 19, 3:45 pm)

MORPHOLOGY OF THE PETROSAL AND BONY LABYRINTH IN *AFRADAPIS LONGICRISTATUS* (PRIMATES, ADAPIFORMES)

KIRK, E. C., University of Texas at Austin, Austin, TX, United States; KEMP, Addison D., University of Texas at Austin, Austin, TX, United States; SIMONS, Elwyn L., Duke University, Durham, NC, United States; SEIFFERT, Erik R., Stony Brook University, Stony Brook, NY, United States

Afradapis is a large (2-3 kg) adapiform primate known from the early late Eocene BQ-2 locality in the Fayum Depression, Egypt. Here we report the discovery of two isolated petrosals from BQ-2 that are referable to *Afradapis* based on size and morphology. Both petrosals preserve portions of the canals for the facial nerve and branches of the internal carotid artery. The position of the posterior carotid foramen is indicated by the presence of a lemur-like posterior septum that shields the fenestra cochleae and cochlear fossula in ventral view. As in other adapiforms, the internal carotid enters the middle ear posterolaterally near the stylomastoid foramen, and the stapedial and promontory canals divide on the promontorium in close proximity to the fenestra cochleae. The stapedial and promontory canals are nearly equal in diameter and the promontory canal follows the "transpromontorial" route that is probably plesiomorphic for crown primates. In these features, *Afradapis* is similar to many adapiforms and omomyiforms but differs from crown haplorhines. The preserved portions of the facial canal are unremarkable except in one respect: the hiatus Fallopii (intracranial exit for greater petrosal nerve) is very large, exceeding the diameter of the facial canal by 30-50%. It is likely that the geniculate ganglion was lodged in this large opening, as occurs in 5% of humans. This peculiar morphology is apparently typical for *Afradapis* because it is preserved in both known specimens, but is not seen in other adapiforms. Both specimens also demonstrate that the mastoid was heavily pneumatized, as in adapines and *Mahgarita*. Mean semicircular canal radius of curvature is small relative to estimated body mass, suggesting comparatively low sensitivity to angular accelerations. This finding is consistent with astragalar morphology indicative of slow, cautious arboreal locomotion. Mean cochlear volume is 17.5 mm^3, similar to other mammals of comparable body mass with unspecialized hearing abilities. Comparative data linking cochlear volume with both the high and low frequency limits of hearing suggest that *Afradapis* had a range of hearing (~80 Hz to 43 kHz) similar to that measured for *Eulemur fulvus* (72 Hz to 43 kHz; thresholds at 60 dB SPL). The anatomy of the petrosal and inner ear of *Afradapis* is consistent with its previous placement as a derived adapiform stem strepsirrhine, and provides no evidence for a phylogenetic link with anthropoids.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW DINOSAURS FROM THE BASE OF THE CRETACEOUS IN EASTERN UTAH SUGGEST THAT THE 'SO-CALLED' BASAL CRETACEOUS CALCRETE IN THE YELLOW CAT MEMBER OF THE CEDAR MOUNTAIN FORMATION, WHILE NOT MARKING THE JURASSIC-CRETACEOUS UNCONFORMITY, REPRESENTS EVOLUTIONARY TIME

KIRKLAND, James I., Utah Geological Survey, Salt Lake City, UT, United States; DEBLIEUX, Donald D., Utah Geological Survey, Salt Lake City, UT, United States; MADSEN, Scott K., Utah Geological Survey, Salt Lake City, UT, United States; HUNT, Gary J., Utah Geological Survey, Salt Lake City, UT, United States

Over the years, the Jurassic/Cretaceous (J/K) boundary has been placed progressively lower in Utah's Mesozoic section. A multitiered calcrete in the Yellow Cat Member (YC) has been identified as the J/K boundary marker bed for about 25 years. A dinosaur fauna represented by the polacanthine ankylosaur *Gastonia*, the iguanodont *Hippodraco,* the

theropods *Utahraptor* and *Nedcolbertia*, a basal macronarian sauropod, and the brachiosaur *Cedarosaurus* characterizes the YC above the calcrete. The discovery of a distinct fauna below a medial Yellow Cat 'caprock' near Green River, Utah, characterized by a giant polacanthine, the basal therizinosaur *Falcarius,* a primitive troodont *Geminiraptor*, and the large basal iguanodont *Iguanocolossus* suggests the presence of dinosaur fauna perhaps older than that of the *Gastonia* fauna. The correlation of this 'caprock' with the calcrete cannot be proven. Forty miles east, a multitaxic, Cretaceous dinosaur fauna is preserved below the calcrete in the Doelling's Bowl Bonebed (DB). The occurrence of this new dinosaur fauna raises the possibility of testing the hypothesis that the calcrete, although not representing the J/K unconformity, at minimum represents evolutionary time as dinosaur taxa turned over fairly rapidly, on the order of every 1–2 million years. This hypothesis may be tested by examining related species in different dinosaur clades occurring above and below the calcrete. At DB, the small dromaeosaur *Yurgovichia* has proven to be close to *Utahraptor.* The polacathine ankylosaurs at DB represent a new taxon based on comparisons with the braincases of the Jurassic *Gargoyleosaurus* and *Mymoorapelta* and the 10 known braincases of *Gastonia*. Still under study, the iguanodont material includes many dentaries that lack the distinct shelf of *Hippodraco*. Most promising has been the discovery of a juvenile, basal macronarian sauropod skeleton that had been mired in DB and that is associated with parts of a larger adult animal. Much of the skeleton is preserved, including skull material, pelvic elements, limb bones, an articulated pes and lower leg, and most of the vertebral column including the semi-articulated terminal 10 procoelus vertebrae of the tail. Brigham Young University is researching extensive material from more than a dozen individuals of a closely related basal macronarian sauropod found with *Gastonia* at the Dalton Wells Quarry north of Moab, Utah. Differences between these sauropods provide an additional test of our hypothesis.

Preparators' Session (Thursday, October 18, 11:00 am)

MAPPING AND LAB PREPARATION OF A CRETACEOUS (CENOMANIAN) TURTLE FROM THE WOODBINE FORMATION OF NORTH TEXAS: THE UNUSUAL CHALLENGES OF THE FLYING TURTLE PROJECT

KLINE, Patrick, University of Texas at Arlington, Arlington, TX, United States; KLINE, Margie, University of Texas at Arlington, Arlington, TX, United States; MAIN, Derek J., University of Texas at Arlington, Arlington, TX, United States

In the Fall 2010 field season, a complete turtle carapace and plastron, along with disarticulated postcrania, was discovered by a local student, excavated, and removed. This discovery comes from the Arlington Archosaur Site (AAS) which is a diverse fossil locality from the Late Cretaceous (95 Mya) Woodbine Formation of north Texas. The AAS occurs in an ancient delta plain that was situated along the southeastern interior seaway. The AAS preserves fossil components of a coastal ecosystem that includes: lungfish, crocodyliforms, dinosaurs (ornithopod and theropod), carbonized logs, and turtles. This specimen was embedded in a matrix of hardened, stratified peat with gypsum and carbonized wood integrated throughout. During transport to the fossil lab at the University of Texas at Arlington (UTA), this turtle, wrapped in a plaster jacket but not secured to the truck bed, was ejected (launched) from the bed of the transporting truck landing 'pancake'-style on the roadbed below. The turtle was substantially damaged, but recovered and returned to the UTA lab. This incident became known as the 'Flying Turtle.' Once safely located in the lab at UTA, the plaster jacket was removed and an assessment of the external damage could be started. Due to the impact, several fissures had been opened on the exposed shell that demonstrated a downward and outward separation. The right side of the specimen, which possessed pre-discovery crushing damage, was further compromised and shattered. It was determined that the criteria for preservation should be systematic, accurately plotted, and completed with a goal of reconstruction of all of the elements of the specimen. Four planes of reference were established: the carapace, internal skeletal, plastron, and surrounding matrix. Lacking sophisticated equipment, the project proceeded using hand tools and dedicated volunteer effort. The resulting grid-coordinate mapping method devised for each plane as well as the fossil sorting and storage using commonly available materials represents a creative approach to preserving smaller complete specimens.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

3D RECONSTRUCTIONS OF THE BRAIN ENDOCAST AND INNER EAR OF A TITANOSAUR (SAUROPODA: TITANOSAURIA) FROM THE LATE CRETACEOUS OF SPAIN

KNOLL, Fabien, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain; WITMER, Lawrence M., Ohio University, Athens, OH, United States; RIDGELY, Ryan C., 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

Titanosaurs were a flourishing group of sauropod dinosaurs during the Cretaceous. Fossils of titanosaurs have been found on all continents (including Antarctica) and their remains are abundant in a number of Late Cretaceous sites. Nonetheless, the cranial anatomy of titanosaurs is still very poorly known. We studied an incomplete but relatively well preserved titanosaur braincase from the locality of "Lo Hueco" (Fuentes, Spain) in the Villalba de la Sierra Formation (Late Campanian-Early Maastrichtian). The specimen, which is small by sauropod standards, resembles the braincase of *Ampelosaurus atacis* from France. Based on CT scanning, digital 3D renderings of the brain endocast and endosseous labyrinth of the inner ear were generated. The endocast has moderate pontine and cerebral flexures (about 40º). In contrast with sauropods for which the endocranial anatomy is well known (such as *Spinophorosaurus*, *Diplodocus*, and *Camarasaurus*), the cerebral region of the Spanish specimen is not dominated by any remarkable dural expansion. However, we suggest that there remain paired longitudinal dural venous sinuses that, as in some other sauropods, course dorsolaterally through the cerebral region. The cleft between these pronounced venous swellings is very deep and broad suggesting that the two cerebral hemispheres were very little inflated and must have been extremely modest. As in other non-avian archosaurs in general, the midbrain and hindbrain are relatively poorly defined in the endocast due to former meningeal coverings and apparently substantial dural venous sinuses, which obscure details of the optic lobes and the cerebellum. The cranial nerves present roughly the configuration seen in other sauropods although there are derived features that appear to characterize titanosaurs. For example, the abducens nerve canal passes lateral to the pituitary fossa as in most other titanosaurs rather than entering it, which is the general condition in other sauropods. Likewise, the hypoglossal nerve exits the skull via a single foramen. This feature is observed in other titanosaurs, but is at variance with most saurischians, including *Giraffatitan*, which is a basal titanosauriform. In contrast with *Spinophorosaurus* and *Giraffatitan* but similar to other titanosaurs, the labyrinth shows a dramatic reduction of the magnitude of the vestibular system such that the rostral semicircular canal is much shorter and comparable in size to the caudal canal. As in most but not all sauropods, the lagena is relatively short. Our investigation highlights that, although titanosaurs are derived sauropods with a successful evolutionary history, they present a remarkably modest level of paleoneurological organization.

Technical Session I (Wednesday, October 17, 10:30 am)

ORNITHISCHIAN-LIKE DENTAL ARRANGEMENT IN A BASAL THERIZINOSAUR DINOSAUR FROM NORTHEASTERN CHINA

KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; PU, Hanyong, Henan Geological Museum, Zhengzhou, Henan, China; XU, Li, Henan Geological Museum, Zhengzhou, Henan, China; WU, Yanhua, Henan Geological Museum, Zhengzhou, Henan, China

A basal therizinosaur dinosaur from the Lower Cretaceous Yixian Formation of Jianchang County, western Liaoning Province, was reported previously. It was suggested that it differs from *Beipiaosaurus inexpectus*, but its phylogenetic status has never been discussed. Its anatomy and phylogenetic status are examined in this study. A strict consensus tree places it as a basal therizinosaurian and a sister taxon to the Therizinosauroidea (the clade of *B. inexpectus* and higher taxa), confirming that it is a different taxon from *B. inexpectus* despite both being known from the same formation. This therizinosaur is unique mainly in features of the skull, vertebrae, and pelvis, suggesting that it is a new taxon. This new taxon fills the morphological gap between *Falcarius utahensis* and *B. inexpectus*, in characters related to feeding behavior (downturned anterior end of dentary with a gap, and inset anterior teeth with a shelf). Derived features in the skull of the new therizinosaur, but primitive features in the postcrania (especially pelvis and hindlimbs), suggest that adaptations for herbivory in cranial morphology evolved before changes in the postcrania, as seen in ornithomimosaurs and pterosaurs.

The most striking feature of this taxon is its dental arrangement in the middle and posterior dentary. Middle and posterior dentary teeth (posterior to the seventh tooth) are offset medially from lateral border of the dentary by a shelf, and these crowns show reversed tooth morphology (concave labial side and convex lingual side), whereas the crowns of all maxillary teeth and six anterior dentary teeth have the normal condition (convex labial side and concave lingual side). The anterior portion of the upper jaw was covered by a rhamphotheca, and that of the lower jaw is down-turned with normal tooth morphology. The anterior jaws might have functioned to pluck food (e.g., plant material), and the posterior portions, where dentary and maxillary teeth have an opposite arrangement (where the tips of the upper and lower teeth abut one another to maximize biting stress) to cut plant fibers, which is an arrangement similar to ornithopods and ceratopsians. This line of evidence suggests that this taxon was adapted for herbivory in a different way from any other therizinosaur.

Technical Session XIII (Friday, October 19, 3:30 pm)

HYPOTHETICAL MODEL FOR THE EVOLUTION AND DIFFERENTIATION IN PEDAL DISTAL PHALANGES OF PRIMATES

KOENIGSWALD, Wighart V., University of Bonn, Paleontology, Bonn, Germany

Pedal distal phalanges are more morphologically diverse in primates than in most other mammals. The occurrence of claws or even grooming claws in various groups has prompted discussions about the primitive condition. The question of whether the Eocene adapoid *Darwinius* had a grooming claw or not, initiated an extensive survey of pedal distal phalanges among primates. The morphology of the modified distal phalanx as well as its specific position among the five digits must be considered. The grooming claws and claws of the various groups differ in morphology and position indicating occurrence of parallel evolution. Accepting this, a fairly simple hypothetical model can be advanced for the evolutionary modifications of the pedal distal phalanges, fully independent from that of the hands. Starting with laterally compressed claws as in *Tupaia* and *Plesiadapis*, the first step was the differentiation of the first toe as an opposable hallux. The bone is scutiform and has a flat nail. This structure of the hallux was retained throughout most of the primates. As a second step the remaining distal phalanges, most probably, evolved a columniform shape with a small nail, as is preserved in several anthropoideans. From such a structure all

further modifications can easily be deduced. In lemuroids the second toe was separated as a grooming claw, while the lateral distal phalanges became scutiform. This most probably was related to a specific way of grasping. In adapoids a similar - if not the same - differentiation occurred represented in two different evolutionary stages by *Notharctus* and *Europolemur.* In the haplorhine clade, tarsioids evolved a functionally similar pattern, but it is significantly different in shape and position, thus not homologous. Among anthropoids columniform distal phalanges with flat nails on the lateral toes are widespread. This has to be regarded as the primitive condition for ceboids and cercopithecids. In ceboids the callithrichines evolved claws but the hallux retained its scutiform shape. *Aotus* has a grooming claw like structure. In the cercopithecine and hominin clades the columniform distal phalanges were mostly preserved as in, e.g., *Cercopithecus, Macaca*, and *Pan.* Only in humans the distal phalanges were modified to have very irregular distal tuberosites. This hypothesis postulates several cases of parallel evolution, but no evolutionary reversals and loss of specialized structures are required.

Technical Sesssion XII (Friday, October 19, 2:30 pm)

A NEW RECONSTRUCTION OF THE HIP IN HYDROPEDAL MOSASAURS (SQUAMATA, MOSASAURIDAE): FROM ATTACHED TO DETACHED
KONISHI, Takuya, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

A pelvic girdle maintaining the symphyseal articulation between ischia is preserved on the recently described specimen of *Prognathodon overtoni* (Mosasauridae, Mosasaurinae), TMP 2007.034.0001. This, along with comparison of the specimen to other aquatic tetrapods allows the position of the pelvis in this animal to be re-evaluated. Using the articulated ischia, the maximum distance between the acetabula of this specimen is 24.5 cm. If the ilia are distally connected with the vertebra, the circumference of the space surrounded by the pelvic girdle and the vertebral column is slightly less than 85 cm, or only 15% of the estimated total body length of this mosasaur at 6 m. With respect to the posteriorly tapering (i.e., streamlined) torso hypothesized for hydropedal (derived) mosasaurs, this suggests at least three possibilities: (1) given that mosasaurs utilized their muscular tails as a main means of underwater propulsion, only the base of the tail of this mosasaur was abruptly constricted to become 15% of the body length in circumference; (2) the maximum girth of the tail was not significantly greater than 15% of the body length, showing an abrupt decrease in circumference at the posterior end of the animal's trunk; and (3) the tail attained its maximum girth at the base at a much greater dimension than 15% of the total body length, more or less continuous with the posterior trunk region in dimensions. The third scenario is preferred, as the first two imply a hydrodynamically less efficient body outline by creating turbulence at the tail-body interface. The second scenario also indicates that the total tail muscle mass would be insufficient to provide and maintain propulsion strong enough for a 6-m animal. At the same time, in order to achieve the third condition, the pelvic girdle in mosasaurs must be free of ilio-vertebral articulation so as to position it further ventrally, a view contrary to the long-standing hypothesis that the hipbone in these large seagoing lizards contacted distal ends of the transverse processes on the first caudal vertebra. Further osteological support for the new hypothesis constitutes: (1) the notable absence of articular facets at distal ends of any transverse processes in the caudal series; (2) the lack of changes in orientation of the transverse processes near the base of the tail unlike in sauropterygians, where a group of transverse processes on each side of the sacral vertebrae converge distally to meet at a point of ilio-vertebral articulation; and (3) the simple rod-like morphology of the ilium. These features found in hydropedal mosasaurs are shared with derived ichthyosaurs, which are reconstructed to show separation between the pelvis and the vertebral column. Based on those lines of evidence and comparison, I conclude that pelvic girdles in hydropedal mosasaurs most likely lacked direct contact with the axial skeleton.

Technical Session VII (Thursday, October 18, 3:15 pm)

RESOLVING THE HOMOLOGY AND MIXED EMBRYONIC ORIGIN OF A MAMMALIAN SKULL BONE: THE IDENTITY OF THE INTERPARIETAL BASED ON PALEONTOLOGICAL AND DEVELOPMENTAL DATA
KOYABU, Daisuke, University of Zurich, Zurich, Switzerland; MAIER, Wolfgang, University of Tubingen, Tubingen, Germany; SÁNCHEZ-VILLAGRA, Marcelo R., University of Zurich, Zurich, Switzerland

The mammalian interparietal is a dermal bone situated between the parietal and supraoccipital. Its presence, development, terminology and homology across living and fossil synapsids are yet poorly known and largely undocumented, with contradictory statements in literature. Furthermore, the interparietal is a critical and problematic element in embryonic studies of the head because of its reported mixed embryonic tissue origin. To solve these issues, we conducted a comprehensive taxonomic and ontogenetic sampling across extinct and extant mammalian taxa, integrating embryonic evidence and fossil records.

There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian "orders". The presence of this bone has been often overlooked because of bone fusion around birth. Our investigation of mammalian embryos demonstrates that the interparietal consists of four elements and not by two as in Goodrich's paradigm and textbook knowledge. Since the lateral interparietal pair quickly fuses to the medial interparietal at embryonic stage in many taxa, this makes it critically difficult to identify the lateral interparietal pair. Although it is generally assumed that the tabular bone is lost in modern mammals, given the presence of the lateral interparietal element in extant taxa, we hypothesize that the postparietal of basal tetrapods is homologous to the medial interparietal elements of mammals and that tabulars are retained within the mammalian interparietal rather than being lost. If the medial and lateral extrascapulars of osteolepiform fishes are respectively homologous to the postparietal and tabular of basal tetrapods, the medial and lateral extrascapulars of osteolepiform fishes are presumably still conserved as the four elements constituting the interparietal of mammals.

Our four-element view for the interparietal provides a synthetic understanding of the dermal skull roof of mammals and hints a possible bridge between paleontology and developmental biology. Recent experimental study on the derivation of the mammalian skull reported a dual origin for the interparietal: the medial portion being neural crest cells derived and the lateral portion mesoderm derived. This suggests that the two medial interparietal elements are developmentally derived from the neural crest cells and the lateral elements from the mesoderm. If this is the case, the dual origin found for the mammalian interparietal could be regarded as the evolutionary consequence of the fusion between the crest derived "postparietal bones" and the mesoderm derived "tabular bones".

Technical Session X (Friday, October 19, 10:45 am)

THE FIRST CRANIAL REMAINS OF A GONDWANATHERIAN MAMMAL
KRAUSE, David, Stony Brook University, Stony Brook, NY, United States; HOFFMANN, Simone, Stony Brook University, Stony Brook, NY, United States; GROENKE, Joseph, Stony Brook University, Stony Brook, NY, United States

Gondwanatherian mammals are an enigmatic clade of Cretaceous and Paleogene mammals known from South America, Africa, Madagascar, India, and the Antarctic Peninsula. The six valid species, each belonging to a monotypic genus and the first of which was described only 26 years ago, are represented almost exclusively by isolated teeth; the only non-dental remains of gondwanatherian mammals consist of fragmentary dentaries attributed to *Sudamerica ameghinoi*, *Gondwanatherium patagonicum*, *Ferugliotherium windhauseni*, and an unnamed Tanzanian form. No cranial (i.e., skull exclusive of the mandible) or postcranial material has heretofore been assigned to the Gondwanatheria, a severe limitation that has precluded a comprehensive assessment of phylogenetic affinities. This limitation has resulted in controversy about the affinities of the clade, which was assigned first to the Xenarthra (Edentata), then to the Multituberculata (Allotheria), then to Mammalia incertae sedis, and most recently regarded as a sister group to Multituberculata within Allotheria. Here we describe the first cranial material of a gondwanatherian mammal. This material consists of a nearly complete and well-preserved cranium, recovered from the Upper Cretaceous (Maastrichtian) Maevarano Formation in the Mahajanga Basin of northwestern Madagascar. Salient features of the cranium include elongate, scimitar-like jugal flanges, a huge orbit, and a vaulted nuchal region. The preserved upper dentition consists of three molariform cheek teeth on one side and a single molariform on the other. The hypsodont nature of these molariform teeth, their oblique (dorsomedial-ventrolateral) implantation in the maxilla, their flat occlusal wear, and the presence of cementum-filled infundibula descending vertically into the crown and cementum-filled furrows on one side of the crown are features that serve to unequivocally identify the teeth, and therefore the cranium, as that of a gondwanatherian mammal. The alveoli demonstrate that, as for the dentary of *Sudamerica ameghinoi*, there were four molariform cheek teeth on each side. They also reveal, however, that there was a single, peg-like tooth mesial to the molariform cheek teeth and that the cheek tooth series on each side was separated from two large procumbent incisors by a large diastema. In that an associated upper dentition of a gondwanatherian mammal has never been known, we focus our presentation on these teeth. Nonetheless, this single specimen provides the first opportunity to include any gondwanatherian in a comprehensive phylogenetic database and more reliably assess the position of Gondwanatheria within Mammalia; a preliminary analysis indicates that gondwanatherians are not closely related to either the Multituberculata or the Allotheria.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

BODY MASS AND SHEARING QUOTIENTS OF MICROSYOPIDAE (MAMMALLIA, PRIMATES) FROM THE EARLY EOCENE, BIGHORN BASIN, WY (WASATCHIAN, NALMA): PALEOECOLOGICAL IMPLICATIONS FOR DIET
KRISTJANSON, Heather L., University of Toronto, Toronto, ON, Canada; PRUFROCK, Kristen A., University of Toronto, Toronto, ON, Canada; SILCOX, Mary T., University of Toronto, Scarborough, Toronto, ON, Canada

The Microsyopidae are extinct mammals from North America and Europe usually considered stem primates ("plesiadapiforms"). Large collections of the family are known from the Willwood Formation, Bighorn Basin, Wyoming (Early Eocene, Wasatchian North American Land Mammal Age). A well-documented mammalian faunal turnover event (Biohorizon A), associated with an increase in mean annual temperature (MAT), has been suggested to mark a considerable degree of change in the body mass of microsyopids. Previous work has shown an existing relationship between body mass and the dietary adaptations in extant primates. Here we investigate the shearing potential of a sample of Willwood microsyopids to examine whether a modification in dietary adaptation occurred along with a change in body mass. The lengths of shearing crests were measured, along with mesiodistal length and buccolingual width, in both upper and lower second molars. The shearing quotient (SQ), a measure of shearing potential, was used to infer change in diet. For the upper molars, this was based on a new study of variation in SQ in extant strepsirrhines. All specimens in the sample were categorized as utilizing insects as the primary source of protein in the diet. Body mass calculated from lower molars demonstrated a significant shift during Biohorizon

A. However, SQ values derived from lower second molars did not change significantly in this interval. The pattern in body mass and SQ in upper second molars is consistent with that observed in the lowers, although the relationship between SQ and diet is more ambiguous in the upper dentition. Collectively, SQ values from the upper and lower second molars suggest that microsyopid diet did not change in Biohorizon A despite changes in body mass. This suggests that with the increase in MAT more insect resources might have been available for exploitation by insectivorous stem primates, allowing for body mass increase.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

APPLICATIONS OF ELECTRON BACKSCATTER DIFFRACTION ON FOSSILIZED AND MODERN EGGSHELL

KRUK, Betsy, Montana State University, Bozeman, MT, United States; SUSORNEY, Hannah, Montana State University, Bozeman, MT, United States; JACKSON, Frankie D., Montana State University, Bozeman, MT, United States; SHAW, Colin, Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States

Electron backscatter diffraction (EBSD) provides high resolution information on crystal orientation. EBSD is routinely used in material science, but has only recently been applied to study the crystallography of fossilized and modern eggshell. This technique allows the study of the microstructure of fossilized dinosaur eggshell from the Cretaceous Tiantai basin, Zhejiang Province, China, fossilized turtle eggshell from the Kaparowitz Formation of Utah, and modern avian eggshell. The samples used in this study were cut radially and micro-polished for mapping. The EBSD detection on a scanning electron microscope was used to map pixel by pixel, the average orientation of the crystals. The orientations were then identified using the pixel data and displayed in maps and stereographic pole figures to show the preferred orientation and spatial arrangement of individual crystals. Details of calcite and aragonite structure of the eggshells, (i.e., preferred orientation, misorientation between adjacent shell units, lattice distortions, and sub-grain structure), were then observed and quantified. Avian eggshell was previously mapped and will be used to compare its structure to the fossilized dinosaur eggshell, thereby showing possible morphologic differences and effects of diagenesis. The turtle eggshell was mapped to show both preferred orientation and location of possible calcite replacement of the original aragonite. This technique allows the microstructure of fossilized and modern eggshell to be studied at high resolution and could be used for morphological and diagenetic studies.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE FIRST RADIOMETRIC DATES FOR THE WAYAN FORMATION OF IDAHO, STRATIGRAPHIC PLACEMENT OF FOSSIL LOCALITIES, AND REGIONAL CORRELATIONS

KRUMENACKER, L. J., Intermountain Paleo Consulting, Vernal, UT, United States; BRITT, Brooks B., Brigham Young University, Provo, UT, United States

Recent work in the Cretaceous Wayan Formation of eastern Idaho provides the first radiometric ages, provides the first indication of marine influence, and places some vertebrate fossil localities in a stratigraphic context.

Idaho's Wayan Formation consists of a thick suite of pedogenically imprinted fluvial deposits deposited in a rapidly subsiding foreland basin associated with early tectonic activity in the Sevier Foreland Basin. It crops out east and southeast of Idaho Falls near the Wyoming border. In Tincup Canyon in Caribou County the unit is 1,344 m thick. In that section the basal-most vertebrates (fragmentary, indeterminate dinosaurs) occur 133 m above the base. Other fossils in this section include elongatoolithid eggshell at 156 m, a partial *Oryctodromeus* skeleton at 501 m, an associated ankylosaur at 1,036 m, and semionotid fish and elongatoolithid eggshell at 1,082 m. A stratigraphic analysis of fossil localities throughout the formation indicates that 1) most fossils occur roughly in the lower and middle portions of the formation, and 2) *Oryctodromeus* is the most common vertebrate and it occurs within calcic paleosols.

The Wayan Formation has long been regarded as middle–late Albian in age. Our radiometric detrital zircon dates yielded a peak age of 99.3 + 2.5/−2.3 Ma 120 m above the base of the formation, indicating the formation can be no older than the Albian/Cenomanian stage boundary. An *Oryctodromeus* locality in the middle of the formation yielded an age of 96.5 ± 3.1 Ma from the youngest crystal and a peak age of 99.1 +1.5/−1.3 Ma. Newly recovered palynomorphs independently corroborate a 'mid'-Cretaceous age of the formation and provide the first evidence for marine influence in the Wayan fluvial systems.

A major finding of this study is that the Wayan Formation of Idaho and the Blackleaf Formation of Montana are synonymous based on age, lithology, stratigraphy, fauna (including *Oryctodromeus*), and structural trends. These formations are simply different areas of the same depositional basin or basin system, and their equivalence was not previously noted because the middle of the Wayan-Blackleaf basin is covered by Snake River Plain volcanics.

Finally, the radiometric ages indicate the Wayan is coeval with the uppermost unit (Mussentuchit Member) of the Cedar Mountain Formation of Utah and the member's fluvial facies, the Dakota Sandstone, which was traditionally considered a discrete stratum.

Technical Session XVII (Saturday, October 20, 3:15 pm)

FLYING ROCKS AND FLYING CLOCKS: EXPLAINING DISCREPANCIES BETWEEN FOSSIL AGES AND MOLECULAR DATES IN BIRDS

KSEPKA, Daniel T., North Carolina State University, Raleigh, NC, United States; WARE, Jessica L., Rutgers University, Newark, NJ, United States; LAMM, Kristin S., North Carolina State University, Raleigh, NC, United States

Major disparities have been recognized between molecular divergence dating estimates and ages provided by the fossil record for critical nodes in the Tree of Life, but broad scale patterns and underlying drivers remain elusive. We harvested 268 molecular divergence estimates for 67 major clades within Aves using the online database TimeTree. We also collected the ages of the oldest fossil occurrence for each of these clades, taking into account the age of fossils from sister taxa where relevant. Molecular dates were on average more than 1.5 times as old as the age of the oldest fossil record in these 67 clades, extending the estimates for targeted divergences by an average of approximately 25 million years per terminal branch. This resulted in molecular divergence estimates for 40 avian clades with earliest fossil records restricted to the Cenozoic being pushed into the Mesozoic by molecular estimates, implying a wave of mass survival across the K–Pg mass extinction for which fossil evidence is currently lacking.

Several pervasive patterns were observed. Mitochondrial genes yielded older dates than nuclear genes for an overwhelming proportion of targeted divergences. Disparity between molecular divergence estimates and the fossil record was substantially higher for divergences within major clades (crown divergences) than for divergences between major clades (stem divergences). The first pattern may be attributed to higher rates of substitution, compositional bias, and site saturation in mitochondrial versus nuclear genes. However, the second pattern is less easily explained because the quality of the fossil record is expected to increase towards the present. The basal crown divergences within a given clade by definition must have occurred more recently than stem divergence between that clade and its sister clade, so an explanation of the bias towards relatively older crown dates versus stem dates must be sought elsewhere. We identify some proposed effects of calibration strategy that may explain the patterns observed in birds, and more broadly result in systematic overestimates in molecular divergence estimates for other clades such as insects.

Technical Session XI (Friday, October 19, 3:45 pm)

A NEW ABELISAURID (THEROPODA: CERATOSAURIA) SKELETON FROM THE UPPER CRETACEOUS BAJO BARREAL FORMATION OF CHUBUT PROVINCE, ARGENTINA

LAMANNA, Matthew C., Carnegie Museum of Natural History, Pittsburgh, PA, United States; CASAL, Gabriel A., Universidad Nacional de la Patagonia San Juan Bosco, Comodoro Rivadavia, Argentina; MARTÍNEZ, Rubén D., Universidad Nacional de la Patagonia San Juan Bosco, Comodoro Rivadavia, Argentina

Abelisaurids were the most diverse and abundant large-bodied theropods in the Gondwanan landmasses at the end of the Cretaceous. Nevertheless, the initial stages of this carnivorous dinosaur radiation remain insufficiently understood, with most Early and 'middle' Cretaceous abelisaurids being represented by fragmentary or only briefly described fossils. We report a new abelisaurid partial skeleton (Universidad Nacional de la Patagonia San Juan Bosco Paleontología de Vertebrados [UNPSJB-PV] 1003) from southern Chubut Province in central Patagonia, Argentina. Recovered from the Cenomanian–Turonian Lower Member of the Upper Cretaceous Bajo Barreal Formation, UNPSJB-PV 1003 preserves most of the caudal half of the skull, both dentaries, isolated teeth, the partial sacrum, 23 caudal vertebrae, at least two dorsal ribs and 15 hemal arches, the left scapula, and much of the right tarsus and pes. Within Abelisauridae, the new skeleton probably pertains to a basal member of the clade, as evidenced by its retention of multiple plesiomorphic character states (e.g., minimal cranial ornamentation; fenestra between lacrimal, postorbital, and frontal; dorsoventrally thin frontal; lack of awl-like, proximally-directed projection at lateral end of proximal caudal transverse process; mediolaterally slender metatarsal III). Furthermore, the specimen exhibits a number of probable autapomorphies (rounded prominence bordered caudally by mediolaterally-oriented groove on caudolateral part of dorsal surface of frontal; low, acute caudomedial tuberosity on dorsal surface of frontal bordering 'caudal median fossa'; and proximal caudal transverse processes abruptly expand in proximodistal dimension well medial to their lateral extremes), suggesting that it belongs to a previously-unrecognized taxon. The abelisaurid *Xenotarsosaurus* has already been recorded in the Bajo Barreal Formation; unfortunately, however, no elements of the only known specimen overlap with UNPSJB-PV 1003, precluding direct comparisons between them. The proximal-most preserved caudal vertebra of the new specimen does differ in several regards from that of another abelisaurid partial skeleton previously described from this geologic unit. The sacrum and metatarsal III of the new skeleton are marked by shallow, subparallel grooves that probably correspond to feeding traces left by other archosaurs. Given that most of the shed tooth crowns discovered at the UNPSJB-PV 1003 site are referable to Abelisauridae, it is possible that this individual was scavenged by other members of its clade, and perhaps even cannibalized. UNPSJB-PV 1003 therefore sheds light on the sequence of character acquisition in abelisaurid evolution, and may also lend insight into the paleoecology of basal members of this important group.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 10:45 am)

VEGETATION AND CLIMATE RECONSTRUCTION OF DINOSAUR-BEARING LATE SANTONIAN, EARLY CAMPANIAN UNITS IN ALABAMA AND MISSISSIPPI

LAMB, Jr., James P., University West Alabama, Livingston, AL, United States

Pollen, leaves and charcoal from the near-shore marine Late Cretaceous (L. Cret.) (Late Santonian – Early Campanian) Eutaw Sand and Mooreville Chalk Formations in Alabama and Mississippi indicate a unique taphonomic bias for each plant part. Previous reconstructions of L. Cret. flora from the Southeastern United States (SeUS) indicated a dominance of angiosperms in both leaf and pollen data. Wood data have been lacking. Leaf data are skewed towards foliage resistant to physical degradation in the high-energy environment of deposition. Pollen is the best indicator of diversity in the overall flora, but for many angiosperm taxa, stature of the plant is unknown, and diversity does not necessarily equal total biomass. Pollen taphonomy is affected by varying degrees of aqueous flotation; some taxa may not be particularly relevant for floral reconstructions unless complimented by other plant parts. Data from charcoal (n=125) indicates that conifers comprised 95% of tree-sized flora. A smaller sample (n=12) of petrified wood indicates conifers comprised 92% of the tree-sized flora. Although charcoal taphonomy can be affected by differential flotation among taxa, similar results from charcoal and petrified wood indicate the dominance of conifers is not an artifact. Six new dicotyledonous taxa have been identified from charcoal. Growth rings in trees vary considerably among taxa, and the identity of taxa must be known for growth ring analysis to be relevant. Growth ring morphology in conifers and dicots and carbon isotopes from a single conifer indicate seasonal variation in rainfall, and suggest a monsoonal climate regime. Pollen indicates dicots comprised 46%, pteridophytes 27%, gymnosperms 24%, and monocots 3% of the flora, and a warm, humid climate. Angiosperm diaspore size indicates a closed forest canopy. Conifer dominance of the tree-sized component of the flora differs from other contemporaneous sites in the SeUS. This may reflect the lack of wood data in most floral reconstructions. Climate simulations, the presence of hummocky-bedded sands, and localized sand lenses entrained within the Mooreville Chalk Formation indicate the occurrence of paleo-hurricanes. A hurricane/fire disturbance regime may explain the prevalence of conifers, although data reflect knowledge only of coastal areas. Flooding, drowning and flotation may explain the presence of a high concentration of associated dinosaur carcasses in the study area. Dinosaur carcasses are concentrated near barrier island inlets, and storm runoff may explain how dinosaur carcasses and eggs are transported across the high-energy shore-face to be deposited in shallow marine chalks. Dinosaur bone preservation is strongly controlled by bottom water oxygenation.

Technical Session V (Wednesday, October 17, 3:30 pm)

THE ARCHAIC BEAKED WHALE *NINOZIPHIUS PLATYROSTRIS*: CLUES ON THE EVOLUTIONARY HISTORY OF THE FAMILY ZIPHIIDAE (CETACEA, ODONTOCETI)

LAMBERT, Olivier, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; BIANNUCI, Giovanni, Università di Pisa, Pisa, Italy; DE MUIZON, Christian, Muséum national d'Histoire naturelle, Paris, France

Beaked whales (Family Ziphiidae) are a species-rich clade of medium to large size odontocetes (toothed whales). In most extant species the dentition is drastically reduced, a feature interpreted as related to suction feeding. Only one or two pairs of mandibular teeth are usually retained, transformed in tusks in adult males. Shared with sperm whales, the habitat of ziphiids can be described as extreme; several species have been recorded performing feeding dives at depths greater than 1000 m, locating their prey in the darkness using their sonar. *Ninoziphius platyrostris* has long been considered as the best-known fossil ziphiid, based on the holotype, a skull from the early Pliocene of Peru with associated ear bones, mandible, and several postcranial elements. However, the poor preservation of the dorsal surface of the skull, including the diagnostic vertex and rostrum base, proved to be an obstacle for the analysis of the phylogenetic relationships of this key archaic species, displaying a full set of functional upper and lower teeth on its elongated snout, as well as several other plesiomorphic characters. The addition to the sample of two newly prepared skulls from the same Peruvian locality and level as the holotype (Sud-Sacaco, Pisco Formation) leads to a reappraisal of *Ninoziphius* in the light of numerous recent discoveries of fossil ziphiids. In the frame of an updated phylogenetic tree, with *Ninoziphius* as the most basal stem ziphiid, this review yields clues for the early steps of the evolution of the specialized feeding technique, habitat, and social behavior of beaked whales. Thanks to morphological data from various parts of the skeleton of *Ninoziphius* and other archaic ziphiids (proportions and size of snout, degree and types of tooth wear, asymmetry of the facial region, size and topology of the pterygoid sinuses, proportions of the vertebrae, development of mandibular tusks, compactness and pachyostosis of rostral elements, sexual dimorphism, body size) we test and refine the potential factors, both ecological (for example the shift to deep water predation) and behavioral (for example sexual selection), of the successful Neogene diversification(s) of this family.

Technical Session VII (Thursday, October 18, 2:00 pm)

TOWARD A QUANTITATIVE WAY TO IDENTIFY ANCESTORS IN THE FOSSIL RECORD: A BAYESIAN APPROACH

LAMM, Kristin S., North Carolina State University, Raleigh, NC, United States

The only direct evidence of the diversity of life through geologic time is contained in the fossil record, and this record is biased and incomplete. Fossils provide information that cannot be obtained from studying living organisms alone, but they bring with them unique methodological challenges. When a fossil lineage is densely sampled through time and space, it is possible to characterize patterns of morphological change through time. When an unbroken transition in morphology is observed between older and younger forms, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendent relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are constrained to represent extinct side-branches on the tree of life. However, fossils can also be sampled from lineages that lead to other fossil or living taxa. This study presents a novel quantitative approach toward evaluating the ancestral status of a fossil taxon. Birth-death processes provide a natural, tractable and formal framework for modeling a wide variety of biological processes. Consider such a process with constant birth rate λ , constant death rate μ , beginning with a single lineage at time 0 and ending with at least one lineage at time T. In this context, we express the probability that a single fossil selected at random from among the lineages that exist at time $0<t<T$ does not have at least one descendent at time $T>t$. Interestingly, this expression is independent of the number of lineages that existed at the time t when the fossil is sampled. These results can be implemented as a prior distribution and combined with models of morphological character change to obtain the posterior probability that a particular fossil lies directly ancestral to another sampled lineage.

Technical Sesssion XII (Friday, October 19, 4:00 pm)

TOOTH VARIATION IN *VARANUS KOMODOENSIS* AND IMPLICATIONS FOR INTRASPECIFIC VARIATION IN EXTINCT XIPHODONT CARNIVORES

LARSON, Derek W., University of Toronto, Toronto, ON, Canada; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

Understanding the range of intraspecific variation of taxonomically informative characters is essential when recognizing species based on morphological characters, particularly in the fossil record. In fossil datasets, this information is often lacking due to small sample sizes, with many fossil vertebrate taxa known only from single specimens. *Varanus komodoensis*, the largest extant lizard and the largest living terrestrial animal with xiphodont (laterally compressed, serrated) teeth, has often been used in palaeobiological studies as a model for theropod dinosaur feeding behaviour and tooth and jaw biomechanics. Here we use *V. komodoensis* to illustrate variation in the teeth of an extant xiphodont faunivore. Fifteen skulls of adult *V. komodoensis* were measured in order to quantify morphological variation of the dentition present in the species. Three gross tooth measurements, as well as mesial and distal tooth denticle size, were measured for each of ten teeth across the tooth rows. The number of tooth positions varies little between specimens; maxillary and premaxillary tooth counts remain identical in all specimens, but the smallest specimens have one fewer dentary tooth position than the largest skulls. Denticle size and tooth width in regionally equivalent teeth also remain essentially constant (negative allometry) across the size ranges even though tooth length and height increase isometrically with respect to skull size. These findings suggest that some aspects of tooth morphology are remarkably consistent between individuals and robust to differences in body size. Data from multiple individuals and comparison to other varanids indicate the potential of diagnostic characters in teeth.

These results have implications for understanding the diversity of small theropods, as extensive information on their abundance and diversity is derived from isolated teeth. Comparison with specimens of the dromaeosaurids *Atrociraptor marshalli*, *Bambiraptor feinbergi*, and *Dromaeosaurus albertensis* indicates that the standard deviation of denticle size is similar (~0.2–0.4) to that of individual specimens of *V. komodoensis*, showing that within-individual denticle size is consistent. However, comparison to the large number of isolated teeth referred to these same species shows much greater disparity than would be expected from intraspecific variation in *V. komodoensis*. This suggests that hidden ontogenetic or taxonomic factors are likely contributing to fossil tooth disparity. Although ontogenetic variation of teeth is not well understood in theropod dinosaurs, these results are consistent with a growing body of evidence that alpha diversity of small theropods is underestimated.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 8:15 am)

THE CRETACEOUS NEOTROPICS: COLOMBIAN VERTEBRATES AT THE BOUNDARY OF SHIFTING ENVIRONMENTS AND THE MESOZOIC MARINE INTERCHANGE

LARSSON, Hans C., McGill Univ Redpath Museum, Montreal, QB, Canada

Jurassic and Early Cretaceous times in northwestern South America witnessed dramatic geographic changes. The Tethys seaway penetrated southwestward through present day Colombia to unite with the Pacific Ocean. This seaway expansion would mark the separation between North and South America for the next 150 million years. Fossil marine invertebrates of this region have seen much attention to models of biogeographic interchanges and local

endimisms. However, the paucity of vertebrate fossils has made the inclusion of this clade difficult. A new marine and terrestrial vertebrate fauna from the upper Valanginien (ca. 138 Ma) is presented. The age is constrained by the presence of the small ammonite *Saynoceras verrucosum*. The fauna is composed of chondrichthyans, actinopterygians, testudines, a plesiosaur, a crocodyliform, a possible pterosaur, and a dinosaur. These are interpreted in the context of the biogeographic interchange that would have dominated faunal dynamics in the region during this time.

Technical Session I (Wednesday, October 17, 10:45 am)

A BIOMECHANICAL MODEL OF *ERLIKOSAURUS ANDREWSI* (DINOSAURIA: THERIZINOSAURIA) WITH IMPLICATIONS FOR CRANIAL FUNCTION AND DIETARY PREFERENCES

LAUTENSCHLAGER, Stephan, University of Bristol, School of Earth Sciences, Bristol, United Kingdom; RAYFIELD, Emily J., University of Bristol, School of Earth Sciences, Bristol, United Kingdom; WITMER, Lawrence M., Ohio University, Department of Biomedical Sciences, College of Osteopathic Medicine, Athens, OH, United States; ALTANGEREL, Perle, National University of Mongolia, Ulaanbaatar, Mongolia

Theropod dinosaurs have historically been regarded as an exclusively carnivorous and predatory group. However, recent analyses have suggested that herbivory may have been more widespread amongst the different theropod clades than previously thought, leading to far-reaching ramifications for the evolution of dietary specialisations in theropods. Therizinosauria represents one such herbivorous clade and their highly unusual anatomy has led to a variety of dietary assumptions. These range from piscivory and insectivory to various forms of herbivory, whereas the edentulous tip of the snout has been regarded as evidence for the presence of a keratinous beak. However, these assumptions have not been subjected to a more rigorous, biomechanical analysis.

We analysed the biomechanical behaviour of the skull and lower jaws of *Erlikosaurus andrewsi* – the only therizinosaur preserving a nearly complete and articulated skull. Using information derived from computed tomography (CT) scanning, the complete skull of *Erlikosaurus* was digitally reconstructed. The three-dimensional model subsequently served as a foundation for the detailed reconstruction of the adductor musculature, thus allowing for the estimation of individual muscle and bite forces. The latter were calculated for different positions in the skull and lower jaws: the edentulous tip of the snout, the first tooth position and the posteriormost tooth position. The estimated bite forces for *Erlikosaurus* are relatively low, both in actual numbers as well as in comparison to other theropods or in relation to its body size (ca. 100-200 kg). Different finite element (FE) models were created, incorporating muscle and bite force estimates, to test the mechanical capabilities of *Erlikosaurus*. Two hypothetical models were further tested, which contained a keratinous sheath or beak, covering the edentulous premaxilla and partly the maxilla.

The results of the finite element analysis demonstrate that even the comparably low bite forces would cause increased stress values in the skull of *Erlikosaurus*, in particular when applied to the posterior teeth. The addition of a keratinous beak on the skull and lower jaws considerably reduces the generated stresses for the anterior bite scenarios. The lack of wear facets, tooth occlusion and the possible presence of a large gut to process plant material, further suggest that the available bite force would not have been used for extensive mastication and chewing processes. This supports a hypothesis that *Erlikosaurus* would use the edentulous snout (potentially covered by a keratinous sheath) and anterior teeth to procure plant matter by branch-stripping and cropping of soft vegetation.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE BRAINCASE AND ENDOCRANIAL SPACE OF THE IGUANODONTIAN *LURDUSAURUS ARENATUS*

LAUTERS, Pascaline, IRSNB, Brussels, Belgium; TAQUET, Philippe, MNHN, Paris, France; VERCAUTEREN, Martine, ULB, Brussels, Belgium; GODEFROIT, Pascal, IRSNB, Brussels, Belgium

Lurdusaurus arenatus is a heavily built iguanodontian discovered in the Aptian (Early Cretaceous) of Gadoufaoua, Niger. Since its first descriptions in 1988 and 1999, *L. arenatus* remained poorly known and its endocranial region was not studied. Information on the structure of its brain is presented based on a silicone endocranial cast. The endocast of *L. arenatus* shows several peculiar features not observed on the endocasts of other iguanodontians. The olfactory lobes are comparatively small, suggesting that the sense of smell was less developed than in the other ornithopods observed by the authors. The cerebral hemispheres are narrow and oval in shape. Despite the large size attained by *L. arenatus*, the pituitary body, responsible of the production of the growth hormone, was small. The position of the inner ear is not marked by a profound constriction, contrary to what is observed in other ornithopods. With its straight endocranial cavity, *L. arenatus* shares the derived condition observed in *Iguanodon bernissartensis* and in hadrosaurids. The most likely causes of variation in the angles of the primitive flexure pattern are absolute skull size and relative eye size. Because *L. arenatus* was a large animal, the brain was probably not as constrained by space limitation as in smaller animals. The cerebrum represents 19% of the total volume of the endocranial space; its size is comparable to *Iguanodon bernissartensis*. The estimated Reptile Encephalization Quotient is higher than in sauropods, ceratopsians, and iguanodontians. It is lower though than those calculated for the hadrosaurids and most non-avian theropods. The degree of encephalization in *L. arenatus* was therefore intermediate between iguanodontians and hadrosaurids. This result further supports the phylogenetic position of *Lurdusaurus arenatus* as a transitional form between these two clades.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FOSSIL AND MODERN TURTLE EGGSHELL: TESTING THE VALIDITY OF EGGSHELL CHARACTERS IN CLADISTIC ANALYSES

LAWVER, Daniel R., Montana State University, Bozeman, MT, United States

Several studies demonstrate the usefulness of egg and eggshell characters in determining phylogenetic relationships among extinct non-avian taxa as well as extant avian taxa. However, such analyses based solely on egg and eggshell characters have not been adequately tested with eggs of extant species outside of Aves. Therefore, a cladistics analysis was conducted to determine whether egg and eggshell characters are phylogenetically significant within Chelonia. Ingroup taxa include 24 extant turtle species from multiple clades (e.g., Chelidae, Kinosternidae, Dermatemydidae, Trionychidae, Bataguridae, and Testudinae) and one fossil specimen.

Eggshell from each taxa was freshly broken and half of each fragment prepared as a standard thin section (30 μm thick) and examined under a Nikon Eclipse LV100POL light microscope. The other half of each fragment was mounted on an aluminum stud, coated with gold, and imaged under a JEOL JSM-6100 scanning electron microscope at 15 kV. Images included the inner and outer surfaces and radial views of each eggshell. This analysis allowed for identification of features used in the cladistic analysis, including mineral composition and structural features (e.g. shell unit height/width, shell unit spacing, pore length/width, pore shape and number of shell layers). Features, such as egg shape and size are also included in the analysis. Additional characters obtained from the literature permit a more comprehensive cladistic analysis of eggshell. Four outgoup taxa were included in this analysis in order to polarize the characters (i.e., two crocodilian and two avian taxa). Characters and character states were analyzed using PAUP/MacClade software in order to determine the most parsimonious trees. The trees were then be compared to previously published phylogenies of extant and extinct turtles.

Resulting consensus tree shows a large polytomy comprised of chelonian taxa. Within this polytomy, an archosaurian clade is resolved containing both a crocodilian clade as well as an avian clade. This suggests that egg and eggshell characters are not phylogenetically adequate for distinguishing among chelonian taxa; however, these characters are phylogenetically significant and sufficient for differentiating Chelonia from non-turtle taxa.

Technical Session XI (Friday, October 19, 2:00 pm)

PEDAL DIGIT IV PROPORTIONS REVEAL BODY-SIZE ASSOCIATED CONSTRAINT ON DINOSAUR FOOT MORPHOLOGY

LEARY, Brian, University of Massachusetts Dartmouth, North Dartmouth, MA, United States; KAVANAGH, Kathryn, University of Massachusetts Dartmouth, North Dartmouth, MA, United States

The proportions of the pedal phalanges of tetrapods have been found to correlate with foot function. Plotting the phalangeal proportions of birds in morphospace not only allows us to discriminate functional groups, but also reveals a restricted range of variation in which many potential morphologies are unrepresented. Additionally, we observed some striking examples of convergent evolution. In previous studies, digit III of the foot was used to infer function as it was hypothesized to be the most functionally significant. However, we found that digit IV is more effective in discriminating functional groups in birds. We applied this insight to the pedal phalanges of 30 non-avian theropods and bipedal ornithischians to identify functional groups and compare the range of variation in the ancestors of modern birds. Using Principal Component Analysis and Generalized Linear Modeling, we have shown that (1) the phalangeal proportions of all dinosaurs sampled fall within a subset of the range of variation observed in birds, (2) ornithischian dinosaurs fall exclusively within the range of terrestrial, non-perching birds (e.g., running, walking, swimming), exhibiting in most cases, extreme proximodistal gradient patterning, (3) non-avian theropods fall within a range spanning from terrestrial birds to highly arboreal taxa, but extreme raptorial morphologies are conspicuously absent, and (4) the phalanx proportions of non-avian theropods are strongly correlated with body length. Extreme distal elongation does exist in the forelimbs, but not hind limbs, of some non-avian theropods. Since body length is not predictive of phalanx proportion variation in birds, this apparent constraint on hind limb proportions may only exist at the extreme body sizes found in large dinosaurs. The evolution of flight and reduction of body size are thus correlated with the expansion of variation in the distal phalanges of the avian lineage.

Technical Session XIV (Saturday, October 20, 8:00 am)

DENTAL HISTOLOGY OF DIADECTOMORPHA AND THE EVOLUTION OF CEMENTUM AND ALVEOLAR BONE WITHIN AMNIOTA

LEBLANC, Aaron R., University of Toronto Mississauga, Mississauga, ON, Canada; REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada

Recent studies of tooth implantation using histological methods in squamates and other diapsid reptiles have led to a novel hypothesis for the homology of amniote tooth tissues. These studies have demonstrated the presence of alveolar bone, cellular and acellular cementum, and periodontal ligaments in squamates, ichthyosaurs, and crocodilians, which is similar to the condition in mammals. The presence of these tissues in distantly related

reptiles suggests that this characterizes tooth implantation for Amniota instead of being unique to mammals. To test this hypothesis, thin sections were made of the marginal dentition of diadectids from the Lower Permian of Texas. Diadectids are suggested to have been the first high fiber herbivores in terrestrial communities, and also occupy an important position in amniote phylogeny as stem amniotes. As such, diadectids are important subjects for the identification of primitive conditions of tooth implantation in Amniota. Histological examination of the marginal dentition of *Diadectes* shows for the first time that plicidentine (dentine infolded towards the pulp cavity) was present in Diadectidae, but does not significantly contribute to an increase in surface area for attachment of the teeth to the jaws. Instead, the teeth are set in deep sockets lined with alveolar bone that was shed with each tooth replacement event. Although no periodontal ligament is preserved, the teeth appear to be ankylosed to the alveolar bone via a network of thick Sharpey's fibers that insert into cellular and acellular cementum coating the root of the tooth. The carnivorous basal diadectomorph *Limnoscelis* also possesses deep roots lined with alveolar bone and roots coated with cementum, suggesting that these features are not associated with high fiber herbivory in this clade. The presence of these tissues indicates that the potential to produce thecodont periodontal tissues is present in these stem amniotes and may be primitive for Amniota.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NATIONAL PARK SERVICE VERTEBRATE COLLECTIONS AT THE SMITHSONIAN: COLLABORATION TO SUPPORT SCIENCE AND STEWARDSHIP

LESSER, Samantha, Geological Society of America, Rochester, NY, United States; SANTUCCI, Vincent L., National Park Service, Washington, DC, United States; JORSTAD, Thomas, Smithsonian Institute, Washington, DC, United States

The Smithsonian Institution's National Museum of Natural History maintains paleontological collections from approximately fifty units of the National Park System. A large percentage of these fossil specimens were collected prior to the area being administered by the National Park Service. Therefore a database does not currently exist that enables efficient searches for NPS fossil specimens. In 2012, the National Park Service worked with staff from the Natural History Museum to begin a pilot project to inventory and photograph these fossil collections. The initial work focused on three specific inventories: Charles Gilmore's Paleozoic vertebrate ichnofossils from Grand Canyon National Park; Remington Kellogg's Pleistocene vertebrate fossils and coprolites from Rampart Cave, Grand Canyon National Park; and, Lloyd Logan's Pleistocene vertebrate fossils from Musk Ox Cave, Carlsbad Caverns National Park. Each of the collections was inventoried, photographed and any archival information and associated field notes were scanned and entered into the Museum's collection database. Historic images were also scanned for each collection. The information obtained is being used to support research, resource management and curation at the respective parks. This pilot work is the foundation of much more extensive collaboration to inventory other National Park Service paleontological resources in the Smithsonian's collections.

Technical Session XV (Saturday, October 20, 11:00 am)

VARIATION IN CERATOPSIAN HISTOLOGY AND GROWTH: NEW DATA FROM SOUTHERN LARAMIDIA AND IMPLICATIONS FOR PALEOENVIRONMENTAL DIFFERENCES

LEVITT, Carolyn G., Natural History Museum of Utah, Salt Lake City, UT, United States

Ceratopsid dinosaurs from western North America (Laramidia) were one of the most diverse dinosaur clades during the latest Cretaceous. Previous histology studies investigated several basal ceratopsians and centrosaurine ceratopsids (e.g., *Centrosaurus, Pachyrhinosaurus, Einiosaurus*), but chasmosaurine ceratopsids have yet to be sampled. I conducted histological analysis on the limb bones of the chasmosaurine ceratopsids *Kosmoceratops richardsoni* and *Utahceratops gettyi* from the late Campanian Kaiparowits Formation of southern Utah, and also reexamined the long-bone histology of *Psittacosaurus mongoliensis, Protoceratops andrewsi*, and *Centrosaurus apertus*. I compared these data with those of centrosaurine ceratopsids from Alaska and Alberta, examining annual lines of arrested growth (LAGs), and vascular canal orientation and density, to see how growth strategies differed taxonomically and geographically across Laramidia.

Basal ceratopsians grew more slowly than the large quadrupedal ceratopsids, as evidenced by a generally higher number of definitive growth lines prevalent throughout development. In contrast, the presence of dense osteocytes, and reticular and radially-oriented vascular canals, are rapid growth indicators shared by all sampled large ceratopsids. Among these taxa, there is a clear latitudinal pattern seen in the abundance of LAGs in subadult/adult individuals, where *Pachyrhinosaurus* from Alaska preserves numerous (18) growth zones, *Centrosaurus* from Alberta preserves at most seven, and the southern forms from Utah, *Utahceratops* and *Kosmoceratops*, display a maximum of two LAGs. All taxa display some reticular canals, but southern taxa have a higher proportion of radial canals. There are several possible explanations for this latitudinal trend. First, because these taxa were largely endemic to their own basins, I could not sample the same species across the entire latitudinal range, so each species of ceratopsid has a unique growth pattern. Second, these dinosaurs are found in penecontemporaneous, but not necessarily coeval, strata, so these data could reflect temporal variation. Third, Campanian climate varied latitudinally across Laramidia, and this affected growth duration and/or growth rate. I cannot rule out the first two hypotheses, but the latitudinal climate hypothesis is most convincing, because there was a latitudinal climate gradient during the Campanian, histological variation in ceratopsids systematically follows this gradient, and the trend matches latitudinal histological patterns for extant mammals. These results are also consistent with a similar latitudinal signal described for the hadrosaurid *Edmontosaurus*.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A LARGE-BODIED BASAL ENANTIORNITHINE BIRD FROM THE EARLY CRETACEOUS OF CHINA WITH A PROPOSED RAPTORIAL FEEDING ECOLOGY

LI, Zhiheng, The University of Texas at Austin, Austin, TX, United States; ZHOU, Zhonghe, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; CLARKE, Julia A., The University of Texas at Austin, Austin, TX, United States

Enantiornithes are proposed to comprise the most significant radiation of Mesozoic birds in terms of species richness and ecological diversity. Their earliest records are Early Cretaceous in age. Although fossils relevant for understanding this radiation are globally distributed, Early Cretaceous Enantiornithes are best represented in the Yixian and Jiufotang Formations of northeast China. In the fauna known from these Formations, the Jehol Biota, the diversity of Enantiornithes greatly exceeds that of other groups of birds (e.g., Ornithurae, or more basal avialans). However, only a handful of Jehol taxa have been proposed as basal parts of Enantiornithes (e.g., *Protopteryx, Pengornis,* and *Eoenantiornis*). Globally this early part of the lineage is poorly sampled, and early arising synapomorphies for the group are still not fully understood. Here, we describe a new large-bodied species of basal enantiornithine bird from the Early Cretaceous of China that sheds light on both morphological variation and ecological specialization in the clade. The new specimen, a complete skeleton with a well-preserved skull, shows a unique combination of characters for basal avialans: reduced maxillary and dentary dentition with smaller, peg-like premaxillary teeth; sternum with the posterior sternal midline and lateral trabeculae approximately equal in posterior extent; a flat to sub-concave lateral margin of the coracoid with a small lateral process; abbreviate rod-like hypocleidium on the furcula, an extremely robust sub-rectangular acromion process on the scapula; a small metacarpal I with a weakly-bowed anterior margin; and, markedly elongate, recurved pedal unguals. The body size of the new species is only slightly smaller than *Pengornis*, the largest described enantiornithine taxon, and is larger than all other Early Cretaceous Enantiornithes. Based on the novel combination of both cranial and pedal attributes we propose the new species may have had a raptor-like ecology. By providing new insight into character evolution and ecological range in basal Enantiornithes, the reported taxon improves our understanding of the early part of a key Mesozoic radiation.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

USING STABLE ISOTOPE ANALYSIS OF COPROLITES TO DETERMINE PALEODIET OF LATE PLEISOTOCENE MAMMALS

LIGHTNER, Erik, University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States; FOX-DOBBS, Kena, University of Puget Sound, Takoma, WA, United States; MINCKLEY, Thomas, University of Wyoming, Laramie, WY, United States; KORNFELD, Marcel, University of Wyoming, Laramie, WY, United States

Stable isotope analysis has contributed to reconstructions of paleoenvironment and paleodiet of fossil taxa across glacial intervals during the Late Pleistocene-Holocene. Yet, few Pleistocene studies have examined $\delta^{13}C$ and $\delta^{15}N$ values in coprolites. Stable isotopic analysis of coprolites can aid in dietary reconstruction of fossil consumers, but only after diet-feces discrimination, taphonomic effects, and past environmental conditions (e.g., variation in the $\delta^{13}C$ of atmospheric CO_2) have been taken into account. To test the degree of influence of these factors on $\delta^{13}C$ and $\delta^{15}N$ values, we analyzed rodent (*Neotoma sp*.) and sheep (*Ovis catclawensis)* coprolites from the Last Canyon Cave rockshelter in southern Montana. These coprolites form a continuous record spanning the last 40 ka, and occur in association with well-preserved pollen and mammal fossils, which provide an independent record of paleoenvironmental information for this deposit.

Coprolite $\delta^{13}C$ and $\delta^{15}N$ values varied with depth and age within the measured section. $\delta^{15}N$ values of coprolites were higher in both *Neotoma sp*. and *Ovis catclawensis* than would be anticipated for terrestrial consumers, with some values exceeding 20‰. This reflects the combined effects of 1) enrichment due to microbial activity, 2) possible evaporative enrichmentprior to burial, and 3) an assumed diet-feces discrimination of 2.1‰ for *Neotoma sp*. and 3.1‰ for *Ovis catclawensis*. Mean (± 1 s.d.) $\delta^{13}C$ values for *Neotoma sp*. (-25.7 ± 1.0‰) and *Ovis catclawensis* (-26.5 ± 0.8‰) were not as enriched in ^{13}C as compared to $\delta^{15}N$ values, which is consistent with results from modern soils. This suggests that $\delta^{13}C$ values in coprolites are a more reliable indicator of paleodiet. Thus, the seemingly stochastic variations through time in our results could be explained by changes in individual foraging preferences, possibly by switching between gymnosperm and angiosperm plant types, or by variation in cactus consumption over time.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PERLEIDIFORM ACTINOPTERYGIANS FROM THE PELSONIAN (MIDDLE ANISIAN, MIDDLE TRIASSIC) OF YUNNAN PROVINCE, SOUTHWESTERN CHINA

LIN, Hunqin, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Zuo-Yu, Department of Geology and Geological Museum, Peking University, Beijing, China; TINTORI, Andrea, Dipartimento di Scienze della Terra, Milano, Italy; LOMBARDO, Cristina, Dipartimento di Scienze della Terra, Milano, Italy; JIANG, Da-Yong, Department of Geology and Geological Museum, Peking University, Beijing, China

Ten well preserved fossil fishes have been collected from the Luoping Fauna, in the Upper Member of the Guanling Formation (Pelsonian, Middle Anisian, Middle Triassic), exposed around the Dawazi village (Luoping County, Yunnan Province, South China). They can be ascribed to Perleidiformes on the basis of skull pattern, with the large rostral separating the nasals, dentition made of stout peg-like teeth and the almost vertical preopercular dorsally expanded. Furthermore, the anterior mid-flank scales are deeper than long and the caudal fin shows a few epaxial fin rays. Based on the new material, four morphotypes, including the already described *Perleidus sinensis*, have been recognized; they all are close to the genus *Perleidus* and can be considered in the basal perleidiform group related to the type genus.

Characters used for discriminating morphotypes are related both to the skull and the postcranial skeleton. Marginal peg-like teeth are more or less numerous and stout, as for the crushing dentition, five to seven supraorbitals and two or more branchiostegal rays are present, opercular/subopercular ratio is highly variable. Squamation may have two or three horizontal rows of deepened flank scales persisting to the level of the pelvic fins, scale rows vary from 45 up to 53. The exposed surface of the scales can be ornamented or smooth. All specimens have less than ten epaxial rays. Well preserved axial skeletons in two specimens allow for a detailed description, much improving our knowledge of the vertebral column of 'subholostean' actinopterygians. The new material from the Luoping Fauna further confirms that the radiation of actinopterygians took place at least in the Pelsonian, involving not only neopterygians but also the basal subholosteans that then will further differentiate in the western Tethys area by the end of the Anisian.

Technical Sesssion XII (Friday, October 19, 2:45 pm)

TAIL FIN EVOLUTION IN MOSASAURS (SQUAMATA, MOSASAURIDAE)

LINDGREN, Johan, Department of Geology, Lund University, Lund, Sweden; KADDUMI, Hani F., Eternal River Museum of Natural History, Amman, Jordan; POLCYN, Michael J, Southern Methodist University, Dallas, TX, United States

Mosasaurs are secondarily aquatic squamates that became the dominant marine reptiles in the Late Cretaceous. Though early members of the group possessed body shapes similar to extant monitor lizards, derived forms have traditionally been portrayed with rectilinear bodies and straight tails. However, over the last few years a growing body of data collected from skeletal morphology and caudal vertebral centrum morphometrics has indicated that the distal third of the tail in derived mosasaurs was structurally downturned in life. It has also been suggested that certain advanced forms had semilunate tails resembling those of pelagic sharks, though dorsoventrally mirrored, and in that regard similar to the hypocercal caudal flukes of derived ichthyosaurs and metriorhynchid crocodyliforms. Until now, however, no soft tissue evidence to support these claims has been reported. Here we review current knowledge on the shape and function of the mosasaur tail fin, and describe a new specimen that provides definitive evidence that derived mosasaurs were propelled by bilobed, asymmetrical caudal flukes. This demonstrates that mosasaurs are convergent with ichthyosaurs, metriorhynchid crocodyliforms and whales in the development of a specialized, crescent-shaped propulsive surface for enhanced locomotor efficiency.

Technical Session II (Wednesday, October 17, 11:00 am)

GROWTH, AGE AND SIZE OF *LEEDSICHTHYS*, THE LARGEST BONY FISH

LISTON, Jeff, National Museums Scotland, Edinburgh, United Kingdom

Pachycormiformes were the first group of marine animals to pioneer the niche of large (> 2 metres standard length) suspension-feeding vertebrates, a trophic role today occupied by a variety of chondrichthyans and baleen whales. The last decade was one of new discoveries and re-identified specimens that revealed that pachycormids dominated this niche from the Middle Jurassic to the end of the Late Cretaceous, but their acme remains the Callovian *Leedsichthys*. The larger the adult size of a pachycormid taxon, the smaller the amount of the skeleton that ossifies. This reduction in preservation potential for the axial skeleton means that only separated elements are ever preserved for this genus. Consequently, estimates of the size of this animal have been highly contentious, relying on a variety of scaling techniques based solely on these disparate isolated skeletal components. Here, a review of material collected globally over the past 140 years has enabled the first constrained estimates of size, in conjunction with age estimates derived from growth ring analysis and size ranking of identical bony elements from individual specimens. The five most complete specimens of *Leedsichthys* were selected and placed in a likely rank order of relative size, based on the dimensions of cranial elements common to more than one specimen. As the respiratory surface of gill filaments is effectively a two dimensional area that varies with body mass, larger animals would have a disproportionately large gill basket for the body length. Hence, cranial elements were rejected in favor of postcranial elements, for the purpose of scaling in order to estimate absolute size of the five individuals. Meristic elements common to all selected specimens were sectioned, and counts of annuli used to derive estimated ages for the individuals. All three processes produced congruent results, with the rank order of specimens derived from cranial elements tallying with the order of the postcranially-based size estimates (ranging from 8.0-16.5 metres), which in turn agreed with the estimated ages derived from annular counts of the meristic elements (ranging from 21-45 years). Although examination of further material is necessary for the detailed resolution of growth rate, in particular in the first years of life, this technique has importantly demonstrated a consistent pattern of size and age among different specimens of *Leedsichthys* from three differing areas of their skeletal remains. The size and age estimates are compatible with what is known of the growth of large modern-day oceanic suspension-feeding chondrichthyans.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

BODY SHAPE DIFFERENCES BETWEEN NORTH AMERICAN AND ASIAN FOSSIL CATOSTOMIDS AND ONTOGENETC CHANGE IN EARLY CYPRINIFORMS

LIU, Juan, University of Alberta, Edmonton, AB, Canada; TSENG, Zhijie J., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; WILSON, Mark V., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

The most studied early fossil catostomid *Amyzon aggregatum* (Cypriniformes, Catostomidae), recorded from the early Eocene of Canada, was highly variable in its meristic and metric characters. Measurements and meristics of two other well-known species of *Amyzon* overlap with this species. One of these, *A. gosiutense* from the Green River Formation, has been considered by some to be a junior synonym of *A. aggregatum*. The other, *A. hunanense*, from southern China, is difficult to distinguish from *A. aggregatum* based solely on meristic and metric characters. To examine body shape differences of early catostomids and shape change through ontogeny of early cypriniforms, geometric morphometric analyses were performed on three early catostomid species, as well as on the Eocene *Jianghanichthys hubeiensis*, a putative basal cypriniform. Anatomical landmarks were digitized in two dimensions on complete fossil specimens preserved on slabs. First, principal component analysis (PCA) shows that the body shape of *Jianghanichthys* differs from that of all included species of *Amyzon*, and that a difference between North American and Asian catostomids is also apparent within the body shape morphospace. The Asian species possess a comparatively shorter head, caudal peduncle, and dorsal fin base, a more caudally placed anal fin, and a deeper body. Second, regression analysis of shape changes with size shows a parallel pattern of body shape change through ontogeny in all tested taxa. General shape changes with growth include: skull, caudal peduncle, and anal fin base shorter, body deeper, dorsal fin base extended farther anteriorly and posteriorly, and pectoral fin originating more anteroventrally. Interestingly, PCA performed on the residuals of the body size and shape regression analysis (to remove size effects) showed that the body shapes of tested taxa became less distinct from one another when compared with the results of analysis prior to size correction; this holds true even between *Amyzon* and *Jianghanichthys*. This indicates that comparisons among species should concentrate on individuals of similar body size. The size-corrected morphospace nevertheless shows *Amyzon* having a shallower body and longer head than *Jianghanichthys*. Discriminant function analysis of both datasets returned negligible errors in correct identification of species based on body shape, but these results were statistically significant ($p<0.0001$) only between genera. In conclusion, body shape changes indicated by geometric morphometrics analysis has the potential to improve diagnosis of closely related fossil catostomids, as well as to illuminate inter-specific differences in morphological shape that become more pronounced after ontogeny (as measured by body size) has been taken into account.

Technical Session IX (Friday, October 19, 8:45 am)

TESTING LATE CRETACEOUS LARAMIDIAN PALEOBIOGEOGRAPHIC HYPOTHESES: EVIDENCE FROM THE EVOLUTION OF BAENID TURTLES

LIVELY, Joshua R., University of Utah, Salt Lake City, UT, United States

Recent discoveries demonstrate that Campanian dinosaur assemblages across the western North American sub-continent (Laramidia) exhibit basin-scale endemism, with each sedimentary basin possessing its own unique assemblage, and an apparent higher-level biogeographic boundary between northern and southern Laramidia. Subsequently, during the Maastrichtian, most taxa are present in multiple basins, with some forms, such as *Alamosaurus*, *Edmontosaurus*, and *Triceratops*, supporting the presence of distinct northern/southern provinces, whereas others are more cosmopolitan (e.g., *Tyrannosaurus rex*). Despite these dinosaur biogeographic data, little attention has been paid to other vertebrate groups. To test these biogeographic hypotheses, I examined the paleobiogeography of the paracryptodiran turtle clade Baenidae using a newly-generated species-level phylogeny. Baenids were one of the most diverse and abundant turtle clades during the Late Cretaceous, are restricted to North America, and have a well-sampled fossil record, making them an ideal study system for examining Laramidian biogeography.

To reassess the phylogeny of Baenidae, I revised and expanded the character and taxon sampling of previous studies, with 106 characters and 32 baenid taxa (the pleurosternid *Glyptops plicatulus* was the outgroup), including adding three new taxa from the middle Campanian Kaiparowits Formation of southern Utah. These are two new, large-bodied species of the genus *Neurankylus* and a taxon closely related to *Hayemys latifrons* from the Maastrichtian Lance Formation of Wyoming. I also added new morphologic data from known taxa, such as the previously undescribed skull of *Denazinemys nodosa*. Based on

occurrences alone, Campanian baenid assemblages display distinct northern and southern provinces with no taxonomic overlap. To investigate the evolutionary patterns of this biogeographic signal, I applied a dispersal-extinction-cladogenesis model to the strict consensus tree and three randomly selected most parsimonious trees (out of a total of 18) from my phylogenetic analysis. For each tree, I computed both smoothed and strict temporal calibrations. My analysis reveals that the ancestral ranges for basal baenid branches were cosmopolitan across either Laramidia or all of North America. More derived baenids (i.e., sub-clade Baenodda) possessed ancestral ranges in the area of Montana, Wyoming, and the Dakotas; the analysis reconstructs multiple individual lineages then dispersing to southern Laramidia and Alberta.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:00 am)

CONFIDENCE INTERVALS ON NODE AGE ESTIMATES IN VERTEBRATE PHYLOGENY

LLOYD, Graeme T., University of Oxford, Oxford, United Kingdom; FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom; BELL, Mark A., University of Glasgow, Glasgow, United Kingdom

Paleontology and biology are increasingly converging on common goals and methods, particularly with regard to constructing the tree of life. However, the relatively recent adoption of Phylogenetic Comparative Methods (PCM) by paleontologists has exposed a hitherto unrecognised problem in how fossil trees are dated. Specifically, the approach of dating each node using its oldest descendant means at least of half of all branches have a duration of zero – an untenable and unrealistic result. Previous solutions to this problem have been somewhat arbitrary in nature, for example: adding a million years to each node. Here we use a novel approach that takes as its input the topology, tip ages and, critically, outgroup ages for a given clade. All internal nodes are then dated by either a probabilistic- (where specific requirements are met) or randomisation-approach. The method then returns a distribution of ages for each node, allowing for median and 95% confidence estimates.

Exploratory application of this approach to a 554-taxon phylogeny of placental mammals gives a median age for the origin of the clade as 84.28 Ma with 95% confidence intervals of 71.32-106.04 Ma. Comparison with a recent molecular clock analysis shows that for all comparable nodes (Carnivora, Ceratomorpha, Perissodactyla and Placentalia) the 95% confidence intervals comfortably overlap. Thus, explicitly taking into account the uncertainty implied in the fossil record indicates a greater congruence between fossil and molecular records than previously suggested.

Beyond cross-correlation between dating methods future applications of this approach include: 1) leveraging more fossil data than merely the oldest crown-group occurrence for a clade to provide better calibration dates for molecular clock approaches, 2) providing more accurate branch-length estimates as input data for PCM approaches such as trait evolution and, 3) establish non-minimal backward range extensions for analyses of diversity, origination and extinction.

Technical Session I (Wednesday, October 17, 9:00 am)

THE EARLY EVOLUTION OF TYRANNOSAUROID DINOSAURS: NEW ANATOMICAL, PHYLOGENETIC AND BIOGEOGRAPHIC EVIDENCE

LOEWEN, Mark A., University of Utah, Salt Lake City, UT, United States; SERTICH, Joseph J., Denver Museum of Nature and Science, Denver, CO, United States; IRMIS, Randall B., University of Utah, Salt Lake City, UT, United States

Recent descriptive and phylogenetic work over the past decade has identified an increasing number of Middle-Late Jurassic and Early Cretaceous small theropods that may be early representatives of Tyrannosauroidea, a clade that includes the Late Cretaceous radiation of western North American and Asian tyrannosaurids. However, the interrelationships of these early small-bodied forms, and the taxonomic composition of Tyrannosauroidea, remain controversial. To elucidate the early evolution of tyrannosauroids, we conducted a phylogenetic analysis of 57 taxa and 501 characters, with both increased character sampling as well as critical reexamination of existing character definitions and codings. This analysis also includes a broad sampling of neotheropod and coelurosaur outgroups to ensure proper character polarization. In conjunction with this analysis we re-examined material assigned to the Late Jurassic theropod *Stokesosaurus clevelandi*, from the Cleveland-Lloyd Dinosaur Quarry in the Upper Jurassic Morrison Formation of central Utah.

Re-analysis of theropod materials from the Cleveland-Lloyd bonebed resulted in the identification of significant new early tyrannosauroid material. These remains enhance the known morphology of *Stokesosaurus* and permit detailed comparisons with other early members of Tyrannosauroidea. Among the elements that can now be referred to *Stokesosaurus* are a premaxilla, maxilla, complete braincase, two ilia, and two ischia. The craniofacial elements are morphologically similar to other early tyrannosauroids including *Dilong*, *Guanlong*, *Proceratosaurus* and *Kileskus*. Particularly notable, the ilia of *Stokesosaurus* are very similar to *Juratyrant*, *Eotyrannus, Iliosuchus* and *Yutyrannus* in possessing a dorsocaudally inclined supraacetabular crest, a rounded dorsal outline and a peg-and-socket ischial suture. The ischium of *Stokesosaurus* is similar to *Juratyrant*. The results of the phylogenetic analysis dramatically enhance our understanding of the early history of the clade between 170 and 120 Ma, demonstrating a close link between most early tyrannosauroid taxa and *Stokesosaurus*. In contrast, the Early Cretaceous taxa *Dilong, Eotyrannus* and *Yutyrannus* represent more derived tyrannosauroids more closely related to Tyrannosauridae, indicating an independent radiation of basal tyrannosauroids in the Late Jurassic. This new information suggests that early tyrannosauroids had a widespread Laurasian distribution during the Late Jurassic and Early Cretaceous, potentially indicating repeated dispersal events between Europe, Asia, and North America.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

HIGH OBSERVER VARIABILITY IN DENTAL MESOWEAR ANALYSIS OF AN EXTREME GENERALIST *CORMOHIPPARION EMSLIEI* FROM FLORIDA: CAUTIONARY LESSONS LEARNED FROM INTEGRATING GEOCHEMICAL AND DENTAL MESOWEAR DATA

LOFFREDO, Lucas F., Vanderbilt University, Nashville, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States

Dental mesowear is an inexpensive and quick method used to assess the average diet of herbivorous mammals. In contrast to dental microwear that captures dietary information produced via abrasive food material during the last few weeks of an animal's life, mesowear captures wear produced over the lifetime of the animal by both attrition and abrasion. Most mesowear methods focus on qualitatively categorizing cusp shapes as high, round, or blunt (also noting high or low relief), or categorizing teeth into numerical categories (typically 0 to 6, from sharp to blunt) that integrate these variables. As mesowear requires an observer to make subjective judgments as to tooth categories, we aim to assess observer variability similar to what has been done with other observer reliant methods such as dental microwear. Additionally, we integrate carbon isotope geochemistry with mesowear data in a generalist herbivore *Cormohipparion emsliei* to assess if mesowear similarly records average dietary information. Stable carbon isotope samples from *C. emsliei* from the Bone Valley of Florida (~5 Ma) were analyzed and added to previously published data, yielding a $\delta^{13}C$ range of 13.7‰ (-12.9 to 0.8‰). These geochemical data suggest extremely generalized dietary behavior ranging from primarily browsers to grazers. Mesowear data conducted by experienced individuals and minimally trained individuals are significantly different from one another, with experienced individuals assigning lower average shape categories (e.g., assigning blunt over round; $p<0.001$) and lower relief categories (e.g., assigning low over high relief; $p=0.024$), while assigning higher numerical categories ($p<0.01$). Furthermore, multiple linear regression models of shape and relief categories significantly predict assignments of 0-6, while experienced individuals have higher R^2 values than novices ($R^2=0.95$, $R^2=0.81$, respectively). All shape and relief categories were assigned to 83% and 100% of teeth sampled ($n=23$), respectively. Despite these differences, average mesowear values of all teeth sampled are ~4.0 (on a 0-6 scale) for both groups of observers and consistent with a mixed diet. However, stable carbon isotope and mesowear data for identical specimens are not significantly related, with $\delta^{13}C$ extremes (-12.9 and 0.8‰) yielding mesowear values only 0.7 apart (4.9 and 4.2), based on experienced classifications. Collectively, these data demonstrate that mesowear data is highly variable and should not be interpreted as similar to geochemical data.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW SPECIES OF *ICHTHYOSAURUS* FROM THE LOWER JURASSIC (PLIENSBACHIAN) OF WEST DORSET, ENGLAND

LOMAX, Dean R., Doncaster Museum and Art Gallery, Doncaster, United Kingdom; MASSARE, Judy A., Earth Sciences Dept, SUNY College at Brockport, Brockport, NY, United States

A new species of Pliensbachian ichthyosaur from the Stone Barrow Marls Member (Charmouth Mudstone Formation) of Dorset, England is recognized. The species is assigned to *Ichthyosaurus* on the basis of humerus, forefin, and pectoral girdle morphologies. Diagnostic features of the new species include a long, fairly robust snout, moderate to small orbit, short stout humerus, and very small femur (and hindfin) relative to the humerus (and forefin). Two specimens are known, the proposed holotype and a nearly complete skeleton of a juvenile, possibly from Lyme Regis (stratigraphy unknown). According to current criteria for assessing the maturity of ichthyosaurs, it appears that the holotype is at least a sub-adult. The new species brings the diversity of Pliensbachian ichthyosaurs to at least three and possibly as many as five species, representing three genera: *Ichthyosaurus*, *Leptonectes*, and *Temnodontosaurus*.

Technical Session II (Wednesday, October 17, 9:15 am)

A PECULIAR TETRAPODOMORPH FISH FROM THE MIDDLE DEVONIAN OF AUSTRALIA SUPPORTS GONDWANA ENDEMISM IN THE STEM TETRAPOD RADIATION

LONG, John A., Natural History Museum of LA Co., Los Angeles, CA, United States; HOLLAND, Timothy, Museum Victoria, Melbourne, Australia; YOUNG, Gavin C., Australian National University, Canberra, Australia

A new tetrapodomorphan fish (Osteichthyes; Sarcopterygii) from the late Middle Devonian (late Givetian) Harajica Sandstone member of the Amadeus Basin, central Australia, is represented by several near complete skulls and much of the body and postcranial skeleton. It has been studied from latex casts made from detailed sandstone impressions. It had a long parietal shield relative to its postparietal, a posteriorly broad postparietal shield, very small orbits and broad, triangular extratemporal bones, allowing confident phylogenetic placement within the canowindridoid clade, as shown by a new PAUP analysis of tetrapodomorphan fishes. Our analysis also questions the long held position of Rhizodontida at the base of the

clade containing total group Tetrapodomorpha minus *Kenichthys*. Canowindridoids are an endemic clade of tetrapodomorph fishes only known from the Middle-Late Devonian of Australia and Antarctica. This new form shows greater morphological disparity and reveals new points of anatomy not previously known for the group, such as the structure of the palate and parasphenoid, which is v-shaped posteriorly. It is also unusual in having large open spiracles on top of the head, cheek plates tightly integrated anteriorly to the skull roof, and large lateral extrascapulars that almost meet mesially. The significance of the large spiracles, also seen in the late Devonian *Gogonasus andrewsae*, hinges on the fact that the new genus is older than *Gogonasus*, well before the period of anoxia in the Devonian reef previously thought to be a possible explanation for these structures being developed for accessory air-breathing. The new find suggests that large spiracles appear at different times and at widely differing nodes in the stem tetrapod radiation so were most likely a convergent feature that did not become phylogenetically significant until established as a robust character in the more derived elpistostegalians, and later transformed in early tetrapods into the tympanum.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

MULTIPLE INTERCONTINENTAL DISPERSALS OF THE RHIZOMYINAE (SPALACIDAE, RODENTIA)

LÓPEZ-ANTOÑANZAS, Raquel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; FLYNN, Lawrence J., Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, MA, United States; KNOLL, Fabien, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

The Subfamily Rhizomyinae is known from the late Oligocene to the present. Today, this group comprises only six species, which live in southern Asia and eastern Africa: *Rhizomys sinensis*, *R. pruinosus*, *R. sumatrensis*, *Cannomys badius*, *Tachyoryctes splendens,* and *T. macrocephalus*. However, the rhizomyines were more diverse and had a much wider distribution in Asia and Africa in the past. Thus far, 33 fossil species can be referred to this group: *Rhizomys* (*Brachyrhizomys*) *shansius*, *R.* (*Brachyrhizomys*) *shajius*, *Miorhizomys nagrii*, *M. micrus*, *M. blacki*, *M. pilgrimi*, *M. harii*, *M. tetracharax*, *M. choristos*, *Protachyoryctes tatroti*, *P. makooka*, *T. pliocaenicus*, *T. konjiti*, *Rhizomyides sivalensis*, *R. punjabiensis*, *R. carbonnelli*, *R. platytomeus*, *Kanisamys indicus*, *K. nagrii*, *K. sivalensis*, *K. potwarensis*, *Eicooryctes kaulialensis*, *Anepsirhizomys opdykei*, *A. pinjoricus*, *Pronakalimys andrewsi*, *Nakalimys lavocati*, *Prokanisamys kowalskii*, *P. arifi*, *P. benjavuni*, *P. major,* and *P.* sp. from Libya. A cladistic analysis involving fossil and living species has been carried out. The most basal representative of the subfamily Rhizomyinae belongs to *Prokanisamys* and the crown-group is formed of two clades: Tachyoryctini and Rhizomyini. This analysis provides information about the origin of the African rhizomyines and allows inference of multiple dispersal phenomena from their Asian center of radiation to Africa at different times during the Miocene. Thus, a first geodispersal of *Prokanisamys* from Pakistan to East Africa would have taken place at the beginning of the early Miocene. From this first event *Prokanisamys* sp. from Jebel Zelten would have originated. The second and third geodispersal events took place probably not earlier than 18 Ma and would have given rise to the middle Miocene *Pronakalimys* and to the late Miocene *Nakalimys*. With respect to the late Miocene *Protachyoryctes makooka* and the African Tachyoryctini, two unidirectional dispersal events from southern Asia to Africa took place in the late Miocene (not earlier that 8.2 Ma). The first involved the origin of *Protachyoryctes makooka*, whereas the derivation of the African Tachyoryctini (*Tachyoryctes* spp.) would have come from an independent entry into this continent.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PATTERNS OF ENCEPHALIZATION IN THE EARLY EVOLUTION OF PRIMATES

LOPEZ-TORRES, Sergi, University of Toronto, Toronto, ON, Canada; SILCOX, Mary T., University of Toronto, Scarborough, Toronto, ON, Canada; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

Ancestral state reconstruction techniques are widely used to estimate character states for traits such as brain size in basal nodes of phylogenetic analyses. Previous attempts to infer ancestral brain size for the basal euprimate did not include data from stem primates ("Plesiadapiformes") or their closest relatives. This study performs ancestral state reconstructions of absolute and relative brain size (encephalization quotient; EQ) on key nodes related to Primates, including Euarchonta, Primates *sensu lato* (including "Plesiadapiformes"), Euprimateformes (Plesiadapoidea + Euprimates), Euprimates, Strepsirrhini, and Halporhini. Two ancestral state reconstruction methods were used: Bayesian Markov Chain Monte Carlo, using a random walk model, and square-change parsimony. We examined data for brain size and EQ values for 37 species of extant primates to estimate the state for the ancestral euprimate. In order to see the effect of adding outgroups, we first incorporated five species of living euarchontoglirans (Dermoptera, Scandentia, and Rodentia), permitting the state reconstruction for the ancestral euarchontan. Subsequently, data on 15 species of fossil euprimates were included to see how fossil data impacted the state reconstruction obtained. Finally, brain size and EQ data for three plesiadapiform species (*Plesiadapis cookei*, *Ignacius graybullianus*, *Microsyops annectens*) were included, as well as for the apatemyid *Labidolemur kayi* (the most basal euarchontogliran known from endocranial data). The estimate for the ancestral stem primate from the parsimony analysis with all taxa included yields a value of 3.8 cc for brain size, and an EQ between 0.44 and 0.62, depending on the equation used. In contrast, the basal euprimate had a brain size of 6.3 cc and an EQ between 0.77 and 1.08. Results from the Bayesian analysis matched this pattern. This suggests a significant brain size increase at the euprimate node, consistent with hypotheses that link cerebral expansion to improvements in visual processing. Including fossils and relevant outgroups proved critical to refining ancestral state reconstructions.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A DIVERSE WOMBAT FAUNA FROM THE PLIOCENE CHINCHILLA SAND FORMATION, SOUTHEASTERN QUEENSLAND, AUSTRALIA

LOUYS, Julien, The University of Queensland, Brisbane, Australia

The Chinchilla Sand Formation is a Pliocene fluvial system of interbedded clays, sands and conglomerates representing several episodes of deposition. It is one of Australia's few vertebrate Pliocene sites, and one of the richest with 14 new species described and a total of 57 species represented at the site. Despite well over 100 years of research on the Chinchilla Local Fauna, the wombats have never before been systematically described, and the taxonomic identity of the Vombatidae preserved in the deposit remains unknown. Here, I describe the wombat material from Chinchilla. At least four species of wombat can be identified in the deposit, making this Australia's richest wombat assemblage. Identified species include *Vombatus ursinus, Phascolonus gigas, Ramsayia lemleyi* and *"Phascolomys" medius*. Most of the identifiable material is represented by mandibular fragments, although some identifiable cranial fragments are also preserved. Isolated teeth are relatively common, however they can only be assigned to Vombatidae gen. et sp. indet. The most abundant wombats recovered are of the large-bodied forms such as *Phascolonus, "Phascolomys"* and *Ramsayia*, with *Vombatus*-sized elements relatively less common. Both adult and juvenile wombats are preserved. The incredible richness of Chinchilla's wombat fauna suggests a considerable grassland component to southeast Queensland's Pliocene palaeoenvironments, and supports a mid to late Pliocene age for this site.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW ALVAREZSAURID (DINOSAURIA, THEROPODA) FROM UPPERMOST CRETACEOUS OF LUANCHUAN, HENAN PROVINCE OF CHINA

LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; XU, Li, Henan Geological Museum, Zhengzhou, China; ZHANG, Xingliao, Henan Geological Museum, Zhengzhou, China; PU, Hanyong, Henan Geological Museum, Zhengzhou, China; CHANG, Huali, Henan Geological Museum, Zhengzhou, China

Alvarezsauridae, is a highly specialized group represented in the Cretaceous by small, long-legged running dinosaurs once regarded to be a group of flightless birds and now known to represent one of the maniraptoran lineages. First described in the 1990s', they include *Mononykus* and *Shuvuuia*, from the Late Cretaceous of Mongolia. Currently they are also known from the early Late Jurassic and Late Cretaceous of China, and the Early and Late Cretaceous of North and South America.

Herein reported is a new alvarezsaurid dinosaur discovered from the uppermost Cretaceous deposits of the Qiupa Formation, Tantou Basin, Henan Province of central China. The Qiupa Formation (late Maastrichtian) is dominated by brownish red thick-bedded siltstone, calcareous mudstone, interbedded with thin fine conglomerates, and parallel and cross laminations which indicate shallow lacustrine and braided river delta facies. The new taxon is assigned to Parvicursorinae based upon: supracetabular crest on ilium extending only over the cranial half of the acetabulum; and proximal end of metatarsal III reduced, not reaching the tarsals. It represents the youngest alvarezsaurid dinosaur from China.

A preliminary phylogenetic analysis was performed using 77 characters and 15 taxa (including two taxa: Tyrannosauridae and Dromaeosauridae as outgroups and 13 taxa as ingroups). The analysis produced two most parsimonious trees of length 109 steps (consistency index of 0.78, rescaled consistency index of 0.67, and a retention index of 0.67). The strict consensus of the two most parsimonious trees shows that the new alvarezsaurid dinosaur is basal to the Mongolian parvicursorines (*Mononykus* plus *Shuvuuia*). It shares one character with Mongolian parvicursorines: metatarsals II and IV subequal in length. The apomorphies of the new taxon are: cervical centra with flat sides, dorsal vertebrae amphiplatyan and proximal end of grooves on manual ungual I partially enclosed by notches.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FOSSIL CAMELS FROM THE LATE OLIGOCENE EASTLAKE LOCAL FAUNA, OTAY FORMATION, SAN DIEGO COUNTY, CALIFORNIA

LUBAR, Candace A., Occidental College, Los Angeles, CA, United States; PROTHERO, Donald R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States

Fossil camel skulls and jaws recovered from the upper Oligocene Otay Formation (Eastlake local fauna) in southern San Diego County has never been fully described or identified. Re-examination of this material and comparison with previously described camels shows that the San Diego camel is referable to *Miotylopus leonardi*, the smallest of three species of the primitive stenomyline camel *Miotylopus* previously known only from the early to middle Arikareean deposits (Gering-Monroe Creek equivalents) from eastern Wyoming. Both the small and medium-sized morphs from Wyoming include clear examples of male and female jaws with their distinctive canines, ruling out a size difference due to sexual dimorphism. The larger camel *Dyseotylopus migrans* from the upper Oligocene Sespe Formation in Ventura County is a junior synonym of the medium-sized stenomyline *Miotylopus gibbi*

from the same Arikareean beds in Wyoming. These identifications extend the geographic range of these previously rare and badly misunderstood camels from a limited area of eastern Wyoming to the Pacific Coast.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW SPECIES OF THE ENIGMATIC ARCHOSAUROMORPH DOSWELLIA FROM THE UPPER TRIASSIC BLUEWATER CREEK FORMATION, NEW MEXICO, USA

LUCAS, Spencer G., New Mexico Museum of Natural History, Albuquerque, NM, United States; HECKERT, Andrew B., Dept. Geology, Appalachian State University, Boone, NC, United States; SPIELMANN, Justin A., New Mexico Museum of Natural History, Albuquerque, NM, United States

The occurrences of doswelliid archosauromorphs from the Upper Triassic Chinle Group of the American Southwest are based on incomplete material, principally osteoderms. Here, we document a new species of the doswelliid archosauromorph genus *Doswellia* based on an incomplete, but associated, skeleton from NMMNH (New Mexico Museum of Natural History and Science) locality 5700 in the Upper Triassic Bluewater Creek Formation of the Chinle Group in west-central New Mexico, U.S.A. The new specimen, NMMNH P-61909, differs from *D. kaltenbachi* Weems, the type and only other known species of *Doswellia*, in its larger size, higher tooth count and greater heterodonty, possession of keels on the cervical centra, and the presence of discrete knobs or spikes on some osteoderms. Our reconstruction thus shows a more complex snout shape, with terminal nares, but also multiple lateral bulges reminiscent of phytosaurs, albeit with greater heterodonty in that the teeth in the bulges are much larger than those between them. Other preserved elements, such as the quadrate and surangular, are extremely similar to the type of *D. kaltenbachi*, so we do not consider the Sixmile Canyon material a distinct genus. The cervical centra are particularly distinctive, being strongly laterally compressed such that they are nearly x-shaped in cross-section with prominent ventral keels. Most of the osteoderms are indistinguishable from those of *D. kaltenbachi*, but some posses a distinct spike projecting from the dorsal surface.

This is the fourth occurrence of *Doswellia* and only the second occurrence of a *Doswellia* skull. The Sixmile Canyon material includes portions of both the premaxilla and maxilla (which were previously unknown) and therefore the best upper dentition, and also has the best-preserved cervical vertebrae. Although it adds to our knowledge of the anatomy of *Doswellia*, this new information does not alter previous concepts of the phylogenetic relationships of the doswelliid genera, largely because they are so poorly known anatomically. The genus *Doswellia* is known from the Newark Supergroup in Virginia, and the Chinle Group in Texas, New Mexico and Utah, in strata of Otischalkian-Adamanian age. Because of the strong similarity of most osteoderms of both the new taxon and *D. kaltenbachi*, records of *Doswellia* based on osteoderms can only be referred to *Doswellia* sp., although they are distinct from the other named doswelliids *Archeopelta* and *Tarjadia*. NMMNH locality 5700 is approximately 43 m stratigraphically below a bed from which U-Pb dating of detrital zircons by multiple techniques yields a maximum depositional age of ~220 Ma, so this is a reasonable approximate upper limit for the numerical age of NMMNH P-61909.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW CENTROSAURINE CERATOPSID MATERIAL FROM THE MIDDLE CAMPANIAN WAHWEAP FORMATION OF SOUTHERN UTAH

LUND, Eric K., Department of Biomedical Sciences, Ohio University Heritage College of Osteopathic Medicine, Athens, OH, United States; O'CONNOR, Patrick M., Department of Biomedical Sciences, Ohio University Heritage College of Osteopathic Medicine, Athens, OH, United States; LOEWEN, Mark A., Department of Geology and Geophysics, University of Utah, and Natural History Museum of Utah, Salt Lake City, UT, United States; JINNAH, Zubair A., School of Geosciences, University of the Witwatersrand Johannesburg, Johannesburg, South Africa

The Upper Cretaceous (middle–late Campanian) Wahweap Formation of southern Utah contains the oldest diagnostic evidence of ceratopsids (all centrosaurines) in North America, with a number of specimens recovered from throughout a unit that spans between 81 and 77 Ma. To date only a single specimen has been named, *Diabloceratops eatoni,* from the middle member of the formation. The phylogenetic affinities of other Wahweap Formation ceratopsids remain ambiguous, due in part to the recovery of incomplete specimens. The new centrosaurine material (Utah Museum of Natural History VP 20550) reported herein derives from the upper member of the Wahweap Formation and lends insight into ceratopsian diversity in the formation. UMNH VP 20550 represents a single individual recovered from a calcareous mudstone and consists of: two curved and elongate orbital horncores, a left jugal, a nearly complete, slightly deformed braincase, the left squamosal, and a parietal ornamented by caudally projected, rostrally curved, elongate spikes on either side of a midline embayment. The fan-shaped, stepped squamosal is diagnostic of Centrosaurinae and differs from the rectangular parietal in *Diabloceratops*. UMNH VP 20550 also differs in the possession of rostrally (rather than laterally) curved epiparietal ornamentation and a caudomedially oriented tab-like flange along the entire length of the epiparietal ornamentation. UMNH VP 20550 shares a triangular (rather than round) frill and spike-like epiparietal loci (p1) ornamentation with the stratigraphically distinct *Diabloceratops* from the lower middle unit. Taken together, these features suggest the presence of either (1) variation in morphology within *Diabloceratops* and an extended temporal range of the taxon or (2) a distinct centrosaurine ceratopsid in the upper member of the Wahweap Formation In either case UMNH VP 20550 contributes to the known diagnostic centrosaurine record of the late Campanian of Laramidia.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

NEW INSIGHT INTO THE LOCOMOTOR BEHAVIOR OF THE GIANT SHORT-FACED BEAR, *ARCTODUS SIMUS*, REVEALED BY 3D LANDMARK MORPHOMETRIC ANALYSIS OF THE FORELIMB

LYNCH, Eric R., East Tennessee State University, Johnson City, TN, United States; SCHUBERT, Blaine W., East Tennessee State University, Johnson City, TN, United States

Researchers have long been aware of the characteristic skeletal morphology displayed by the Pleistocene giant short-faced bear, *Arctodus simus* (Ursidae, Tremarctinae), but none have confidently interpreted the functional implications of those features that set it apart from the rest of the Ursidae. One hypothesis is that *A. simus* filled a similar niche to the extant African lion, *Panthera leo*, using its shortened rostrum for a more powerful bite and its relatively long legs for more cursorial locomotion, but more recent studies have proposed alternative interpretations. *A. simus* is reconstructed as a high-speed predator, long-distance scavenger, specialist herbivore, or generalist omnivore depending on the researcher asked. Most comparative studies aimed at recreating the paleobiology of this species have focused on craniodental features or basic postcranial indices, and none have studied the finer details of shape between elements and muscle attachment sites within the appendicular skeleton of *A. simus* and extant ursids. Given that the forelimb of quadrupedal mammals is a compromise between feeding ecology and locomotion, it follows that a detailed analysis of the major bones of the forelimb will shed light on the elusive behavior of the giant short-faced bear. Such an endeavor was here pursued using traditional and three-dimensional landmark morphometrics and represents one of the first 3D landmark analyses of whole postcranial elements. Previous observations of the scapula, humerus, radius, ulna, scapholunar, magnum, and third metacarpal are confirmed, and while overall gross morphology and proportions are quite bear-like, a trend of reduced abductor-adductor/supinator-pronator musculature, more restricted parasagittal joint motion, increased stride length, and lighter, more packed distal elements is suggested. These trends agree with the hypothesis that *A. simus* represents a bear in the early stages of cursorial evolution and was likely capable of efficient, high-speed, straight-line, long-distance locomotion.

Romer Prize Session (Thursday, October 18, 10:45 am)

EVOLUTIONARY DEVELOPMENTAL MODEL FOR THE ORIGIN OF THE TURTLE SHELL AND A NOVEL FUNCTIONAL HYPOTHESIS FOR THE ORIGIN OF THE CHELONIAN LUNG VENTILATION MECHANISM

LYSON, Tyler R., Yale University, New Haven, CT, United States

The origin of the turtle shell and the constraints it places on how turtles breathe are interdependent problems that have fascinated scientists for the past three centuries. The discovery of the stem turtle *Odontochelys semitestacea* supports the developmental *de novo* hypothesis, because it confirms that the costals and neurals are produced through the outgrowth of (sub)dermal bone from the perichondral collar of the dorsal ribs and vertebrae. This discovery allows for the integration of developmental and fossil data into an evolutionary developmental (evo-devo) model for the shell's origin that makes explicit predictions for the contentious early history of the turtle stem. I expand this model by integrating novel anatomical and histological data for *Eunotosaurus africanus*, a species recovered as a stem turtle in both global phylogenetic analyses of amniotes and parareptiles. I consider the phylogenetic signal within a dataset based on shell-related characters and shelled taxa currently considered as potential relatives of turtles. This analysis tests the hypotheses that the *de novo* shell appeared once in amniote history and that *E. africanus* is a stem turtle.

Results support the hypotheses that the *de novo* shell appeared only once in vertebrate evolution and that *E. africanus* is a stem turtle. The successive divergences of *E. africanus* (broadened ribs; dermal outgrowth of bone from the ribs; re-organization of locomotion/respiratory muscles), *O. semitestacea* (broadened ribs/neurals), and finally *Proganochelys quenstedti* (fully ossified carapace) results in a sequence of character acquisitions that is fully congruent with predictions drawn from the evo-devo model.

The evo-devo model further provides a transitional and mechanistic hypothesis for the origin of the unique abdominal muscle lung ventilation system in turtles. As the ribs broaden along the turtle stem, they increasingly support the abdomen, while simultaneously becoming less effective lung ventilators due to mechanical conflict created between adjacent overlapping ribs. As the ribs broaden, the dual functioning abdominal muscles are slowly freed from their role of providing additional support to the abdominal cavity against torsion and are delegated into a purely respiratory function. There was a shift from the dual functions found in both the ribs and abdominal muscles of early amniotes, to a division of function in turtles with the ribs taking on a purely support role and the abdominal muscles functioning to only ventilate the lungs.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

RECONSTRUCTION OF INACCESIBLE ANATOMY FROM AN EARLY PERMIAN LANTHANOSUCHOID (AMNIOTA: PARAREPTILIA), AND A NEW PHYLOGENTIC ANALYSIS OF THE PARAREPTILIA

MACDOUGALL, Mark J., University of Toronto Mississauga, Mississauga, ON, Canada; REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada

One of the newest parareptiles to be described from the Richards Spur locality of Oklahoma consists of an exquisitely preserved small, triangular skull (total skull length ca. 25mm) with both rami of the mandible in perfect articulation. Some important areas of the holotype and only known specimen are inaccessible to detailed anatomical study, and cannot be observed through direct visual examination. These areas include the tooth bearing surfaces of the dentaries, portions of the palate that are covered by supportive matrix and other elements, and parts of the braincase that are covered by the skull roof. The skull has been scanned using computed tomography (CT) because these regions of the skull are critical for detailed phylogenetic analyses of parareptile interrelationships. The resulting data have been used in conjunction with imaging software to produce three-dimensional models of the obscured elements of the skull. Reconstruction of the dentaries reveals that the dentition of the mandibles is very similar to that of the maxillae, with the presence of recurved, unicuspid teeth. Each dentary also exhibits the presence of two large caniniform teeth, much larger than the other marginal teeth of the dentaries. Reconstruction of the palate allows for the lateral portions of the palatal surface, obscured in this specimen by supportive matrix and the mandibular rami, to be seen in their entirety. A previous phylogenetic analysis including this new taxon revealed that it was a member of the parareptilian clade Lanthanosuchoidea. A new analysis incorporating the anatomical data revealed by this study, together with the addition of other recently recovered Richards Spur parareptiles further solidified the position of the new taxon as a lanthanosuchoid and revealed that the newly added parareptiles were also members of the Lanthanosuchoidea.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 10:30 am)

THE NEW WORLD TROPICS AS A CRADLE OF BIODIVERSITY DURING THE EARLY MIOCENE: CALIBRATION OF THE CENTENARIO FAUNA FROM PANAMA

MACFADDEN, Bruce J., University of Florida, Gainesville, FL, United States; FOSTER, David A., University of Florida, Gainesville, FL, United States; RINCON, Aldo F., University of Florida, Gainesville, FL, United States; MORGAN, Gary S., New Mexico Museum of Natural History, Albuquerque, NM, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Panama City, Panama

New excavations along the Panama Canal have yielded a growing Miocene vertebrate assemblage referred to as the Centenario Fauna. Despite its proximity to South America, the mammals of the Centenario Fauna have entirely North American affinities. The Centenario Fauna, which is distributed throughout a ~115 m stratigraphic interval encompassing the uppermost Culebra and Cucaracha formations, mixes taxa diagnostic, or characteristic, of three successive North American Land Mammal Ages (NALMAs) as these are defined from temperate North America, i.e., the Arikareean, Hemingfordian, and Barstovian. This sympatry can neither be explained by superpositional biostratigraphy (because taxa of different NALMAs exist at the same horizons), nor by reworking (REE analyses refute this explanation), and thus we assert that these associations are biologically meaningful. Previously published age determinations using Sr-ratio and U-Pb methods constrain the age of the lower limit of the Centenario Fauna to no younger than ~19 Ma, but the upper limit has remained problematical. A fresh exposure of the Cucaracha tuff, which is demonstrably interbedded within the principal reference section measured at Centenario Bridge, has yielded two new radioisotopic ages: (1) a Ar/Ar weighted plateau age of 18.94 +/- 0.83 Ma; and (2) a U-Pb zircon age of 18.81 +/- 0.30 Ma. In addition, paleomagnetic data indicate essentially a reversed polarity (chron C5Er) at the Centenario Bridge section that correlates to chron C5Er (18.78 to 19.05 Ma). Given these geochronological and paleomagnetic constraints, the age of Centenario Fauna from the Bridge section occurs within the 0.27 myr interval of chron C5Er. This essentially correlates to the late Arikareean NALMA (Ar4) interval during the early Miocene. These results have significant ramifications for biogeographic heterochrony of Barstovian, and possibly Hemingfordian, mammals. The ancient New World tropics during the early Miocene apparently supported a cradle of biodiversity from which numerous taxa subsequently dispersed northward, accounting for their better-known distributions in temperate North America.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE GEOLOGY AND PALEONTOLOGY OF COGLAN BUTTES, OREGON: THE FIRST DISCOVERED ARIKAREEAN VERTEBRATE FOSSIL LOCALITY IN THE NORTHWESTERN GREAT BASIN

MACKENZIE, Kristen A., University of Oregon, Eugene, OR, United States; WHISTLER, David P., John Day Fossil Beds National Monument, Bend, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States

The John Day fauna of North-central Oregon is famous for its diverse assemblage of Late Oligocene and Early Miocene terrestrial mammals; however, few sites of similar age are known from the Northwest. The sedimentary beds found in the vicinity of Coglan Buttes, Oregon, contain a little-known vertebrate megafauna and microfauna. While a few publications refer to the existence of the fauna, it has in the past been regarded as likely Hemingfordian in age. Our more extensive collection reveals that this is the first Arikareean site to be found in the Northwestern Great Basin, though parts of the fauna seem also to represent the Hemingfordian. The closest localities that are age-correlative with the Arikareean part of the fauna are almost 200 miles away to the north in the Crooked River Basin, Oregon. The fauna initially collected shares some similarities with the Upper John Day Formation, Oregon, and the Wounded Knee Fauna of South Dakota. The stratigraphy at Coglan Buttes consists of multiple layers of highly tuffaceous paleosols with little discernable bedding inter-bedded with tuff breccias, welded tuffs, airfall volcanic tephras and volcanic flows (andesites, dacites and basalts). Hence, the rocks may be of similar age to the John Day Formation, but are lithologically quite different. To date, cranial and postcranial material from at least 15 mammalian taxa, and some unidentified plant material, have been recovered from the fossiliferous horizons. Most abundant in the fauna are a diversity of camels, most likely miolabines and larger, ?aepycameline forms with elongate, partially fused metapodials. Oreodonts are the next most abundant, represented by both cranial and postcranial material. Hypertragulid is also well represented. The microfauna, screened both from anthills and in situ sediment, includes teeth of aplodontids (Allomys and a meniscomyine), cricetids (Leidymys), geomyids, heteromyids, mylagaulids, lagomorphs, and hypertragulids. Additional specimens of tapirs and rhinoceros and equid material tentatively assigned to Archaeohippus have also been found. Fragmentary specimens add three size classes of canids, a felid, a chalicothere, and some possible paleomerycids to the fauna. Many of the best-preserved taxa are represented by partial skeletons. While our work is at an early stage, we are already finding some important differences (e.g. the dominance of camels) from the John Day region at the same time. Understanding the Coglan Buttes fauna will contribute to our overall picture of the early Miocene landscape of the West by filling an important gap in the terrestrial fossil record.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:30)

WHEN AND HOW DID LAND VERTEBRATES REACH THE GREATER ANTILLES?

MACPHEE, Ross D., American Museum of Natural History, New York, NY, United States; ITURRALDE-VINENT, Manuel A., Museo Nacional de Historia Natural, Habana, Cuba

When and how (and how often) land vertebrates reached the Greater Antilles has been a contentious question in historical biogeography since the early 20th century. Although a number of new discoveries have been made in recent years, the axes of interpretation—and disagreement—remain the same: Can most propagule introductions be explained by sweepstakes-style, over-water transport? Some? None? How do you know? Do fossils provide a good time-stamp for dating dispersals? Fair? Irrelevant? How do you know? Is there good evidence for ancient continent-island connections that may have provided dry-land routes for immigrating species? Marginal evidence? No evidence? How do you know? In recent years, debate has taken a new turn with the appearance of molecular clock models for computing age-of-divergence (AOD) estimates for a number of Antillean taxa whose closest relatives live (or lived) in circumjacent continental areas. However, different models using different genes give different results; at present, AOD estimates for various groups with Antillean representation (e.g., solenodontid insectivores, platyrrhine primates, various bat families, *Peltophryne* frogs) form a crazy-quilt of possibilities, with no particular time for latest Mesozoic/Cenozoic immigration events being apparently more likely than any other. This seems improbable. At least for Cenozoic invasions, one alternative is the GAARlandia hypothesis, which utilizes tectonic, stratigraphic, and regional uplift history to posit that northernmost South America and the Greater Antilles Arc were briefly connected by the once-subaerial Aves Rise, ca. 35-33 Ma. This notion provides a single event horizon for AODs affecting certain groups, such as most Antillean mammal groups, and should be eminently falsifiable; however, adequate testing procedures for this hypothesis have proven elusive. We require (1) much more fossil evidence from the islands themselves to better establish arrival times and (2) appropriate ocean-floor drilling data from the spine of the Rise to better date its emergence. Nonetheless, new evidence for late Paleogene drawdown events in the Caribbean Basin indicate that the Eocene/Oligocene transition is still the likeliest single period for many land vertebrate invasions, whether they occurred by land or by sea. Interpolation of such events into Bayesian frameworks of analysis might lend some realism to clock computations and yield a closer concordance between geological, paleontological and molecular sources of information.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:30)

THE MIOCENE OF EQUATORIAL SOUTH AMERICA AND THE BIOTIC CONSEQUENCES OF ANDEAN UPLIFT

MADDEN, Richard H., University of Chicago, Chicago, IL, United States; DUNN, Regan E., University of Washington, Seattle, WA, United States; STRÖMBERG, Caroline A., University of Washington, Seattle, WA, United States; KOHN, Matthew J., Boise State University, Boise, ID, United States

At equatorial latitudes, both Andean and Amazonian sequences of Miocene fauna and flora are now known and intrinsically interesting for examining the role of tectonism and uplift on the evolutionary history of tropical biota. The well-dated Laventan Land-Mammal Age fauna from the Honda Group in the Magdalena valley of Colombia has correlatives that include the Fitzcarrald fauna from the Pebas or Ipururu Formation along the Inuya, Mapuya and Urubamba rivers in southeastern Peru, along the Napo River in northeastern Peru, and the Solimoes Formation at Talisma on the Purus River in Brazil. Distinctive

vertebrate taxa from the type Laventan are widespread across northern equatorial South America, Amazonia and along the Andes from Ecuador and Bolivia to as far south as Chubut Province in Patagonia. Older and younger faunas are known from both the Miocene lowland and highlands of equatorial South America. The faunal sequence in southern Ecuador includes the Biblian, Burrohuaycu, Mangan and Letrero formations spanning the interval from the early Miocene to 11.2 megannums. Argon/Argon age and faunal content reveals pre-Laventan, Laventan, and younger levels. Associated crocodilians, turtles, and leaf morphology indicate a temporal progression from lowland humid tropical to submontane and montane habitats between sea-level and 2000 (+/- 500) meters elevation. Rank correlation and multivariate partial constrained ordinations of modern faunas along altitude gradients in the tropics indicate that altitude influences faunal composition through temperature and moisture (dry season) effects by increasing proportions of grazers ($p<0.01$), fossorial ($p<0.05$), and terrestrial ($p<0.001$) mammals. Applying these results to the paleofaunas of southern Ecuador, pre- and post-uplift faunas have fossorial taxa indicating annual rainfall <2000 millimeters (consistent with results from leaf morphology), and higher crowned rodents and toxodontids appear in the post-uplift fauna. Shared mammal taxa suggest orographic continuity extended southward at least to Bolivia. The post-uplift mammal assemblage differs in characteristics of ecological morphology that suggest dryer, more open or mosaic habitat. By analogy with modern vegetation, such environments at the equator would require an orographic rainshadow. However, leaf morphology shows no significant change in valley bottom vegetation during the interval of uplift. Neither canopy continuity nor upland vegetation are yet sampled, although a pilot study confirms the presence of well-preserved phytoliths in the San Cayetano and Letrero formations (pre- and post-uplift). Forest indicator phytoliths (palms and bamboo) dominate the assemblages and indicate mostly closed habitats.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

USING PALEOSOLS TO IDENTIFY NICHE PARTITIONING IN MIOCENE EQUIDS OF CENTRAL OREGON

MAGUIRE, Kaitlin C., UC Berkeley, Berkeley, CA, United States

In Miocene deposits throughout North America, several genera of equids are frequently found co-occurring. Here I test whether these co-occurrences are consistent with niche partitioning as detected through environmental proxy data. Although equid niches traditionally are inferred based on morphology, the sedimentary record, especially that of paleosols, provides an independent second line of evidence to characterize the niche occupied by a given taxon. I used information from paleosols to characterize niche-space of equids at the level of genus, focusing on Barstovian deposits that commonly contain equid fossils in Central and Eastern Oregon. There the three dominant genera are *Archaeohippus, Desmatippus,* and *Merychippus*. The genera differ dramatically in tooth morphology and size and on that basis it has been suggested that they occupy different dietary niches and environments. I tested this hypothesis by using the paleosol record to reconstruct precipitation values for the environment with which each genus is associated. Paleosol samples were taken from Bw and Bt horizons in which specimens of each genus were found: these span the Barstovian deposits of the study area both spatially and temporally. The bulk geochemistry was analyzed using X-ray fluorescence (XRF). Paleoprecipitation was calculated using a published relationship between the chemical index of alteration without potassium (CIA-K). Preliminary results indicate the early Barstovian was wetter than the Arikareean, Hemingfordian and Clarendonian in concordance with the mid-Miocene climatic optimum. *Archaeohippus* specimens are associated with deposits that have the highest calculated precipitation values, consistent with its low crowned molars that suggest it was most likely a browser in densely vegetated areas. *Merychippus* specimens, in contrast, are associated with the lowest precipitation values, consistent with their high-crowned molars that suggest a full grazing diet in grasslands. Precipitation results are less clear for *Desmatippus,* which is inferred to have had a diet consisting of more grassy vegetation than *Archaeohippus* based on its more complex and hypsodont tooth morphology. These results are the first to provide paleoprecipitation data for Barstovian deposits in Oregon, and demonstrate how the sedimentary record can be utilized as a second line of evidence in reconstructing ecological niches.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:15 am)

WILDFIRE PALEOECOLOGY FROM THE CRETACEOUS COAST OF SOUTHWEST APPACLACHIA AT THE ARLINGTON ARCHOSAUR SITE, TEXAS

MAIN, Derek J., University of Texas, Arlington, TX, United States; NOTO, Christopher R., University of Wisconsin-Parkside, Kenosha, WI, United States; SCOTESE, Christopher R., University of Texas, Arlington, TX, United States; WEISHAMPEL, David W., Johns Hopkins University School of Medicine, Baltimore, MD, United States

The Arlington Archosaur Site (AAS) is a diverse fossil locality from the Cretaceous (Cenomanian; 95 Mya) Woodbine Formation that occurs within the Dallas–Ft. Worth Metroplex of North Texas. The paleogeographic setting is a coastal plain that stretched across a peninsula along the southern interior sea of southwest Appalachia. The climate in this part of Appalachia during the Cenomanian was moist, with a distinct dry season. The beginning of the wet season may have begun with intense tropical storms that sparked wildfires via lightning strikes. The AAS offers a unique chance to study southern Appalachian paleoecology and the effect of seasonal disturbance on an ancient coastal ecosystem.

The AAS fossil exposures occur within a 2 m section of peat and paleosol. The peat is fossil rich and contains numerous, well preserved vertebrates including fish, amphibian, mammal, turtle, crocodyliform and dinosaur (theropod and ornithopod), as well as the remains of numerous trees. The crocodyliform recovered from this bed consists of remains from an interesting new taxon. Overlying the peat, is a paleosol sequence containing dinosaur, crocodyliform, and lungfish. The dinosaur material recovered to date consists of remains from a new taxon of basal hadrosauroid. The paleosol contains two distinct horizons. The upper is mottled and well-rooted with numerous calcareous concretions, within which are preserved charcoal, from individual fragments to large stumps and root systems. The lower horizon is a gray mudstone lacking root traces and preserving the majority of the fossils. Concretions formed during the dry season, where the water table dropped to the level of the lower horizon, which remained waterlogged year round.

Alternating seasons brought the threat of wildfires, as shown through abundant charcoal found throughout the site. Charcoal conglomerate beds and numerous fragments are visible throughout the outcrop, occurring below, within, and above the vertebrate fossil horizons. The presence of charcoal conglomerates is typical of coastal, deltaic systems where burned materials were transported by river channels. We suggest that periodic wildfires were influential in driving the high diversity preserved at the AAS and provide a unique opportunity to study the Intermediate Disturbance Hypothesis (IDH) in a coastal Cretaceous ecosystem. The IDH states that diversity is highest in environments experiencing moderate levels of disturbance, such as those experiencing seasonal storms. Wildfires are not geographically random, but occur within specific paleoclimatic zones that are predisposed to fires. Continued study of wildfires may elucidate links between paleoclimate and biodiversity in coastal Cretaceous ecosystems.

Technical Session XV (Saturday, October 20, 11:15 am)

EVOLUTIONARY TRENDS IN THE SHAPE OF THE SQUAMOSAL IN CERATOPSID DINOSAURS

MAIORINO, Leonardo, Roma Tre University, Rome, Italy; FARKE, Andrew A., Raymond M. Alf Museum, Claremont, CA, United States; PIRAS, Paolo, Roma Tre University, Rome, Italy; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; TERRIS, Kevin, Montana State University, Bozeman, MT, United States

The well documented Late Cretaceous Ceratopsidae had one of the highest rates of dinosaur speciation, as documented by the rapid variation in their diagnostic cranial ornamentation, including that on the nasal, postorbital, and parietosquamosal frill. To investigate shape change across the two main ceratopsid clades, Chasmosaurinae and Centrosaurinae, we applied geometric morphometrics (GM) using a 22 landmark configuration for 74 squamosals, including juveniles, subadults, and adults (juveniles only in centrosaurines sample), of 25 ceratopsid species (11 Centrosaurines and 14 Chasmosaurines). Principal Component Analysis indicates that centrosaurines have a uniform squamosal shape, with the exceptions of the basal centrosaurs *Diabloceratops eatoni* and *Avaceratops lammersi*, and the more derived *Spinops sternbergorum*. A Mantel test between a phylogenetic covariance matrix and a Procrustes distance matrix demonstrates that disparity in the ceratopsid squamosals is highly constrained by phylogeny. An evolutionarily significant allometric signal exists between the two clades (Chasmosaurinae and Centrosaurinae), but not within clades. Even when accounting for phylogeny (Phylogenetic Generalized Least Squares), the relationship between squamosal shape and size is significant. Phenotypic evolutionary rate analysis revealed a significant phenotypic shift in shape at the node for *Diabloceratops* and a significant size shift at the node for *Chasmosaurus*. Mapping shape data on to ceratopsid phylogeny, we estimated ancestral shapes at nodes using squared change parsimony. From root to tips, centrosaurine squamosals were found to be conservative, but exhibit a slight dorsoventral expansion and a narrow angle between the infratemporal process and the caudoventral margin in more derived taxa. Chasmosaurines, compared to centrosaurines, show a derived morphology with a trend towards being strongly expanded dorsoventrally and a narrower angle between the infratemporal process and the caudoventral margin. In this study GM allowed us to analyze quantitatively squamosal shape across different ceratopsid clades and to reveal previously unquantified phenotypic shifts and different shape patterns between clades through time.

Technical Session XV (Saturday, October 20, 11:30 am)

CERATOPSIANS DIDN'T JUST GET BIGGER: EVIDENCE FOR DWARFISM IN *PSITTACOSAURUS*

MAKOVICKY, Peter J., Field Museum of Natural History, Chicago, IL, United States; ERICKSON, Gregory M., Florida State University, Tallahassee, FL, United States; GAO, Ke-Qin, Peking University, Beijing, China; ZHOU, Cheng-Fu, Paleontological Museum of Liaoning, Shenyang, China

Over large evolutionary and temporal scales, Dinosauria and its major constituent clades exhibit an increase in average body mass, although this may reflect passive rather than active processes. Ceratopsians follow this general pattern and increase in body size through both time and evolutionary history. Proposed instances of evolutionary size reduction, such as the small ceratopsid *Brachyceratops*, likely represent juvenile specimens and are thus inconclusive evidence for shifts in life history strategy.

Joint expeditions to Laiyang, Shandong Province, China by Peking University and the Field Museum of Natural History in 2005 and 2007 resulted in the collection of over a dozen specimens of the small ceratopsian *Psittacosaurus sinensis*. Histological analysis of hind

limb bones of three of these individuals reveals that they attained adulthood at a significantly smaller body size than in either *P. mongoliensis* or *P. lujiatunensis*, which have statistically indistinguishable growth patterns. Specifically, 11 year old, mature individuals of *P. sinensis* match the size of four year old juveniles of the other two species, which are still in the lag phase of growth. Because *P. sinensis* is more closely related to *P. lujiatunesis* than to *P. mongoliensis*, its unique growth pattern is most parsimoniously interpreted as dwarfism, and thus represents the first histologically confirmed instance of evolutionary body size reduction in ceratopsian evolutionary history.

P. gobiensis represents another dwarf taxon, but results are equivocal as to whether it is closely related to *P. sinensis*, or whether these species evolved small body size independently. Whereas *P. sinensis* is not sympatric with other species of *Psittacosaurus*, *P. gobiensis* does co-occur alongside a larger species of *Psittacosaurus*, suggesting niche partitioning between closely related and morphologically similar species. *P. sinensis* is only definitively known from the Shandong Peninsula, which is traversed by a major fault at its base, and the peninsula would have been positioned up to several hundred miles north of its current position during the Early Cretaceous. It would have formed an island during part of its Mesozoic tectonic history, substantiating the possibility that *P. sinensis* represents an instance of island dwarfism. Thus dwarfism in *Psittacosaurus* may represent a common strategy in the face of increased competition, whether intraspecific or interspecific in nature.

Technical Session XV (Saturday, October 20, 8:30 am)

DIETARY NICHE PARTITIONING AS A MEANS FOR THE COEXISTENCE OF MEGAHERBIVOROUS DINOSAURS FROM THE DINOSAUR PARK FORMATION (UPPER CAMPANIAN) OF ALBERTA, CANADA

MALLON, Jordan C., University of Calgary, Calgary, AB, Canada

During the Late Cretaceous, megaherbivorous dinosaurs flourished in the western interior of North America (Laramidia). At any one time, there were typically two ankylosaurs (one ankylosaurid plus one nodosaurid), two ceratopsids (one centrosaurine plus one chasmosaurine), and two hadrosaurids (one hadrosaurine plus one lambeosaurine) living in sympatry. This diversity exceeds that of living megaherbivorous mammal communities, and is only rarely observed in the mammalian fossil record. Opinions differ about how this diversity was achieved. Some have argued that megaherbivorous dinosaurs thrived because of their low metabolic rates, or because of high primary productivity during the Late Cretaceous, implying that food resources were not limiting. It is also possible that predation pressure kept megaherbivore populations from fully exploiting the available resources. Others have argued that dietary niche partitioning played an important role in the coexistence of these animals, with each species consuming a different plant resource than the next, thereby minimizing interspecific competition.

This study uses the megaherbivorous dinosaur assemblage from the upper Campanian Dinosaur Park Formation (DPF) of Alberta, Canada as a model to test the dietary niche partitioning hypothesis by examining several aspects of ecomorphology known to relate to the procurement and mastication of food. These include feeding height, skull and beak morphology, jaw mechanics, and tooth morphology and wear. Evidence is sought for taxonomic separation in ecomorphospace between coexisting species, which is known to reflect niche relationships with reasonable fidelity.

Although sympatric taxa are better discriminated by some features than others, consideration of the total evidence supports the dietary niche partitioning hypothesis, as even the most closely related, sympatric taxa can be statistically distinguished according to their ecomorphology. Whether these dietary niche relationships arose as a result of long-term competition, or whether they evolved allopatrically is not clear. However, the fact that consubfamilial species coexistence was uncommon—and when it did occur, was either short-lived or involved only rare species—implies that the structure of the megaherbivorous dinosaur assemblage from the DPF was at least partly influenced by competitive interactions.

Technical Session VI (Thursday, October 18, 3:15 pm)

THE EVOLUTIONARY HISTORY OF TITANOSAURIFORM SAUROPODS

MANNION, Philip D., Imperial College London, London, United Kingdom; UPCHURCH, Paul, University College London, London, United Kingdom; BARNES, Rosie N., University College London, London, United Kingdom

Titanosauriforms represent the most diverse clade of sauropod dinosaurs, with over 90 distinct species, a global distribution and a temporal range extending from the Middle or Late Jurassic through to the end-Cretaceous. However, the interrelationships of this clade are poorly understood, and most previous work has focused on the less inclusive clade of derived titanosaurs. Here we present a new species-level phylogenetic analysis focused on elucidating the evolutionary relationships of basal titanosauriforms. We analyzed a new dataset of over 260 characters for 7 outgroups and 56 putative ingroup titanosauriforms. Many of these characters are heavily revised or novel to our study, and a number of ingroup taxa have never previously been incorporated into a phylogenetic analysis. In addition, we treat quantitative characters as discrete and continuous data in two parallel analyses. Although we recover monophyletic brachiosaurid and somphospondylan sister clades within Titanosauriformes, their compositions are strongly affected by our differing treatment of quantitative data, suggesting that the decision to draw arbitrary boundaries between character states is problematic and may lead to incorrect tree topologies. Several characters traditionally considered titanosauriform synapopmorphies (e.g. the lateral bulge and medially deflected proximal femur) instead characterize the less exclusive macronarian clade. A number of taxa are recovered outside of Titanosauriformes, with the putative earliest titanosaur *Janenschia* positioned as a basal macronarian. This removes any unambiguous pre-Cretaceous body fossil record for Titanosauria, although ghost lineages, trackways and paleoecological analyses suggest that their Jurassic absence can be accounted for by a combination of low diversity and abundance, coupled with a rarity in preservation of suitable environments. Phylogenetic diversity estimates suggest that titanosauriforms were diverse by at least the late Oxfordian, which indicates that this was not a depauperate time interval as proposed by previous analyses, but instead suggests that it is extremely poorly sampled and/or that many Late Jurassic outcrops might be inaccurately dated. Diversity increased throughout the Late Jurassic, and titanosauriforms did not undergo a severe extinction across the Jurassic/Cretaceous boundary, in contrast to diplodocids and non-neosauropods. Titanosauriform diversity remained relatively constant throughout the Early Cretaceous, but there was a severe drop (>60%) in species numbers at the Albian/Cenomanian boundary, representing a faunal turnover whereby basal titanosauriforms were replaced by derived titanosaurs, although this transition occurred in a spatiotemporally staggered fashion.

Technical Session XVIII (Saturday, October 20, 2:30 pm)

BASICRANIAL MORPHOLOGY OF PALEOGENE NYCTITHERIIDAE (MAMMALIA, EULIPOTYPHLA?) AND EVIDENCE FOR EULIPOTYPHLAN AFFINITIES

MANZ, Carly L., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; SILCOX, Mary T., Department of Social Sciences, University of Toronto Scarborough, Scarborough, ON, Canada

Nyctitheriids are small, insectivorous, scansorial mammals that have been linked with Eulipotyphla (shrews, moles, hedgehogs, solenodons) and Chiroptera (bats) based on dental morphology and Euarchonta (primates, tree shrews, dermopterans) using postcranial traits. Due to this range of suggested affinities, nyctitheriids may be critical taxa to unraveling boreoeutherian (Laurasiatheria + Euarchontoglires) relationships. Other than a basicranial fragment (UM 85176) first attributed to a plesiadapiform primate and later tentatively assigned to Nyctitheriidae, cranial morphology has been unknown for the group. Dentally associated nyctitheriid basicrania have been recovered from late Paleocene freshwater limestones from the Willwood Formation, Bighorn Basin, WY. Comparison of these specimens to UM 85176 confirms its attribution to Nyctitheriidae and their morphology closely resembles that of fossil and living Eulipotyphla in having: 1) a moderately expanded ectotympanic ring; 2) no evidence of a fully ossified auditory bulla; 3) a transpromontorial groove on the ventral petrosal associated with the medial entrance of the internal carotid artery (ICA) to the middle ear; 4) transpromontorial grooves for the stapedial and promontorial branches of the ICA; 5) small caudal and rostral tympanic petrosal processes; 6) an open canal for the facial nerve; 7) a laterally positioned epitympanic petrosal wing; and 8) a malleolar sulcus on the ectotympanic. Some of these similarities (2, 3, 4, 6, 8) may be retained primitive features. Nyctitheriid basicrania differ from those of bats in lacking fusion of entotympanic elements to the ectotympanic. Nyctitheriids are unlike some primitive euarchontans in having an epitympanic wing of the petrosal and further differ from most euarchontans (excluding microsyopids) in having no evidence of entotympanic elements and an open pathway for the facial nerve. Nyctitheriid basicrania closely resembles those of fossil and modern Eulipotyphla but many of these similarities are likely primitive and may reflect a retained boreoeutherian cranial morphology, rather than a derived eulipotyphlan relationship.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:45 am)

A PHYLOGENETIC APPROACH TO DETERMINE THE CONTRIBUTION OF LINEAGE EVOLUTION TO PALEOECOLOGICAL CHANGE: AN EXAMPLE USING MAMMALIAN UNGULATES OF NORTH AMERICA

MARCOT, Jonathan D., University of Illinois, Urbana, IL, United States; GLYNN, Amanda, University of Illinois, Urbana, IL, United States

Ecological communities can be characterized by distributions of the functional roles among their constituent taxa. Changes in the functional distributions reflect reorganizations of ecological communities and ecosystem functioning. Such changes are driven by both ecological and evolutionary processes. Ecological processes change communities through differential sorting of taxa with stable functional roles. Examples of ecological processes include the addition or subtraction of taxa from a community due to either migration or interspecies interactions (e.g., predation and competition). On the other hand, even when the taxonomic composition of the community is relatively stable, community change can occur if the constituent taxa themselves evolve and their functional roles change. While numerous studies have documented ecological change due to both ecological and evolutionary processes, the relative role of each in long-term paleoecological change is not clear.

In this study, we use phylogenetic comparative methods to estimate the rates of character change over time, and compare these changes in the distribution of the same characters among coeval members of the herbivorous mammalian ungulate guild. If lineage evolution contributes strongly to community change, we expect rates of character evolution to be highly correlated with changes in functional distributions. We characterize species within the North American ungulate guild using ecologically relevant measurements of their dentitions. We compiled published measurements of cheek teeth from the literature, and supplemented these with novel data from museum specimens. The final data set includes more than

3799 specimens of 802 artiodactyl and perissodactyl species. We determine major axes of variation of dental measurements with principle components analysis (PCA). We estimate body mass for each species using published regression equations. We then determine the distributions of PC scores and taxon body size within 1.5My time intervals between 55 and 5Ma. We estimate changes between distributions in subsequent intervals using the Bray-Curtis distance. We reconstruct ancestral states of the same PC scores and body mass on a composite phylogeny, then calculate the rate of change along branches within each of the 1.5My intervals. Finally, we determine the correlation of these rates with interval-to-interval changes in the distributions.

We find no significant correlation between the dissimilarity between distributions in subsequent intervals and the rate of evolution for either the PC scores or body mass. These results suggest a relatively minor contribution of within-lineage evolution to paleoecological change among ungulates, and that ecological sorting is a dominant influence.

Technical Session XIX (Saturday, October 20, 2:00 pm)

AT THE BEST ANGLE: INCREASED INCISOR PROCUMBENCY ALLOWED POCKET GOPHERS (*THOMOMYS BOTTAE*) TO CLAIM CLIMATE-HARDENED SOILS

MARCY, Ariel E., Stanford University, Stanford, CA, United States; HADLY, Elizabeth A., Stanford University, Stanford, CA, United States; FENDORF, Scott, Stanford University, Stanford, CA, United States

Morphology, changing environmental factors, and competition mediate the unique allopatric distribution of northern Californian pocket gophers (*Thomomys* spp.). While all gophers in the genus use claw-digging, subgenus *Megascapheus* gophers display a range of additional tooth-digging adaptations. GIS analysis of specimen localities mapped on NRCS physical soil maps demonstrates that percent soil clay, bulk density, and shrink-swell capacity separate species with different digging strategies. Clay and bulk density stay constant for 1000s of years, however, low precipitation and high temperatures can rapidly produce shrink-swell behaviors in reactive soils. These climate-hardened soils favor *Megascapheus*, suggesting a mechanism for a gradual replacement event during the Pleistocene-Holocene transition. During this period of increasing aridity, *T. Megascapheus bottae* gophers expanded northward and displaced an exclusive claw-digging species. Geometric morphometric data from 450 adult female crania demonstrate that *Megascapheus* gophers with the largest angle of procumbency tend to occupy the hardest soils. We hypothesize that the expanding populations of *T. bottae* increased incisor procumbency through rostra remodeling as they encountered hardening soils. The strong yet underappreciated interaction between soil and moisture on this major vertebrate group is rarely considered when projecting species responses to climatic change. Understanding how the environment impacts gopher digging efficacy has pinpointed key climatic and associated morphological changes most likely to have influenced past populations of gophers. Given current climate trends and California's abundant shrink-swell soils, these findings could inform distribution predictions for any organism that is dependent on a stable soil structure.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

WHAT DOES THE LIFE HISTORY OF A FOSSIL BOVID TELLS US ABOUT PALEOENVIRONMENT?

MARÍN-MORATALLA, Nekane, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; JORDANA, Xavier, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; GARCÍA-MARTÍNEZ, Rubén, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; MONCUNILL-SOLÉ, Blanca, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; KÖHLER, Meike, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain

Life history traits are shaped by environmental conditions, specifically by extrinsic mortality and resource availability, and may shift in one or the other direction when these conditions change, leading to a complex adaptation of an organism's life cycle termed its 'life history strategy.'

Here, we aim to draw inferences on life history and paleoenvironment of *Tragoportax gaudryi*, an Upper Miocene small to medium sized bovid from Torrent de Traginers (Vallès-Penedès Basin, NE Iberian Peninsula). This bovid has been suggested to have dwelled in habitats with humid wood and very soft ground. We compared the life history traits, specifically age at sexual maturity, of this fossil bovid with that of two extant bovids of similar body size and habitat preferences, *Tragelaphus scriptus* and *Tragelaphus spekii*, that live in bush savannas and dense woodlands in south and central Africa. We counted of Lines of Arrested Growth (LAGs) in thin sections from long bones of these fossil and extant species to determinate age at sexual maturity.

T. gaudryi attained sexual maturity earlier than both species of *Tragelaphus*, indicating a faster life history strategy for this fossil species. In continental ecosystems, the main factor of extrinsic mortality is predation. In *Tragelaphus* ecosystems, the vegetal coverage has been suggested to act as an important burrow role that fends off attacks by top predators such as leopards and lions. However, a faster life history in *T. gaudryi* may indicate a higher predation pressure in the Vallés-Penedés Basin in the Upper Miocene than in extant *Tragelaphus* ecosystems. Our results agree with previous demographic studies on *T. gaudryi* population of Torrent de Traginers that indicate a L-shaped attritional mortality (juvenile predominance) typical of highly predated populations. We therefore suggest a more open habitat with a stronger predation pressure for Torrent de Traginers. This would agree with the presence of top predators such as *Stenailurus* (Felidae) at this site. A higher mortality through higher levels of predation pressure would have led to compensatory changes in the timing of life-history events such as age at sexual maturity, and concomitantly cause a shift towards the fast end of the slow-fast life-history continuum.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A PLATYRRHINE TALUS FROM THE EARLY MIOCENE OF THE AMAZONIAN MADRE DE DIOS SUB-ANDEAN ZONE: THE FIRST FOSSIL PRIMATE FROM PERU

MARIVAUX, Laurent, Institut des Sciences de l'Evolution de Montpellier (ISE-M), CNRS, Université Montpellier 2, Montpellier, France; SALAS-GISMONDI, Rodolfo, Museo de Historia Natural-Universidad Nacional Mayor San Marcos, Lima, Peru; TEJADA, Julia, Museo de Historia Natural-Universidad Nacional Mayor San Marcos, Lima, Peru; ANTOINE, Pierre-Olivier, Institut des Sciences de l'Evolution de Montpellier (ISE-M), Université Montpellier 2, Montpellier, France

Neotropical areas are today among the major hotspots of primate diversity. In South America, Amazonian forests shelter the most diversified platyrrhine communities. However, from a historical perspective, the early evolutionary stages of primates in northern South America (including Amazonia) have proven to be elusive, except for the middle Miocene of Colombia (La Venta) and the late Miocene of western Brazil (Acre), which have yielded diversified crown platyrrhines. Earlier platyrrhines were so far restricted to the late Oligocene of Bolivia (Salla) and to the early Miocene of middle and high latitudes (central Chile and Argentinean Patagonia). Recent paleontological field expeditions in Peruvian Amazonia (Atalaya, Cusco; up. Madre de Dios Basin) have led to the discovery of a new early Miocene locality termed MD-61 (Santacrucian, 17.5-16.5 Ma). Associated with the typical Santacrucian dinomyid rodent *Scleromys quadrangulatus*, we found a well-preserved right talus of a small anthropoid primate (MUSM-2024). Its size approximates that of the talus of living large marmosets (Cebidae, Callitrichinae). MUSM-2024 exhibits a relatively long talar neck, narrowing proximally. The talar head is narrow, fairly round, and slightly rotated laterally. The talar body is moderately high in lateral view, and is short and square in dorsal view. The trochlea is only slightly grooved (surface fairly flat), extends onto the neck (tibial stop), and its rims are parallel and rounded. There is no strong depression in the distal part of the trochlea. Proximally, the groove for the flexor muscle is barely marked (very shallow), and only the medial tubercle is developed. Medially, the facet for the tibial malleolus is elevated from the plantar surface, and it appears as a small cup, which is obliquely oriented and slightly projected onto the proximal part of the neck. The medial side of the talus possesses a well-marked protuberance proximal to the insertion for the posterior talo-tibial ligament. Although some of these features may be found in several groups of platyrrhines, this combination better matches that observed in Cebinae (Cebidae). MUSM-2024 would thus document a *Saimiri*-like cebine, with the body size of a marmoset. Functionally, the features and proportions of MUSM-2024 indicate that this small primate was an arboreal quadruped capable to cling on vertical support, leap and climb, although not particularly specialized for either of these activities. This small talus is the first platyrrhine fossil from Perú and the earliest primate remain from northern South America. Besides, it is likely to document the earliest known crown platyrrhine, as most early Miocene Patagonian platyrrhines seem not to be closely related to modern clades.

Technical Session XIV (Saturday, October 20, 8:30 am)

FINALLY GROWN UP: IS THIS WHAT A MORPHOLOGICALLY ADULT LISSAMPHIBIAN LOOKS LIKE? NEW DATA FOR ONTOGENETICS AND PHYLOGENETICS FROM AN OLIGOCENE NEWT (SALAMANDRIDAE: PLEURODELINAE)

MARJANOVIĆ, David, Museum für Naturkunde, Berlin, Germany; WITZMANN, Florian, Museum für Naturkunde, Berlin, Germany

Lissamphibians, especially caudates, share features with immature and neotenic temnospondyls and seymouriamorphs (lepospondyl ontogeny being largely unknown). This fact features prominently in the discussion about the origin of Lissamphibia. Paedomorphosis has also been a common mechanism of evolution within Caudata.

Pleurodeline salamandrids (newts), particularly the extant *Tylototriton* and *Echinotriton* and the Eocene to Pliocene *Chelotriton* and *Brachycormus*, show peramorphic features: sculpture on the skull, long ribs, presacral neural spines ending dorsally in flat sculptured surfaces that articulate with each other, and contacts of the maxilla to pterygoid and quadrate. In some pleurodelines, the jaw joints lie level with the occiput (slightly caudal in some *Chelotriton* specimens), farther caudal than in any other caudates or even some lepospondyls. Yet, unlike the terrestrial *Tylototriton* and *Echinotriton*, *Chelotriton* and *Brachycormus* were aquatic as shown by their hyobranchium and their ribbon-like tails.

MB.Am 45.1 (Museum für Naturkunde) is a late Oligocene natural mold of an articulated presacral skeleton in dorsal view. While likely referable to *Chelotriton*, it is more peramorphic and larger than all previously known specimens. The jaw joints lie so far caudal to the occiput that the squamosals are inclined rostromedially to caudolaterally, unlike in any other caudate. The ribs are longer than three vertebrae, and at least some of them are curved ventrally; both features are unique among lissamphibians. Carpus and hyobranchium are at least partly ossified. Most of the skull (like the neural spine tables) bears pustular sculpture; the maxilla is honeycombed. The squamosal is uniquely broad rostrocaudally (compared to other caudates). The premaxillae bear very temnospondyl-like alary processes. The specimen is superficially so similar to Carboniferous amphibamid temnospondyls that it was even

identified as one on a label; but features like the frontosquamosal arch and the craniodorsally directed rib spines show unambiguously that MB.Am 45.1 is a pleurodeline as identified by others, there is no trace of any bones absent in other caudates but present in temno- or most lepospondyls, and the matrix fits only the site stated on the back side of the specimen (Orsberg near Erpel, western Germany).

To test whether the peramorphic reversals of MB.Am 45.1 have an impact on the phylogenetic position of caudates or modern amphibians in general, we added it to a large analysis of tetrapod phylogeny that contains *Gerobatrachus*, an amphibamid expected to pull Caudata if not Lissamphibia into Temnospondyli. Still, MB.Am 45.1 emerges as a caudate; Lissamphibia is monophyletic; to move Lissamphibia from Lepo- to Temnospondyli requires 14 extra steps, diphyly 17.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE TAXONOMIC CHALLENGES OF UNDERSTANDING PHENOTYPE IN THE FOSSIL RECORD

MARQUART, Chloe, University of Cambridge, Cambridge, United Kingdom

The reliable identification of 'true' species in the fossil record has proven seriously problematic for palaeontologists over the years. This has been compounded by neontologists shifting from a morphological species concept to definitions using amino acids or genomics that are not available to palaeontologists.

Although phylogenetic methods are undeniably useful for exploring evolutionary signals and differentiating homoplasy from homology, the trees generated are only as good as their underlying matrices. An alternative approach is to investigate how morphological variation manifests itself in extant populations and how this compares to fossil deposits. This approach facilitates estimation of whether particular morpho-characters can be accurately observed in a fossil population, and identifies sources of error that may obscure their recognition.

Morphometric methods allow quantitative assessment of variability, but are not frequently applied to species recognition. A study of extant *Caiman* crocodilians was undertaken to test whether individuals of known species, subspecies and sex could be morphologically distinguished across discrete populations. Results demonstrate that although statistically significant results are frequently obtained, their phenotypic manifestation is not always clear-cut and may be indistinguishable qualitatively. It also shows that the most distinctive phenotype in an analysis is not necessarily the furthest removed taxonomically. Additionally, traits likely to typify differences between species are also likely to be highly variable within populations, making it challenging to differentiate between inter and intra-specific variation. This suggests that while morphometrics is a useful tool for understanding shape variation in a population, a qualitative understanding of phenotype is also needed to evaluate the significance of these differences.

As fossils were once living members of populations of species, every deposit represents a snapshot of a sub-section of a species at a moment in time. If we want to truly understand what a morphological species 'is' from a biological perspective and understand the constraints imposed by taphonomy on these samples, we need to study them as Operational Taxonomic Units before coming to any conclusions about their taxonomic structure. By using populations as the OTU we can compare groups though time and use the changes *between them* to understand which features (that are variable in early populations) have become 'fixed' in later ones and extract a genuine evolutionary signal. It is hoped further advances in developmental plasticity research will give us a far better understanding of what phenotype is and what mechanisms allow it to vary.

Preparators' Session (Thursday, October 18, 9:30 am)

COMBINING MECHANICAL PREPARATION AND X-RAY COMPUTED TOMOGRAPHY TECHNIQUES TO VISUALIZE OBSCURED MORPHOLOGY IN A BASAL SAUROPODOMORPH DINOSAUR

MARSH, Adam D., The University of Texas at Austin, Austin, TX, United States; BROWN, Matthew A., The University of Texas at Austin, Austin, TX, United States; COLBERT, Matthew W., The University of Texas at Austin, Austin, TX, United States; ROWE, Timothy B., The University of Texas at Austin, Austin, TX, United States

The use of X-ray computed tomography (CT) in the study of fossil material has increased significantly in the last decade, and has augmented or even supplanted conventional mechanical preparation techniques in vertebrate paleontology laboratories. CT is dependent upon X-ray contrast between matrix and fossil material, and allows paleontologists to study otherwise unobservable morphological features in specimens. The articulated left forearm and manus of the basal sauropodomorph dinosaur *Sarahsaurus aurifontanalis* presents a unique opportunity to combine CT and standard laboratory techniques. This specimen, found in the Kayenta Formation of Arizona, represents the third described basal sauropodomorph taxon from North America. Standard mechanical preparation was performed until further preparation would have required the disarticulation of the specimen. This left several phylogenetically informative characters obscured by matrix on the palmar surface of the manus, including the presence of collateral ligament fossae, the angular offset of distal condyles, and phalangeal formulae. Because the specimen was left in articulation, articular surfaces of the carpus, metacarpus, and phalanges were also obscured. The specimen was scanned at The University of Texas High Resolution X-ray Computed Tomography Facility (UTCT) and volumetric CT data was processed by digitally removing the mudstone matrix from each individual bone surface. Digital surface files were then generated for each element and printed in acrylic and water-soluble wax by a 3D prototyper at Innovation Park at The University of Notre Dame. These high-quality 3D replicas of the individual bones of *Sarahsaurus* reveal detailed articular surfaces of the elements in the manus, allowing thorough description of the entire specimen and aiding interpretations of the extent of taphonomic mediolateral compression of the fossil. Finally, the individual replicated elements were molded and cast using standard techniques, a process that would have been impossible with the original articulated specimen. Although pouring plastic casts is currently less expensive than digitally prototyping replicas, the cost of this technology is decreasing, and it is possible that future fossil preparation laboratories may have the capability to generate wax, plastic, or even bronze replicas of important fossils. Most importantly, the complementary nature of CT and mechanical preparation techniques may increase specimen longevity and avoid destructive disarticulation of specimens that can involve the loss of valuable morphological and contextual information. Similarly, these methods allow an opportunity to verify interpretations of previously ambiguous or unobservable character data.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

DENS OF THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*) AS TRACES AND THEIR PREDICTIVE VALUE FOR FINDING LARGE ARCHOSAUR BURROWS IN THE GEOLOGIC RECORD

MARTIN, Anthony J., Emory University, Atlanta, GA, United States; PAGE, Michael, Emory University, Atlanta, GA, United States; SKAGGS, Sheldon, Georgia Southern University, Statesboro, GA, United States; VANCE, Robert K., Georgia Southern University, Statesboro, GA, United States

Large archosaur burrows are rarely interpreted from the geologic record, a circumstance that may be attributable to a lack of search images based on modern examples, rather than actual rarity. To test this idea, we measured, imaged, and mapped den structures of the American alligator (*Alligator mississippiensis*) on St. Catherines Island (Georgia, USA). St. Catherines is an undeveloped barrier island on the Georgia coast, consisting of Pleistocene and Holocene sediments. Alligators dug most dens along the edges of freshwater ponds in loosely consolidated Holocene or Pleistocene sand. Adult female alligators use dens to protect offspring, but burrows also aid in thermoregulation or serve as refugia for alligators during droughts and fires. Some dens are evidently reused and modified by different alligators after initial construction. Drought conditions along the Georgia coast have exposed many abandoned dens, thus better allowing for their study while increasing researcher safety. Den entrances have half-moon cross sections, and based on one sample (n = 20), these range from 22-115 cm wide (mean = 63 +/- 23 cm) and 14-55 cm high (23 +/- 9 cm). In addition to field descriptions, we applied geographic information systems (GIS) and ground-penetrating radar (GPR) to help define the ecological context and subsurface geometry of these structures, respectively. GIS gave spatial data relatable to alligator territoriality, substrate conditions, and proximity to potential nest sites. GPR produced subsurface images of active dens, which were compared to abandoned dens for a sense of taphonomic history. Most den entrances are southerly facing, with tunnels dipping to the northwest or northeast. From entrances, tunnels slope at about 10-15°, turn right or left within a meter, and lead to enlarged turn-around chambers. Collapsed dens in formerly ponded areas (secondary-succession maritime forests) provided further insights into subsurface forms of these structures. These features are: 3.1-4.6 m long; 30-40 cm deep, relatively narrow at either end (35-60 cm), and 1.2-1.6 m wide in their middles. Expansive areas were probable turn-around chambers, and total volumes of collapsed dens accordingly reflect maximum body sizes of their former occupants. One sampled area (8,100 m^2), an almost dry former pond, had 30 abandoned dens, showing how multiple generations of alligators and fluctuating water levels can result in dense concentrations of alligator burrows over time. In summary, the sheer abundance, distinctive traits, and sizes of these structures on St. Catherines and elsewhere in the Georgia barrier islands give paleontologists excellent search images for seeking similar trace fossils made by large semi-aquatic archosaurs.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DIVERSITY AND PALAEOECOLOGY OF THE AMIIDAE OF THE DINOSAUR PARK AND OLDMAN FORMATIONS (CAMPANIAN) OF ALBERTA, CANADA

MARTÍN-ABAD, Hugo, Universidad Autónoma de Madrid, Madrid, Spain; NEWBREY, Michael G., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; BRINKMAN, Donald B., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; NEUMAN, Andrew G., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; POYATO-ARIZA, Francisco J., Universidad Autónoma de Madrid, Madrid, Spain

Amiids are important members of fish assemblages and aquatic ecosystems throughout the Cretaceous, but there is still much to be understood about their diversity, distribution, and relationships. We examine amiid material from the Oldman and Dinosaur Park formations (Campanian) from Alberta, Canada, to identify diversity and growth patterns. Amiid specimens were collected from 31 vertebrate microfossil localities at 12 stratigraphic intervals within Dinosaur Provincial Park. Diversity of amiids was addressed using morphology of skull elements and vertebral centra, as well as data on age and growth, and relative abundance. We identified two taxa based on two different morphotypes of maxillae, dentaries, upper postinfraorbitals, opercula, and cleithra. Two morphotypes of precaudal vertebral centra were also recognized, both included in the subfamily Amiinae. They differed from each other in the shape and relative length of the ventral pits (narrow and elongated vs. subovate to D-shaped), as well as in the general contour (ventrally flattened vs. rounded), and the length of the centra (longer towards the posterior region of the column vs. approximately constant length). Each centrum morphotype had similar age distributions

and growth profiles, with no statistical difference, but Morphotype I grew to significantly larger sizes at age three in stratigraphically higher localities, whereas Morphotype II showed no change in size through the section. The relative abundance of each morphotype was different at numerous localities falling outside the 99% confidence intervals to indicate that Morphotype I was found at statistically high or low proportions compared to Morphotype II. It was initially hypothesized that the morphotypes would be attributable to the genera *Cyclurus* and *Amia*. However, we reject that hypothesis as centra of Morphotype I are present in both Mesozoic and Cenozoic *Cyclurus* and extinct and extant species of *Amia*. Morphotype II is not present in these genera, and thus represents a poorly known lineage currently represented by isolated elements that extends at least to the K-P boundary. The presence of two amiines in the mid Campanian of Alberta suggests that amiids had a more complex evolutionary history in the Cretaceous of North America than had been previously recognized.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

PALEOHISTOLOGICAL ANALYSIS OF METAPODIAL BONES OF MIOCENE *HIPPARION CONCUDENSE* FROM SPAIN

MARTINEZ-MAZA, Cayetana, Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain; ALBERDI, Maria T., Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain; PRADO, Jose L., Unuversidad Nacional del Centro, Olavarria, Argentina

The life history of extinct animals may be assessed through the study of their hard tissues. During life, bone microstructure is influenced by internal and external factors such as developmental processes, environmental or seasonal factors, life style adaptations, and biomechanical function. Several works have shown the relationship between these aspects of life history and bone histology. In this work, we analyzed the microstructure of metapodial bones of the extinct tridactyl *Hipparion* to provide data about its development, biomechanics, and paleoecology. The genus *Hipparion* is recorded in Eurasia from the Upper Miocene to the Plio-Pleistocene boundary. These fossil horses represent an intermediate stage in horse evolution towards higher crowned molars, larger size, and reduced autopodials. *Hipparion* horses present an autopod composed of a major central toe and two reduced lateral ones. Previous analyses from a systematic, evolutionary and palaeoecological point of view have suggested that body size and morphological variability are related to environmental conditions and ground characteristics. However, no histological studies have been performed on these skeletal elements. Here, we studied the *Hipparion concudense* species from two basins of the Late Miocene of Spain with different environmental conditions: the Turolian site (Concud, Teruel) and the Vallesian site (Valles de Fuentidueña, Segovia). Transverse ground sections from the midshaft of central and lateral metapodial bones were analyzed with qualitative and quantitative histological techniques. Histological data show changes throughout the development that allowed identification of ontogenetical stages and biomechanical changes. Secondary osteons in the central metapodial bones of young individuals occur in the area associated with lateral metapodials, which show remodeled bone in the region close to central metapod. These histological data confirm that lateral metapodials are involved together with the central metapodial bone in the biomechanic processes of these three-toed horses. We compared these histological data between the two *Hipparion* samples to analyze how these changes in the bone microstructure are related to different environmental conditions.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PRELIMINARY DATA ON THE NEW PARTIAL CARCASS OF THE WOOLLY MAMMOTH, *MAMMUTHUS PRIMIGENIUS,* FROM YAKUTIA, RUSSIA

MASCHENKO, Eugene, Borissiak Paleontological Institute, Russian Academy of the Sciences, Moscow, Russian Federation; POTAPOVA, Olga, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; BOESKOROV, Gennady, Diamond and Precious Metals Geology Institute, Siberian Branch of Russian Academy of Sciences, Yakutsk, Russian Federation; PLOTNIKOV, Valery, Sakha Republic (Yakutia) Academy Sciences, Yakutsk, Russian Federation; AGENBROAD, Larry, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States

A partially frozen and mummified carcass of Woolly Mammoth, *Mammuthus primigenius,* was found on the coast of the Dmitrii Laptev Straight by the Yukagir community members in 2009. The carcass (72°40´ N 142°50´ E) was discovered in the rich bone-bearing Late Pleistocene yedoma (permafrost) deposits of the Oyagossky Yar, approximately 30 km west from the mouth of Kondratievo River. The carcass nicknamed "Yuka" is an adolescent individual. No frozen remains of a mammoth of such age were ever found. Previously found frozen/mummified carcasses belonged to younger, or were much older individuals. The mammoth carcass was found hanging over the melting ledge in the upper third of the facing north slope composed of the loess sediments. The condition of the discovered mammoth was unusual: most of the soft tissues of the torso were gone, but most of the bones were present inside the hide. Incomplete set of unarticulated bones of the head and torso included the cranium with teeth and both tusks, mandible with teeth, atlas, both scapulae, pelvis connected to the sacrum, 4th lumbar, 1st , 2nd and 3rd tail vertebrae, and eight right ribs. All bones were covered by short remnants of mummified tendons and muscles. The legs covered by hide retained all soft tissues and almost all bones. Missing bones included the left humerus, both femora, and most of the left hind foot bones. The carcass is missing the left hind foot, which was scavenged, and two large hide portions on the back (30x40 cm) and the neck (20x30 cm). These portions of the hide were ripped off or cut out from the body; the hide edges are being investigated for possibility of human impact. The tail has puncture marks left by canines of a small, possibly recent, predator, but the trunk skin is intact. A lot of places on the hide (neck, throat, belly, legs) have deep and narrow grooves that were left by a very large predator. No punctures from canines or any obvious wounds were discovered that obviously might have caused the animals' death. The fur of very light tan to light ochre–dark brown color was present on the torso sides and legs. Preliminary analyses of the teeth generation (upper and lower Dp4-M1 in wear) corresponds to approximately 8-9.5 year-old Asian elephant. Taking into consideration the fact that mammoth deciduous Dp2/dp2-Dp3/dp3 eruption occurred faster than that of the African and Asian elephants, the Yuka mammoth age could be lowered down to approximately 6-8 years. Her body length was about 205 cm and shoulder height was about 160 cm. The morphology of the genitals allowed identifying the specimen as a female. The ongoing studies of the Yuka mammoth are AMS dating; X-ray computed tomography (CT scan), and DNA and isotopes analyses.

Technical Session XI (Friday, October 19, 3:15 pm)

OSTEOLOGY OF THE EMBRYONIC THEROPODS FROM THE LATE JURASSIC OF PAIMOGO, PORTUGAL

MATEUS, Octávio, Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia & Museu da Lourinhã, Lourinhã, Portugal; CARRANO, Matthew T., Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; TAQUET, Philippe, Muséum national d'Histoire naturelle, Paris, France

Among the more than one dozen dinosaur egg- and eggshell-bearing localities in the Upper Jurassic Lourinhã Formation of Portugal (upper Kimmeridgian–Tithonian), the nest from Paimogo was one of the first to be found and remains the largest and most significant. Located within the Amoreira-Porto Novo Member (uppermost Kimmeridgian), this nest has yielded about 300 embryonic bones and bone fragments identified as belonging to a theropod dinosaur. Here we present a detailed anatomical description of the nest and embryos.

The Paimogo nest comprised about 100 eggs (or eggshell concentrations that represented individual eggs), but much of the nest had been eroded, indicating that an even greater number of eggs would have been present originally. There is no clear nest structure, but eggs are more highly concentrated in the center, along with the majority of embryonic bones (suggesting a more advanced ontogenetic stage). All the eggs were crushed, but despite this compression, some eggs are complete and retain embryonic bones inside.

The embryonic anatomy is comparable to the holotype of *Lourinhanosaurus antunesi* from the same stratum and region. However, most *Lourinhanosaurus* autapomorphies are in the pelvis and vertebral laminae, rarely preserved in the embryos, making their positive identification more difficult. A single autapomorphy is present in both subadult and embryos: a medial condyle of the tibia that is half the transverse width of the fibular condyle. Other contemporary theropods differ from the embryos in specific details: the embryonic maxilla lacks an antorbital fenestra (present in *Allosaurus*), the ilium lacks a vertical ridge (present in *Aviatyrannis*), and the tibial cnemial crest is short (unlike *Ceratosaurus*). One other nest with embryos from the Lourinhã area, in Porto das Barcas, has been provisionally ascribed to *Torvosaurus*. These embryonic specimens are much larger in size, and the eggshell structure is entirely different. If this assessment of the Porto das Barcas embryos is correct, then the Paimogo embryos cannot be *Torvosaurus*.

In general, the embryos are morphological miniatures of the adults, fully equipped for predation of small prey, and thus may have been precocial (i.e. relatively mature and mobile from the moment of birth or hatching). The teeth have large denticles on the distal carina only and bear some resemblance to those of more derived theropods, suggesting a role for pedomorphosis in theropod evolution.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

TAKING SCIENCE AND EDUCATION OUTSIDE AT THE BLM MOCCASIN MOUNTAIN TRACKSITE, UTAH

MATTHEWS, Neffra A., DOI-Bureau of Land Management, Denver, CO, United States; CHRISTENSEN, Thomas M., DOI-Bureau of Land Management, Kanab, UT, United States; HAINES, Misti E., DOI-Bureau of Land Management, Kanab, UT, United States; NOBLE, Tommy A., DOI-Bureau of Land Management, Denver, CO, United States; BREITHAUPT, Brent H., DOI-Bureau of Land Management, Cheyenne, WY, United States

America's Great Outdoors (AGO) and Take It Outside (TIO) are Presidential initiatives put in place to encourage families to spend more time together enjoying their natural surroundings. What better enticement to go outside and get excited about science than to experience paleontological resources found on America's Public Lands? A relatively new tracksite has been managed and developed for the benefit of the public, establishing opportunities and providing information about paleontology in accordance with current paleontological legislation (PRPA). The Moccasin Mountain Tracksite (MMT) is located in southern Utah on land managed by the Bureau of Land Management's Kanab Field Office. The MMT reveals multiple fossil footprint levels in the Navajo Sandstone (age ~185 million years) in a slick rock sandstone area covering about 1,000 m^2. Over the past four years, the MMT has received funding from AGO and TIO to produce a variety of educational materials, including a brochure, explorer vests, interpretive signage, and a podcast. Families can visit the Kanab Field Office and check out an explorer vest equipped with a digital camera, GPS unit, measuring tape and other equipment for documenting and measuring the tracks at the MMT. A brochure containing photographs and descriptions of the diverse ichnofauna (*Grallator*, *Eubrontes, Otozoum, Batrachopus* and *Brasilichnium*) and a map lead "Early Jurassic Explorers" on a self-guided tour to the location of select

footprints, encouraging the discovery and documentation of other tracks at the site. Signs to be installed on site will follow the theme of exploration, providing basic information on the MMT and complementing the brochure. As this tracksite is surrounded by prime OHV recreational areas, signage will not only help interpret the area to outdoor enthusiasts, but will also discuss the conservation and management of the MMT, as well as encourage local stewardship of these valuable paleontological resources. The podcast (available for download) briefly discusses track and trackway formation, as well as highlighting technology used at the site. In 2008, close-range photogrammetric documentation of the MMT was conducted using both ground-based and low-altitude aerial imagery. Digital terrain data and ortho-imagery (at a variety of scales) were integrated into a real-world coordinate system. These images and 3D data not only form the basis for maps of the site, but also enhance the interpretation by providing virtual renderings of footprints and trackways in the podcast. This cadre of educational and interpretive materials provides an effective tool for presenting the uniqueness of the MMT to the public and encourages children of all ages to explore the paleontological wonders of America's Great Outdoors.

Technical Session XIV (Saturday, October 20, 12:00 pm)

CHANGES IN ICHTHYOSAUR BODY SIZE DURING THE EARLY TOARCIAN EXTINCTION EVENT

MAXWELL, Erin E., Staatliches Museum für Naturkunde, Stuttgart, Germany; VINCENT, Peggy, Staatliches Museum für Naturkunde, Stuttgart, Germany

Extinction events have a characteristic effect on the taxonomic composition, species diversity, and abundance in both marine and terrestrial ecosystems. Body size, both within species and within a fauna, is thought to decrease following an extinction event. Taxonomic diversity is also assumed to decrease, but the abundance of opportunistic species increases. In this study, we examined body size changes in the Lower Jurassic ichthyosaur *Stenopterygius quadriscissus* and body size distribution and generic abundance in the Posidonia Shale ichthyosaur fauna, to test if the early Toarcian extinction event had an ecological effect on large marine vertebrates.

Six elements, two from the skull and four from the postcranium, were measured for adults of *S. quadriscissus* (N=26). The individual score on the first axis of a principal component analysis was used to condense these measurements into a single multivariate size metric. This metric was then plotted against stratigraphic occurrence, based on regional zonation of the Posidonia Shale in the Southwest German Basin. A resampling analysis was designed to examine whether the largest individual for a stratigraphic interval was smaller than expected based on the data and the sample size for that interval. We also divided the ichthyosaur fauna into small (adult body length equal to or less than 4m; *Stenopterygius, Hauffiopteryx*) and large genera (*Temnodontosaurus, Eurhinosaurus, Suevoleviathan*), and examined the stratigraphic abundance of specimens in each size class. We report a significant increase in size in *S. quadriscissus* following the extinction interval, but size remained constant during the survival interval. Following a similar pattern, the ichthyosaur fauna during the extinction interval showed high abundance of *S. quadriscissus*, but low taxonomic diversity (80% of all recovered specimens belonged to the aforementioned species). Large genera were absent from the fauna. Immediately following the extinction interval, large genera gradually became proportionately more abundant, and *S. quadriscissus* steadily declined.

The intraspecific body size, abundance, and generic size distribution of early Toarcian ichthyosaurs follows the classic pattern for a fauna suffering from post-event syndrome. However, this pattern occurred during the extinction interval, not following the interval as in benthic marine invertebrates. These observations suggest that large ichthyosaurs may have been more strongly affected by adverse environmental conditions from the onset of the extinction event, rather than by the final extinction pulse related to global warming and oceanic anoxia, and that conditions in the nektonic realm rapidly ameliorated at the end of the extinction interval.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

TRACKS IN THE ARCTIC: A DINOSAUR ICHNOFOSSIL ASSEMBLAGE FROM THE UPPER CRETACEOUS PRINCE CREEK FORMATION, NORTHERN ALASKA

MAY, Kevin C., University of Alaska Museum, Fairbanks, AK, United States; DRUCKENMILLER, Patrick S., University of Alaska Museum, Fairbanks, AK, United States

Globally, only a small number of formations provide information on the diversity and distribution of dinosaurs from high paleolatitudes. One of the most prolific units known is the Upper Cretaceous Prince Creek Formation of northern Alaska. The Prince Creek Formation (Campanian-Maastrichtian) consists predominantly of siliciclastic sediments shed off of the rising Brooks Range to the south. The formation is a tidally influenced continental succession deposited at polar latitudes (approximately 82 degrees North) on a low-gradient, coastal/alluvial plain. The Prince Creek Formation is well known for its dinosaur fauna, including a taxonomically wide range of both ornithischian and saurischian taxa represented exclusively by body fossils. However, these skeletal remains are not evenly distributed through the unit; the majority of remains are restricted to a small number of productive bone bed deposits in the upper portion of the formation. Field investigations conducted by the University of Alaska Museum between 1997 and 2010 reveal a diverse assemblage of dinosaur tracks and trackways documented in numerous exposures of the Prince Creek Formation along an 80-kilometer leg of the lower Colville River, between Uluksrak Bluff and Ocean Point. At least five track morphotypes are recognized, which are preserved as true tracks, natural casts and underprints. Trampled surfaces have been noted at several localities and tracks can be seen in cross-section throughout the unit. A preliminary analysis of the ichnofaunal assemblage reveals a medium to large ornithopod and a possible ceratopsid. Also present are a medium sized theropod and at least two morphotypes of small theropods, including a probable avian track referable to *Magnoavipes* sp. The tracks are significant in that they occur throughout the entire Cretaceous portion of the unit, are relatively common, and are more evenly distributed within the succession than skeletal remains. The ichnofauna compliments the skeletal record and reveals additional diversity not currently recognized in the formation based on body fossils alone.

Preparators' Session (Thursday, October 18, 9:15 am)

DIGITAL DEVELOPMENT AND MOUNTING OF AN *ALAMOSAURUS* SKELETON FOR THE PEROT MUSEUM OF NATURE AND SCIENCE

MAY, Peter, Research Casting International, Trenton, ON, Canada; FAIR, Matt, Research Casting International, Trenton, ON, Canada; CRAWFORD, Brett, Research Casting International, Trenton, ON, Canada; MAY, Amelia, Research Casting International, Trenton, ON, Canada; MACLEOD, Mike, Research Casting International, Trenton, ON, Canada

Three different specimens were used to develop the first skeletal mount of the giant titanosaur from the late Cretaceous of North America, *Alamosaurus*. The individual elements of all three skeletons were laser scanned, creating digital files of all of the bones necessary to develop a complete skeleton. The individual bones were then manipulated by scaling for size, and if the opposite side was missing a mirror image was made. Once the complete skeleton was digitally developed, it was physically created using 3D printers and a 5 axis router. The specimen from University of Texas, Austin was originally collected in 1973 and consisted of the bones of a single specimen, including femur, humerus, hip and articulated dorsal series through to the first cervical. It had only been partially prepared. in all, 13 unprepared blocks consisting mainly of the hip and dorsal series were prepared for this project. The specimen from the Smithsonian was collected in Utah in 1946. It consists of approximately 30 articulated caudal vertebrae and a front forelimb. The Perot Museum specimen was collected in 1997, and consists of nine articulated cervical vertebrae. Each specimen preserves elements that overlap with the other specimens, and that could be scaled for the reconstruction of the skeleton. The sheer size of the skeleton ruled out 3D printing of the entire skeleton from the original scanned data, due to the restrictive size of the 3D print envelope. The point cloud data generated by laser scanning had to be transferred to CAM files so tool paths could be created for a 5 axis router to carve out the replicated bones from two-pound density polystyrene blocks.

Technical Sesssion XII (Friday, October 19, 3:45 pm)

A NEW OPHIDIOFAUNA FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA AND THE RISE OF COLUBROID SNAKES (REPTILIA, SERPENTES)

MCCARTNEY, Jacob A., Stony Brook University, Stony Brook, NY, United States; STEVENS, Nancy J., HCOM and Center for Ecology and Evolutionary Studies, Ohio University, Athens, OH, United States

An active field program in the late Oligocene Nsungwe Formation in the Rukwa Rift Basin of southwestern Tanzania has begun to shed light on faunal dynamics during the Oligo-Miocene transition on continental Africa. Groups recovered to date include a rich assemblage of mammals, birds, crocodylians, lepidosaurs, anurans, and fishes as well as multiple invertebrate clades. Among the Nsungwe Formation discoveries is a diverse collection of snake vertebrae. The sample (n = 23) can be sorted among four primary morphotypes: a booid of uncertain affinities, a boid, and two colubroid snakes. All of the snake specimens are small, likely representing individuals that did not exceed a meter in total length. The booid morphotype reveals important ecological insights, preserving vertebral features typical of burrowing snakes. The colubroid material strikingly dominates the ophidiofauna, comprising almost 70% of the snake specimens collected to date. This stands in stark contrast to contemporaneous faunas known from Europe and North America, both of which are dominated by booid snakes. In these regions colubroids diversified in the early Miocene, likely as a result of aridification and a spread of grasslands that favored more active predators. Sedimentological interpretations from fossiliferous Nsungwe Formation localities indicate a seasonal environment with perennial availability of water in the form of nearby fluvial and shallow lacustrine settings. The early dominance of colubroids in the Nsungwe Formation may reflect seasonally drier habitats and a general emergence of more open environments in the region. Because of the lack of diverse contemporaneous African faunas for comparison, it is unclear whether this fauna reflects local conditions or a continent-level pattern. Regardless, the Nsungwe Formation fauna illustrates that the pattern of ophidiofaunal turnover in Africa may be more complex than that characterizing the northern continents, either occurring earlier or in a patchier manner than has been documented for Europe and North America.

Preparators' Session (Thursday, October 18, 11:30 am)

THE COLLABORATION OF INSTITUTIONS, AGENCIES, AND VOLUNTEERS FOR A "PAINLESS" EXCAVATION OF A LARGE *GLYPTOTHERIUM* FROM THE LATE BLANCAN OF THE SAN SIMON VALLEY IN SOUTHEASTERN ARIZONA

MCCULLOUGH, Gavin, Arizona Museum of Natural History, Mesa, AZ, United States; WALTERS, Tim, Arizona Museum of Natural History, Mesa, AZ, United States; GILLETTE, David D., Museum of Northern Arizona, Flagstaff, AZ, United States; WHITE, Richard, International Wildlife Museum, Tucson, AZ, United States; THRASHER, Larry, Bureau of Land Management, Safford, AZ, United States

In 2010 a partial carapace and associated skeletal elements of the glyptodont *Glyptotherium texanum* were discovered in the late Blancan fossil beds of southeastern Arizona. Glyptodonts are very common megafauna found in these highly productive fluvio-lacustro-paludal deposits, yet the variable nature of their occurrence means that each excavation can present unique problems requiring novel solutions. This new specimen provided the opportunity for a highly successful excavation combining the skills and energies of many institutions, organizations, and individuals from across the state. The fossils were found in a relatively flat area near an unimproved road, allowing vehicle access. They were partially excavated, covered with a protective plaster cap, and reburied during excavations over the previous two years in preparation for a final large-scale extraction in March of 2012. For the final extraction, volunteers were assembled from the Southwest Paleontological Society, Northern Arizona University's Geology Department, Museum of Northern Arizona, Bureau of Land Management, and local community. The division of labor was such that work was available for volunteers of all skill levels, including pick-and-shovel digging, jackhammering, structural carpentry, and plaster jacketing. The first priority was to remove the backfill dirt and rock that had been used to conceal the *Glyptotherium* from view. Then, the depth and width of the trench surrounding the large (6' x 5' x 3') block were increased, creating a navigable workspace and a ramp for vehicular access. Lumber and custom-bent rebar were incorporated into the plaster jacket to bolster its strength. A cradle/sled built from 4" x 4" and 4" x 6" lumber was set beneath the jacket through cross-tunnels and the block was locked into place with lumber shims. The sled facilitated removal of the pedestal and eliminated the need to flip the jacketed block. Matrix exposed from the pedestal removal was covered with plaster belly bandages slung along the underside to prevent material from falling out of the bottom of the block. An A-frame gantry was erected and fitted with a chain hoist, and the sled-borne block was carefully lifted away from the ground in preparation for final loading. Local volunteers donated their time and a semi tractor-mounted forklift to lift the block up and out of the pit, and onto a flatbed truck for transportation to the Arizona Museum of Natural History. Upon arrival at the paleontology laboratory, the two-ton block was lowered onto a custom-made metal-wheeled dolly with an industrial fork-lift.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FUNCTIONAL MORPHOLOGY IN MODERN HORSES: NATURAL VS. ARTIFICIAL SELECTION

MCHORSE, Brianna K., Univeristy of Oregon, Eugene, OR, United States; DAVIS, Edward B., Univeristy of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., Univeristy of Oregon, Eugene, OR, United States

Functional morphology plays an important role in modern sport horse purchase and breeding decisions. Conformation, or the skeletal proportions of the animal, is considered a reliable indicator of athletic ability and long-term resistance to injury. Generations of artificial selection for desirable traits has led to distinct breeds, each with slightly different conformational ideals. Despite the influence of conformation assessments on equine breeding and trade, few studies have used analytical methods to establish quantitative relationships between conformation and performance in artificially-selected competition horses, and none have examined the differences between domestic breeds and the feral mustang. Existing work suggests a significant relationship between judgments of quality and several conformational variables, especially shoulder and pelvis angle, which influence the reach and timing of the horse's stride. We investigated the conformation-performance correlation in eventing, an equestrian discipline that tests the ability of the horse to complete three phases: dressage, cross-country, and stadium-jumping. For comparison, we conducted the same measurements on extant mustangs, which are under natural selective pressures in the wild. One might expect that the traits that benefit a horse in an all-around discipline like eventing would be similar to those that offer selective advantages in wild horses. Results suggest a significant relationship between conformational variables and competition scores in performance horses; however, the characters that predict performance even in all-around competitions like eventing are not quite the same as those that distinguish between the morphology of mustangs and performance horses. Higher performance correlates with a shorter back, longer neck, shorter metapodials, and a sloping pelvis. Mustangs tend to differ from domestic breeds in their generally smaller size and more compact structure, as well as their narrower range of variation in conformational traits. These results show the need for caution when using domestic horses in evolutionarily-informed studies, as artificial selection for desirable traits can produce animals that are significantly different from their naturally-selected counterparts. Mustangs, even if captured and domesticated after ranging free as part of a feral herd, may be a more appropriate group to use when exploring the evolutionary history and patterns of horses.

Romer Prize Session (Thursday, October 18, 11:00 am)

ONTOGENY AND PHYLOGENY OF TEMNOSPONDYL AMPHIBIANS, A WINDOW INTO TERRESTRIAL ECOSYSTEMS DURING THE PERMO-TRIASSIC MASS EXTINCTION

MCHUGH, Julia, University of Iowa, Iowa City, IA, United States

Temnospondyls are an abundant fossil group across the Permo-Triassic boundary (PTB), the point of the largest mass extinction in the Phanerozoic. Temnospondyli is a long-lived lineage, spanning the Middle Mississippian to Early Cretaceous, crossing the PTB at terrestrial sections around the globe. However, previous attempts at quantifying their diversity and evolution during this interval have been limited by the incompleteness of available phylogenetic hypotheses. To alleviate this and provide better understanding of evolution in this widespread group, a comprehensive species-level phylogenetic dataset was constructed for 99 ingroup taxa and 297 morphological characters with *Greererpeton burkemorani* as the outgroup. The resulting phylogeny was used to estimate ghost lineages and range extensions, and to calculate speciation and extinction rates, using raw occurrence data and incorporating ghost lineages, across the PTB globally and locally in the South African Karoo Basin. This phylogeny also provided the framework to test changes in bone microstructure across the PTB. Thin-sections were taken from multiple postcranial elements of five temnospondyl taxa, spanning the middle Permian to Early Triassic of the Karoo Basin. Permian specimens show slow, zonal growth in long-lived, medium-to-large aquatic stereospondyls; earliest Triassic temnospondyls show azonal, sustained growth in small-to-medium terrestrial forms. Global extinction and speciation rates for temnospondyl lineages are elevated across the PTB; however, extinction and speciation rates derived from only occurrence data are highly correlated with the number of sampled localities, both per geologic stage and normalized per million years. Thus, extinction rate and speciation rate (from only occurrence data) cannot be differentiated from rock record bias at the PTB. Conversely, speciation rate derived from occurrence data and inferred ghost linages is not strongly correlated with the number of sampled localities; however, its sharp increase at the PTB is predominantly the result of the basal radiation of a major subclade (Stereospondyli), and it is unclear how large of an effect can be ascribed to selective pressures during the massive extinction event, or to what degree this radiation is simply coincidental with the PTB. Regardless, these data indicate a Permo-Triassic world favorable to rapidly speciating lineages, as well as individual growth in amphibians, whether long-lived and cyclical or sustained. Temnospondyls may have behaved as disaster taxa, quickly evolving to fill vacant niches in the Early Triassic. This suggests that flexibility in growth and rapid evolution may be key characteristics to not only surviving, but also proliferating through a mass extinction event.

Technical Session VIII (Thursday, October 18, 2:30 pm)

RECONCILING FAUNAL AND FLORAL CLIMATIC INTERPRETATIONS ACROSS THE EARLY BARSTOVIAN OF THE NORTHWEST U.S.A.

MCLAUGHLIN, Win N., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States

Numerous proxies exist for reconstructing past climates, ranging from stable isotopes to sedimentological characteristics. While many more sophisticated tools exist, the most common tools rely on analysis of the fossil flora and fauna. However, these important signatures of past ecosystems must be used with caution given potential biases, and are best when verified by comparison with other independent evidence of climate. Our need to accurately reconstruct past environments has grown in light of issues such as anthropogenic climate change, demanding reanalysis of past times of climatic change, such as the Mid-Miocene Climatic Optimum. Measuring past biotic responses to climate change is necessary for lending predictive power to models of future climatically-driven biotic reactions. We examine four Early Barstovian sites from the northwest U.S. Three classic vertebrate faunas, the Sucker Creek in southern Oregon, the Mascall Formation of north-central Oregon, and Virgin Valley in northern Nevada, and a new locality, Hawk Rim of central Oregon, provide a basis for examining the concordance of climatic proxies. All these sites offer a basis for climatic inference based on flora, fauna, and sedimentology, and some also include paleopedological and radiometric data. Despite rich deposits at all four sites, existing environmental interpretations lack congruency between floral and faunal interpretations and furthermore suggest less ecological diversity between sites than is indicated in a detailed comparison of the data. Early interpretations of the flora generated a reconstruction of a warm and wet densely forested region, dominated by broad leaf deciduous trees, interpretations based solely on the vertebrates played up the role of open habitat taxa while assigning forest taxa to marginal riparian habitats and negating diversity. Broad leaf forests persisted to the west (at Hawk Rim and in the Mascall), with increased occurrences of closed environment taxa as well as riparian organisms. While sites to the eastern edge of the study area (e.g. Sucker Creek) display a relatively elevated concentration of grazing taxa, browsing and other forest-dwelling taxa still represent a greater portion than previously recognized and are often mixed with open habitat indicators, suggesting a strong degree of ecological heterogeneity. The floral component is further indicative of hardwood forests with a limited amount of open habitat. Integration of floral and faunal environmental interpretations paints a picture of not only a wetter and warmer Northwest in the Early Barstovian, than some previous reconstructions have suggested, but also a high level of ecological heterogeneity between sites, influenced by paleotopography and the climatic influence of the early Cascades.

Technical Session XVI (Saturday, October 20, 9:00 am)

MORPHOLOGICAL VARIATION IN THE MANDIBLES OF *SMILODON FATALIS* FROM RANCHO LA BREA IN RESPONSE TO CLIMATE AND ENVIRONMENTAL CHANGES

MEACHEN, Julie, National Evolutionary Synthesis Center, Durham, NC, United States; O'KEEFE, Frank R., Marshall University, Huntington, WV, United States

Climate change drives changes in abiotic and floral elements of ecosystems, changes that can and do impact dependent vertebrate species higher in the food web. Rancho La Brea is an excellent natural laboratory in which to examine these changes through time, as each individual pit serves as a relative time sample among which comparisons can be made. Different pits at Rancho La Brea also coincide with different major climate events; pit 13 coincides with the Last Glacial Maximum (LGM) approximately 16-17 Ky, and pit 61/67 coincides with the Bølling-Allerod warming event and concomitant megafaunal extinction approximately 11.5 Kya.

We examined mandibles of the sabertooth cat, *Smilodon fatalis*, to assess changes occurring through time, and to compare these changes to previous studies on the dire wolf, *Canis dirus*, as well as correlation with major climate shifts through the late Pleistocene. We used two-dimensional geometric morphometrics to examine mandibles from pits 91 (29 Ka), 2051 (21 Ka), 13 (16 Ka), and 61/67 (11.5 Ka). We found that *S. fatalis* from pits 2051, 13, and 61/67 had statistically distinct morphotypes, and pit 91 had an intermediate morphotype. Individuals from 2051 were small, but robust with large canines, coronoid processes, and deep mandibles. During the LGM (Pit 13) *S. fatalis* had elongated p4s, pronounced mandibular flanges, short condyloid processes, and smaller, posterior-facing coronoid processes, an adaptation for reduced bite force, but wider jaw gape. Pit 61/67 individuals were largest despite the warming climate, but relatively gracile, with narrower canines, more pronounced mandibular flanges, shorter coronoid processes, and larger angular processes. *S. fatalis* and *C. dirus* show discordant character change through time, although prior studies suggest both species show resource stress in pit 91, and *C. dirus* shows high resource stress in pit 13. In pit 61/67 both species converge on a gracile morphology, but neither are under resource stress, suggesting that both carnivore species were doing well until the end. These results demonstrate that *S. fatalis* and *C. dirus*, although both hypercarnivores, respond differently to climate and ecosystem shifts. These differences may reflect disparate prey-killing techniques or carcass consumption strategies.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW PLIO-PLEISTOCENE VERTEBRATE SITE IN PHILLIPS COUNTY, COLORADO, PRESERVING EXCEPTIONAL REMAINS OF *STEGOMASTODON*

MEADE-HUNTER, Dena, Denver Museum of Nature & Science, Denver, CO, United States; STUCKY, Richard, Denver Museum of Nature & Science, Denver, CO, United States; HOLEN, Steven, Denver Museum of Nature & Science, Denver, CO, United States; HUNTER, Mark, Denver Museum of Nature & Science, Denver, CO, United States

The Weis Gravel Pit in Phillips County, Colorado, preserves exceptional fossil material of Plio-Pleistocene vertebrates. To date more than 12 tusks, two skulls, a lower jaw, and a partially articulated skeleton and skull of *Stegomastodon* have been excavated. Additional vertebrate remains include: a canid (metacarpal), camel (scapula, fragmentary pelvis, phalange), geomyid (tooth), a medium-sized artiodactyl (paired dentaries), horse (tooth), and a large bird (fragmentary tarso-metatarsus). Screen washed sediment recovered in a field jacket for a rib fragment has yielded a vertebra of a lizard and small mammal limb fragments. The site was discovered by a gravel pit operator during sand and gravel removal by a bulldozer from the Yuma County Road and Bridge Department. The fossil vertebrates come from a 2m sequence of cross-bedded sands and gravels and fine grain sand that lie on top of a 2 to 4 cm thick greenish gray clay. The fossiliferous layer is at a depth of approximately 5 m below ground surface. The partially articulated *Stegomastodon* skeleton includes a series of 20+ articulated vertebrae, ribs, and the pelvis, both patellae, one toe bone, the skull, both tusks which are disarticulated from the skull, a scapula, and several limb elements that remain to be excavated. The skeletal specimen lies directly on top of and partly within the greenish gray clay layer. The specimen itself is almost entirely within a fine-grained sand that has occasional 2-4 cm thick gravel lenses that are of limited extent surrounding and adjacent to some individual bones and above the clay. A fragmentary jaw from approximately 20 m distance may represent part of the same animal. Limited excavations in 2011 of the surface of the clay layer suggest the potential for footprints at the site. The site appears to represent an oxbow environment within a relatively large meandering stream complex. The overall gravel pit site occupies an area of about one and one-half acres. Future mining operations will encompass about a 10 acre area and consequently the site has great potential for being a very significant Plio-Pleistocene locality. The field work and research represent a model of collaboration between the landowner, a government agency, and the Denver Museum of Nature & Science.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE RISE OF *ISCHYRHIZA*: A ROSTRUM FROM ALABAMA

MEHLING, Carl, American Museum of Natural History, New York, NY, United States; CALLAHAN, Wayne R., New Jersey State Museum, Trenton, NJ, United States; MAISEY, John, American Museum of Natural History, New York, NY, United States; MARTIN, George, Auburn, AL, United States

The sawfish *Ischyrhiza mira*, is a very common element of Late Cretaceous marine faunas from all over North America. Both its rostral denticles and oral teeth are frequently encountered, especially in lag deposits. Even though the rostral denticles are very brittle, and are often found broken, they are very distinct in many of their features and can usually be readily recognized even in a very fragmentary condition. The oral teeth are very abundant in some deposits but are often overlooked because of their small size.

The systematic placement of *Ischyrhiza* is uncertain but has traditionally been placed in the Sclerorhynchidae, a lineage long considered convergent with modern sawfishes (Pristidae). Complete *Sclerorhynchus* specimens are known from Lebanon, sclerorhynchid rostra with teeth have been noted for the Moroccan taxa *Onchopristis* and *Schizorhiza*, and fragments identified as *Ischyrhiza mira* rostral cartilage and vertebrae have been reported. However, *Ischyrhiza mira* has only ever been confidently identified from isolated rostral denticles and oral teeth making comparisons with pristids and even other sclerorhynchids difficult.

Recently, a partial *Ischyrhiza mira* rostrum with associated rostral denticles was recovered from the Maastrichtian Ripley Formation (Selma Group) of Lowndes County, Alabama. Found in situ in the formation, the preserved portion is 56cm long, somewhat deformed, and has six rostral denticles still attached. Four more rostral denticles were recovered from matrix near the anterior end. This unique anatomical specimen promises to shed light on this enigmatic group of fishes.

Technical Session XVII (Saturday, October 20, 4:00 pm)

COMPARING LATE PLEISTOCENE WITH PRESENT-DAY AVIAN COMMUNITY STRUCTURE ON FLORES ISLAND, INDONESIA

MEIJER, Hanneke J., Division of Birds, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; JAMES, Helen F., Division of Birds, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; SUTIKNA, Thomas, The National Research and Development Centre for Archaeology, Jakarta, Indonesia; DUE, Rokhus A., The National Research and Development Centre for Archaeology, Jakarta, Indonesia; TOCHERI, Matthew W., Human Origins Program, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States

Wedged in between the large continental landmasses of Asia and Australia, Wallacea constitutes a transitional biogeographic zone renowned for its unique biotic assemblages. While it is largely undisputed that the Wallacean biota is derived from the two large continental areas enclosing it, the details are poorly understood. Liang Bua, on the Indonesian island of Flores, has yielded a rich late Pleistocene and Holocene faunal sequence that can provide important insights into the evolutionary and ecological history of this Wallacean community. In the late Pleistocene, Flores was home to an endemic vertebrate fauna, including the pygmy elephant *Stegodon florensis insularis,* a small species of hominin *Homo floresiensis,* giant rats including *Papagomys,* and Komodo dragons *Varanus komodoensis*. The late Pleistocene avifauna of Liang Bua, composed of at least 23 taxa, represents the first Pleistocene record of an avian community in Wallacea. Here, we present a comparison of the non-passerine Pleistocene avifauna of Liang Bua with that represented by the extant bird community on Flores in terms of body size distribution, feeding guild membership, and habitat spectrum. The results indicate that, despite the disappearance and likely extinction of *Homo floresiensis* and *Stegodon florensis insularis* toward the end of the late Pleistocene, the avifauna remained relatively unaffected by extinction and accompanying change in community structure. The loss of the giant stork *Leptoptilos robustus* and the vulture *Trigonoceps* sp. agrees with prehistoric extinctions observed on other islands and continents, which are generally biased towards larger body sizes. Despite the loss of a few large-bodied taxa, the distribution of body size in the late Pleistocene avifauna is not statistically different from the extant one. Also, the feeding guild membership and habitat spectrum of the late Pleistocene do not differ from the extant avifauna. This is in contrast to other fossil avifaunas, such as those on Hawaii, where prehistoric extinctions significantly altered avian community structure. This suggests that the Pleistocene avifauna on Flores was either less affected by extinctions than was the case on many other islands, or recovered quickly. Additionally, the relatively low extinction rate for birds on Flores suggests that population connectivity with nearby islands protected birds against extinction.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

DESCRIPTION OF A JUVENILE *DIPLODOCUS* FROM DINOSAUR NATIONAL MONUMENT, UTAH AND ITS ONTOGENETIC IMPLICATIONS

MELSTROM, Keegan, University of Michigan, Ann Arbor, MI, United States

Articulated juvenile sauropod material is exceptionally rare and can give unique insights into morphological changes experienced during ontogeny. I describe the partial skeleton of a juvenile *Diplodocus* individual from the Morrison Formation of Dinosaur National Monument, Utah and examine both serial and ontogenetic variation. Vertebral remains are articulated and include three posterior cervical vertebrae, ten dorsal vertebrae, five sacral vertebrae, and at least three caudal vertebrae. Appendicular remains include fragmentary pelvic elements, a partial right femur, and a left femoral head. Small body size, lack of fusion of neurocentral sutures in presacral vertebrae, and the absence of lines of arrested growth in the femur indicate the individual is a juvenile. The excellent preservation of the vertebral column allows documentation of both serial and ontogenetic morphological changes in

Diplodocus. Pneumatic fossae are found in the centrum and neural arch in the posterior cervical series of this juvenile specimen. The pleurocentral fossae are shallower and divided by fewer internal laminae than in more mature specimens. The cervical prezygapophyses extend far anteriorly, terminating above the pneumatic cavity of the preceding vertebra. This condition differs from adults, in which prezygapophyses end above the cotyle of the preceding vertebra. The postzygapophyses of the juvenile are nearly level with the neural spines, whereas the postzygapophyses of adults are more ventrally positioned. Pneumaticity in the dorsal vertebrae varies serially. Large pneumatic fossae punctuate the anterior 4 dorsal centra, but these spaces are occupied by extremely reduced, shallow depressions in dorsal vertebrae 5 and 6. Posterior dorsal vertebrae 7-10 have well-developed pneumatic fossae that resemble those in the anterior dorsal centra. This variation in the middle of the dorsal series may represent a pneumatic hiatus. The nearly complete sacrum illustrates patterns of fusion among the interneural, costovertebral, and intercostal junctions. Interneural junctions s1/2 and s2/3 are already closed in this individual, but more posterior interneural junctions remain unfused. Costovertebral junctions are nearly completely fused in this specimen, save the final costovertebral junction. Intercostal junctions were likely the last osteological unit of the sacrum to completely fuse, with no sutures having fused in this specimen. Additional, well-preserved individuals representing other ontogenetic stages will shed light on the ontogenetic and serial variation in *Diplodocus*.

Technical Session II (Wednesday, October 17, 8:45 am)

IDENTIFICATION OF THE BONES OF THE SNOUT IN LOWER ACTINOPTERYGIANS — A NEW NOMENCLATURE SCHEME BASED ON CHARACTERS

MICKLE, Kathryn E., University of Kansas, Lawrence, KS, United States

Currently, there is no standardized nomenclatural scheme for identifying and naming the bones of the snout in lower actinopterygian fishes. This creates a situation where the same bone names are used to identify very different bones. This is problematic because it makes comparing previously described taxa difficult, presents potential pitfalls when building character matrices for phylogenetic analyses, and impairs our understanding of the diversity of lower actinopterygians. Because of the problems the absence of a standardized nomenclature scheme presents, a new set of rules for the identification of the bones of the snout of lower actinopterygians is proposed. Definitions for what premaxilla, lachrymal, rostral, and postrostral bones constitute are presented. The new definitions are based on the presence of characters that are commonly preserved such as the presence or absence of sensory canal lines, location of bones in relation to other bones, and whether or not the bones contribute to the formation of the nasal openings. When numerous characters are present in a single bone, this bone is considered to be a complex bone and the name reflects this. The snout bones of various Devonian and Carboniferous actinopterygians are re-identified using this nomenclature scheme. When this is done, patterns regarding the makeup of the snout in Devonian and Carboniferous fishes emerge. The snouts of Carboniferous fishes show much more diversity than those of Devonian fishes. Devonian fishes are characterized by a more generalized snout. In depth investigations into characters such as the bones of the snout are important for forming a stronger understanding of the morphological diversity of lower actinopterygian fishes and have implications for phylogenetic studies. When the snout characters in a character matrix are recoded using this terminology and phylogenetic analysis is performed, the resultant tree has clades of lower actinopterygian fishes supported by the revised characters. This tree and the clades supported by the newly defined snout characters are presented and discussed here. For example, there are clades supported by the presence of different complex premaxillary bones and another clade supported by the presence of a separate and distinct premaxilla. Reinvestigating the snout bones of lower actinopterygians is important for understanding morphological diversity and relationships of these fishes. More in depth investigations into specific characters are necessary in the future.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DISTRIBUTIONAL PATTERNS OF †MAWSONIIDAE (SARCOPTERYGII: ACTINISTIA): A TRACK ANALYSIS

MIGUEL, Raphael D., Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil; GALLO, Valéria D., Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil; MORRONE, Juan J., Universidad Nacional Autónoma de México, Distrito Federal, Mexico

Mawsoniidae are a fossil family of actinistian fish popularly known as coelacanths, which are found in continental and marine paleoenvironments. The taxon was proposed in the 1990's and is considered monophyletic according to the most recent reviews. It includes five valid genera (*Axelrodichthys*, *Chinlea*, *Diplurus*, *Mawsonia*, and *Parnaibaia*) and 11 genera with some taxonomical controversy (*Alcoveria*, *Changxingia*, *Garnbergia*, *Heptanema*, *Indocoelacanthus*, *Libys*, *Lualabaea*, *Megalocoelacanthus*, *Moenkopia*, *Rhipis*, and *Trachymetopon*). Mawsoniidae possess a remarkable biogeographical significance due to their extensive temporal range, from the Late Triassic to the Late Cretaceous, and a wide geographical distribution in the Americas, Africa, Asia, and Europe. The genera restricted to the Northern Hemisphere (*Diplurus* and *Chinlea*) possess the oldest records (Late Triassic), whereas those found in the Southern Hemisphere (*Mawsonia*, *Axelrodichthys*, and *Parnaibaia*) extend from Late Jurassic to Late Cretaceous, especially in Brazil and Africa.

We analyzed the distribution patterns of Mawsoniidae, includingall genera, applying a track analysis, which obtained 12 individual species tracks and three generalized tracks (GTs). GT1 (Northeastern Newark) occurs in strata of the Newark Group (Upper Triassic); GT2 (Midwestern Gondwana) occurs in the Lualaba Formation (Upper Jurassic); and GT3 (Itapecuru-Alcântara-Santana) occurs in the Itapecuru-Alcântara-Santana formations (Lower Cretaceous). Individual tracks were also obtained for genera by geological periods, showing congruence with the individual species tracks. The origin of Mawsoniidae can be dated to the Late Triassic of Pangaea. The tectonic events related to the breakup of Pangaea and Gondwana and the evolution of the oceans are suggested as the vicariant events affecting the distribution of this taxon throughout the Mesozoic. The results highlight the potential of the panbiogeographical approach for analyzing distributional patterns of fossil taxa.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EXTRACTION AND ANALYSIS OF INGESTA IMPACTED IN THE DENTITIONS OF MODERN UNGULATES: NEW EVIDENCE FOR LINKING DENTAL WEAR AND FEEDING ECOLOGY

MIHLBACHLER, Matthew C., New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States; BEATTY, Brian L., New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States; AYOUB, Michael, New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States

Dental microwear and mesowear analyses rely on observations of feeding ecology and dental wear in living species. Aspects of dental wear that separate grazers from browsers, such as blunted cusps and excessive numbers of scratches, are thought to be a consequence of high concentrations of phytoliths found in grasses and/or ingestion of abrasive food contaminants (e.g. sand) associated with feeding near the ground. Data pertinent to dental wear, such as ingested sand, are rarely available. However, ungulate skulls often contain ingesta impacted in the infundubula of the teeth. Samples of impacted ingesta are unique because they accumulate over the life of the animal and mostly likely represent a life-long record of ingestion rather than the last few meals represented by fecal or gastric samples. We extracted samples (N=40) of dentally impacted ingesta from two African browsers, black rhino and giraffe, and two grazers, white rhino and zebra, and compared the relative frequencies of grass, wood, and inorganic particles in these samples with microwear and mesowear. To assess the potential of these samples as proxies for feeding habits, we categorized and measured ingesta particles in low-mag photomicrographs.

The compositions of the samples were highly reflective of the known feeding ecologies of the species examined. The ingesta of the browsers contained primarily wood fragments and low concentrations of sand particles. The ingesta of the grazers contained mostly grass fragments with high concentrations of sand particles. The observed abrasive particles were overwhelmingly sand grains (primarily quartz), which were generally several times wider than the microwear features observed on the specimens from which the samples were extracted. This size relationship is consistent with the sand contributing to the microwear. Isolated phytoliths were rare including samples from grazers and, on average, were smaller than the sand grains. Ingesta composition was related to mesowear and microwear. The bluntest and lowest relief cusp apices were associated with the highest concentrations of sand grains. Likewise, higher concentrations of sand were associated with higher concentrations of scratches quantified on molar paracones. A relationship with pits was less apparent. We conclude that dentally impacted ingesta are a valuable resource for investigating the relationship of feeding ecology and dental wear in ungulates, although some complications exist. For example it is unclear if there are sampling biases during ingesta impaction. It will be worthwhile sampling more species in this manner and developing more sophisticated methods for measuring and understanding such samples and how they related to feeding ecology and dental wear.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

TAPHONOMIC DIFFERENCES BETWEEN FOX AND WOLF DENS

MILIDEO, Lauren, Penn State University Department of Geosciences, University Park, PA, United States; GRAHAM, Russell, Penn State University Department of Geosciences, University Park, PA, United States

Interpretation of paleontological sites is dependent upon understanding the ways in which bone accumulations form. Workers wishing to extract paleoecological information from fossil bone assemblages must first determine the temporal and spatial scales that they represent. For example, the degree of time-averaging may indicate the temporal precision of paleoecological information contained in an assemblage. Many taphonomic processes, including transport of partial or complete carcasses, bone weathering, or density-mediated bone destruction, all may remove elements from the original bone assemblage, yielding fossil materials that may reflect their ecosystem only in part. Site formation processes are therefore an essential component of a rigorous understanding of vertebrate assemblages and subsequent paleoecological study.

Modern den and lair sites (hyena, fox, puma) have been studied as possible proxies for fossil bone accumulation localities. Here, we present a comparison of fox (*Vulpes vulpes*) and wolf (*Canis lupus*) den assemblages from Nunavut, Canada. We statistically compare bone damage (particularly processes reflecting carnivore consumption), bone weathering, and the identities and quantities of elements and taxa present. Additionally, we employ GIS software to examine differences in spatial statistical patterns. This study, part of a larger ongoing actualistic taphonomic project, has identified several patterns in the taphonomy of these different den types. These include divergence in taxa types and sizes present, as well as spatial differences between the bone distributions at each den. Such data will aid interpretations of fossil localities, yielding a means of understanding the processes in effect, and accounting for the taphonomic alterations that these processes create.

Technical Session III (Wednesday, October 17, 3:15 pm)

LUMBAR MORPHOLOGY OF SUSPENSORY, GLIDING AND FLYING MAMMALS: IMPLICATIONS FOR THE LOCOMOTOR BEHAVIOR OF SELECT FOSSIL PRIMATES

MILLER, Charlotte E., Duke University, Durham, NC, United States; GRANATOSKY, Michael C., Duke University, Durham, NC, United States; CHESTER, Stephen G., Yale University, New Haven, CT, United States; BOYER, Doug M., Brooklyn College, New York, NY, United States; SCHMITT, Daniel, Duke University, Durham, NC, United States

Lumbar vertebral morphology has been used as an indicator of locomotor behavior in living and fossil mammals. Rigidity within the lumbar region is thought to have importance for increasing overall axial rigidity during various forms of locomotion, including bridging between supports, inverted quadrupedalism, gliding, and flying. But distinguishing between those behaviors using bony features has been challenging. This study used osteological characters of the lumbar spine that appear to limit lumbar mobility in a broad phylogenetic sample of extant taxa, including members of Dermoptera, Chiroptera, Scandentia, Primates, Pilosa, Rodentia, and Marsupialia, representing a wide range of locomotor behaviors. These same lumbar characters were measured in three extinct species for which locomotor behaviors have been debated, the sloth lemurs (*Paleopropithecus* and *Babakotia radofilai*) and paromomyid plesiadapiforms (*Ignacius graybullianus*), in order to further investigate their possible locomotor and positional behaviors.

Results from a principal components analysis of six geometric mean standardized measurements demonstrate that suspensory taxa are characterized by short and cranio-caudally expanded spinous processes and relatively short transverse processes compared to scansorial and gliding mammals. Both dermopterans and chiropterans exhibit these traits and cluster most closely with committed inverted quadrupeds in this sample. The sloth lemur *Babakotia radofilai* groups closely with primate taxa like the lorises and *Pongo*, while *Paleopropithecus* groups with extant sloths. In accordance with previously conducted studies, these finding suggests that *Paleopropithecus* was engaged in inverted quadrupedalism at a high frequency, while *Babakotia radofilai* may have engaged in a more diverse array of locomotor and positionalbehaviors. Corroborating previous studies of the lumbar region, *Ignacius graybullianus* is found to be most similar to scansorial taxa: it shares no similarities in these characteristics with extant mitten-gliders. If the lumbus of suspensory forms is less mobile than that of non-suspensory taxa, then the osteological characters we have measured appear to reflect those differences well and suggest that axial rigidity is advantageous for suspensory locomotion and possibly flight in bats. Furthermore, lumbar rigidity, as reflected by our measurements, would appear to have arisen independently among multiple mammalian lineages.

Technical Session XIX (Saturday, October 20, 3:15 pm)

TEMPORAL MEGABIAS: LATITUDINAL CONTROLS ON TIME-AVERAGING OF TERRESTRIAL DEATH ASSEMBLAGES AND THEIR ECOLOGICAL DATA

MILLER, Joshua H., Florida Museum of Natural History, Gainesville, FL, United States

Maximum survival durations of bones on landscape surfaces are primary controls on the ecological data captured by death assemblages. Particularly if time-averaging is significantly different among climatic settings or across latitudes (even among constant sedimentation rates), death assemblages from similar, or even identical communities could capture different ecological data. Paleoecological comparisons among fossil assemblages from strongly different communities, latitudinal settings, and across geologic time must be cognizant of inherent differences in time-averaging. Here, I test for differences in time-averaging of modern large-mammal death assemblages in tropical, temperate and arctic settings. I also test for climatic and ecological controls on the weathering stage frequency distribution of landscape bone accumulations across this latitudinal gradient. To test the survival durations of bones on arctic landscapes, I radiocarbon-dated 50 antlers, bones, and teeth of adult and neonatal caribou (*Rangifer tarandus*) recovered from bone surveys of Alaska's North Slope (Arctic National Wildlife Refuge). To test for differences in time-averaging durations across latitude, these new data are paired with existing data on survival durations of ungulate bones from high arctic, temperate, and tropical landscapes (including radiocarbon dating and observations of carcasses with known postmortem duration). Clear latitudinal controls on bone survival durations are observed, with time-averaging increasing by successive orders of magnitude between latitudinal bins: maximum bone survival reaches decadal time-scales in the tropics, centennial time-scales in temperate regions, and millennial time-scales in the arctic. While over-all time-averaging duration is driven by climate, the frequency distribution of bone weathering stages is strongly influenced by ecological history, particularly species' population stability (or lack thereof). Ecosystems with significantly different time-averaging durations can produce highly-similar weathering stage frequency distributions, illustrating that such comparisons are not necessarily straightforward. Environmental and ecological settings with faster bone recycling rates (the tropics) may be particularly adept at capturing ecological changes across decadal timescales, without significant blurring by generations from prior centuries or beyond. Colder, more northern ecosystems, including those in temperate and arctic settings, offer extended observational windows, which are particularly insensitive to high-frequency ecological variability. Establishing and/or acknowledging differences in temporal resolution among death assemblages is an important component of any paleoecological comparison.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

ARE *LYSTROSAURUS DECLIVIS* AND *LYSTROSAURUS MURRAYI* SEPARATE SPECIES OR SEXUAL DIMORPHS?

MILLER-CAMP, Jessica, University of Iowa, Iowa City, IA, United States

Sexual dimorphism is present in many vertebrate species. In some cases size is the only noticeable difference, while in others shape is the dominant variable. Detecting sexual dimorphism in extinct species is difficult and must take into account effects from sample size, individual variation, and ontogeny. It can, however, be important for species discrimination. Dimorphism has been proposed in several dicynodont genera. In *Diictodon* and *Aulacephalodon*, it is based on the presence or absence of tusks in adult individuals. Tusks are present in all adult specimens of *Lystrosaurus,* but sexual dimorphism has been postulated on the basis of differences in skull shape and the degree of development of cranial ornamentation. Some researchers have suggested that two species, *Lystrosaurus declivis* and *Lystrosaurus murrayi,* are sexual dimorphs of a single species. Methods used to reach these conclusions are theoretically faulty in several ways, such as using regression lines to search for a 50/50 ratio of morphotypes, assumed to be indicative of a dimorphic species. Additionally, they were never tested on datasets with known gender identifications.

I randomly generated a simulated dataset whose "individuals" were of known sex in a dimorphic species based on *Lystrosaurus* measurements from previous studies. I then randomly sub-sampled the larger dataset to create smaller sets with a variety of male-female ratios. Applying methods previously used to detect dimorphism consistently resulted in a Type 1 error. This indicates that previous methods cannot reliably detect dimorphism and should no longer be used. Qualitative examination of *L. declivis* and *L. murrayi* showed that some traits previously associated with "robust" adults occur in small juveniles of *L. declivis*, causing them to superficially resemble adult *L. murrayi*. This pattern is attributable to peramorphism in *L. declivis* rather than to sexual dimorphism between the two taxa. Additionally, geometric morphometric analyses show statistically significant separation between the two species. These results support the taxonomic distinctness of *L. declivis* and *L. murrayi*.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW MATERIAL OF A LARGE-SIZED MICROCHOERINAE (OMOMYIDAE, PRIMATES) FROM THE LATE EOCENE SITE OF SOSSÍS (NE SPAIN)

MINWER-BARAKAT, Raef, Institut Català De Paleontologia Miquel Crusafont, Cerdanyola Del Vallès, Barcelona, Spain; MARIGÓ, Judit, Institut Català De Paleontologia Miquel Crusafont, Cerdanyola Del Vallès, Barcelona, Spain; MOYÀ-SOLÀ, Salvador, ICREA at The Institut Català De Paleontologia Miquel Crusafont, Cerdanyola Del Vallès, Barcelona, Spain

The locality of Sossís (Southern Pyrenean Basin, Northeastern Spain) is one of the most important Eocene fossil sites from the Iberian Peninsula. It has yielded a large number of vertebrate remains that have allowed the recognition of more than thirty mammal taxa, including marsupials, insectivores, rodents, carnivores, creodonts, perissodactyls, artiodactyls and primates. This assemblage has been assigned to the Late Eocene (Headonian, MP17a). Among primates, several forms have been identified from Sossís. Previous reports included two isolated teeth of a large adapine determined as *Adapis* cf. *parisiensis*, a mandible of a small microchoerine assigned to *Pseudoloris parvulus* and several specimens of a large microchoerine, which was referred in different works either to *Microchoerus erinaceus* or to *Necrolemur erinaceus* (including erroneously the species *erinaceus* in the genus *Necrolemur*). The published material of this latter taxon consisted of a mandible with c1-m3 and three fragments of maxillae with P3-M3, M1-M3 and M1-M2.

Later excavations at this fossil site led to the recovery of a large amount of well-preserved material, including additional specimens of the three primates mentioned above, as well as some teeth that have allowed the recent identification of a fourth taxon, which most probably belongs to a new, still undefined, genus of Anchomomyini. The new, unpublished, material of the large-sized microchoerine from Sossís includes four fragments of mandibles and three fragments of maxillae bearing several teeth and more than 100 isolated teeth, with almost all the dental elements being represented. This material constitutes, by far, the most complete sample of the *Necrolemur-Microchoerus* lineage found in the Iberian Peninsula.

A preliminary observation of the large microchoerine from Sossís (both the unpublished material and that previously published) reveals metric and morphologic differences with the type population of *M. erinaceus* from Hordle Cliff. Some of the most remarkable dissimilarities are the smaller size, the absence of mesostyle in the upper molars, and the less accentuated enamel wrinkling in the lower molars from Sossís. Therefore, the previous specific determination of this material seems to be incorrect. Further detailed study of these remains will surely permit providing a precise determination and clarifying the position of the population from Sossís within the *Necrolemur-Microchoerus* lineage.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

SMALL IS BEAUTIFUL: THE ERQUELINNES MAMMAL FAUNA FROM THE EARLIEST EOCENE OF THE SOUTHERN MONS BASIN, BELGIUM

MISSIAEN, Pieter, Ghent University, Ghent, Belgium; QUESNEL, Florence, BRGM, Orléans, France; DUPUIS, Christian, Polythech Umons, Mons, Belgium; STORME, Jean-Yves, FUNDP, Namur, Belgium; SMITH, Thierry, RBINS, Brussels, Belgium

In 1880, the early Eocene fluvial deposits of the Erquelinnes sand quarry in the southern part of the Mons basin in Belgium yielded their first mammal fossil, a well preserved jaw of a primitive perissodactyl. By 1927, about 40 mammal specimens had been recovered from Erquelinnes and were attributed to *Adapisorex*, '*Protomomys*', *Paramys*, *Plesiadapis*, *Arctocyonides*, *Hyracotherium*, *Coryphodon* and '*Oxyaena* or Miacidae'. By that time however, the Erquelinnes fauna had already been eclipsed by the contemporaneous Dormaal fauna from northeastern Belgium, which yielded thousands of specimens rather than only a few dozen. Since then, attention for the Erquelinnes fauna has therefore been limited to the passing mentions of referred specimens in the formal descriptions of the new plesiadapiform *Platychoerops georgei* and of the miacid *Gracilocyon solei*.

Here we present an updated faunal list of the complete Erquelinnes mammal fauna. We show that also hyaenodontids, mesonychids, hyopsodontids, and dichobunid artiodactyls are present in the Erquelinnes fauna, and some of the earlier identifications are corrected or detailed further. This update of the Erquelinnes mammal fauna almost doubles its diversity, and strengthens the correlation with the earliest Eocene (MP7) Dormaal reference fauna. Results from $\delta^{13}C_{org}$ analysis of the mammal-bearing level at Erquelinnes and the strata immediately below it, seem to independently support the faunal correlation. Faunal differences between Erquelinnes and Dormaal are most likely the result of subtle differences in depositional environments and thus in taphonomic bias. Details of the stratigraphic origin of the Erquelinnes perissodactyl specimens however show that these are derived from two distinct stratigraphic levels, which potentially have significantly different age correlations.

Technical Session XVII (Saturday, October 20, 3:00 pm)

PALEOECOLOGY OF THE JEHOL BIRDS INFERRED FROM MODERN BIRD ECOMORPHOLOGY

MITCHELL, Jonathan S., The University of Chicago, Chicago, IL, United States; MAKOVICKY, Peter J., The Field Museum of Natural History, Chicago, IL, United States; GAO, Ke-Qin, Peking University, Beijing, China

Birds are a major component of modern faunas across the globe, with a staggering amount of ecological diversity. Although the avian fossil record is better than often assumed, it is still sparse enough to make studying the evolution of ecomorphological diversity in birds difficult. Further, all crown and many stem birds lack teeth, obscuring dietary inference in paleoecological settings. To address this problem quantitatively, we scored over 500 genera of living birds for 17 binary ecological variables (e.g., occurrence in lakes, consumption of seeds) and took linear measurements of limb bone lengths of over 1000 specimens of those same genera, representing most modern families. Canonical correlations resulted in six axes with Pearson's correlation coefficients of 0.825, 0.66, 0.554, 0.51, 0.427, and 0.271. Independent contrasts were computed using a published family-level phylogeny of 119 bird taxa, and further supported the coevolution of morphology and ecology (Pearson's r = 0.58). These same measurements were made on over 100 fossils from the Jehol Biota, representing over 30 named genera of early avian taxa. We projected the measurements from the fossil taxa into the canonical space defined by the correlations between modern bird ecology and morphology, and then computed the distances between each fossil taxon and all of the modern taxa. We used these distances to establish distributions for each fossil, and then found the modern birds that were more than 1.645 standard deviations (the 90% confidence limit) closer to the fossil taxa than their mean distance. These modern birds were then considered the robust analogues. Concurrent with previous reconstructions, *Gansus* was found to be closest to the foot-propelled diver *Podilymbus* in our analysis, and despite not including beak characters, the longipterygid taxa were often exceptionally similar to long-billed taxa such as *Colaptes* and *Galbula*. Enantiornithines in general clustered close to cuckcoos (especially *Cuculus* and *Chrysococcyx*) while more basal birds such as *Confuciousornis* tended to cluster by phasianids (especially *Coturnix* and *Lagopus*, also the trogonid *Pharomachrus*). Without including external data on gut contents or beak shape, our method is prone to clustering many ground-dwelling taxa with owls, as they have evolved an exceptionally short tarsometatarsus for the purposes of prey handling, rather than locomotion. On the whole, the avifauna of the Jehol biota was more heavily weighted towards taxa that do the bulk of their foraging on the ground or in forests, with fewer taxa reliant on aerial or aquatic foraging, than modern avifaunas, even when taphonomic biases are taken into account.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

CRANIAL MUSCULATURE OF LIVING JAWLESS FISHES TESTS CYCLOSTOME MONOPHYLY AND CONSTRAINS THE HEAD ANATOMY OF A GNATHOSTOME ANCESTOR

MIYASHITA, Tetsuto, University of Alberta, Edmonton, AB, Canada

At the root of vertebrates, hagfish and lampreys collapse into a polytomy. The two surviving lineages of jawless fishes form the clade Cyclostomata in the majority of molecular phylogenetic analysis, whereas hagfish tend to fall outside the Vertebrata (lamprey+gnathostome) in analyses using morphological data. Does this classic example of molecular-morphological conflict stem from problems inherent to the types of data, or from the lack of a comparative framework? The cranial musculature is a promising set of morphological characters that appear to support cyclostome monophyly. I test previously posited homologues in the cranial musculature of hagfish and lampreys based on the following partly correlated criteria: attachment site, innervation pattern, position relative to other cranial tissues, functional similarities, and, where possible, published accounts of development. Homologues in the cranial musculature of hagfish and lampreys are established at more than one level of organization. That is, a group of muscles may withstand a test of homology, but individual muscles may or may not be compared. To highlight examples, I emphasize the muscle groups controlled by the trigeminal and facial nerves.

The hierarchical organization of the vertebrate cranial musculature depends on the partly interdependent criteria of homology, which may exaggerate or underestimate the level of support. Therefore, putative homology cannot be easily extended to distant living relatives. In the vertebrate phylogeny, the stages at which a cascade of homologues breaks down coincide with the stages onto which a large number of character changes are mapped. After incorporating the nested patterns of homologues in coding of the characters, the cranial musculature neither supports nor rejects cyclostome monophyly. The solution to this problem lies in identifying possible correlates of the cranial muscles in fossil jawless vertebrate lineages. A phylogenetic bracket approach potentially shifts the basal vertebrate phylogeny from the modern view of successive acquisition of gnathostome-like characteristics to a highly divergent, mosaic pattern of character evolution among the lineages.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW INFORMATION ON BASICRANIA OF *TROGOSUS* (TILLODONTIA, MAMMALIA) WITH AN EXQUISITELY PRESERVED PETROSAL

MIYATA, Kazunori, Fukui Prefectural Dinosaur Museum, Fukui, Japan; DEMERE, Thomas A., Department of Paleontology, San Diego Natural History Museum, San Diego, CA, United States

Tillodonts, archaic herbivorous eutherian mammals with elongated incisors (I2s and i2s), have been described from Upper Paleocene through Middle Eocene deposits in North America and Eurasia (Canada, USA, France, Germany, India, Pakistan, China, and Japan). Many tillodont fossils are represented by only whole or partial dentitions and crania and postcrania are unfortunately rare. Important exceptions to this are Bridgerian age specimens of *Trogosus* and *Tillodon* from the Green River Basin, Wyoming, USA and the Huerfano Basin, Colorado, USA. Even more rare are tillodont specimens with well preserved basicrania. Consequently, little is known about functionally and phylogenetically important features such as those associated with the auditory region. The recently prepared skull of *Trogosus* sp. (SDSNH 40819) from the Delmar Formation (Bridgerian) of coastal San Diego County, California, USA provides the best anatomical information for the tillodont basicranium, with an almost complete petrosal area. Based on this new specimen it is possible to describe for the first time the anatomy of the auditory region in the order Tillodontia. Incomplete but unique stylohyoids are also associated with the skull in SDSNH 40819. The anteroposteriorly shortened basicrania of *Trogosus* sp. has an occipitomastoid process with a knobbed head, lateral to the occipital condyle. SDSNH 40819 clearly demonstrates that this process consists of the mastoid process of petrosal (anterolateral half) and the paroccipital process of the exoccipital (posteromedial half). Further, the mastoid process is restricted dorsally between the posttympanic process of the squamosal and the exoccipital. The petrosal of *Trogosus* sp. conforms well to a plesiomorphic morphotype, except for the well developed tympanohyal. The tympanohyal is developed as a flange approaching closely beneath the posterior portion of the promontorium, and showing a small and shallow depression on the ventral surface which probably is associated with the stylohyoid. A small fissure-like stylomastoid foramen exists just medial to the tympanohyal. Just medial to the anterior flange of the tympanohyal is a tiny bone provisionally assigned to the malleus. This bone is positioned near the external acoustic meatus. The protuberant promontorium on both sides show a defined sulcus for the stapedial artery. The anterolateral edge of the jugular foramen on either side is lobated with small notches, suggesting the passages of nerves. Future analysis of this new specimen using computed tomography (CT) will likely reveal additional new anatomical information about tillodont cranial anatomy.

Technical Session IX (Friday, October 19, 10:15 am)

VERTEBRAL MORPHOLOGY AND AXIAL MECHANICS IN EARLY CROCODYLOMORPHS AND MODERN CROCODILES

MOLNAR, Julia L., Royal Veterinary College, Hawkshead Lane, Hatfield, United Kingdom; PIERCE, Stephanie E., Royal Veterinary College, Hawkshead Lane, Hatfield, United Kingdom; TURNER, Alan H., Stony Brook University, Stony Brook, NY, United States; HUTCHINSON, John R., Royal Veterinary College, Hawkshead Lane, Hatfield, United Kingdom

In contrast to extant crocodylians, early crocodylomorphs such as *Protosuchus* and 'sphenosuchians' are thought to have had a fully erect posture, extraordinary athleticism on land, and almost exclusively terrestrial lifestyles. Previous studies have noted anatomical differences in the axial skeleton that may be responsible for these functional differences; for example, it has been postulated that the morphology of the trunk of *Protosuchus* was specialized for fast terrestrial locomotion and would not have allowed significant lateral undulation (or swimming), in contrast to the 'eusuchian' trunk, which mainly permits mediolateral movements during terrestrial and aquatic locomotion. However, the hypothesized relationship between vertebral morphology and mechanical properties in crocodile-line archosaurs has not yet been tested experimentally or quantitatively. Here we present a rigorous biomechanical assessment of these two disparate locomotor styles. Using 5 cadaveric specimens, we first tested the stiffness of intervertebral joints along the dorsal column of *Crocodylus niloticus* in dorsal, ventral, and mediolateral flexion. We then built functional profiles of the vertebral columns of *C. niloticus* and *Protosuchus richardsoni* (with 3D segmentation of CT scan data from the type specimen) using measurements that have been correlated with axial stiffness in mammals. The results of the intervertebral joint

stiffness experiment demonstrate that the vertebral column of *C. niloticus* has a greater propensity (i.e. increased flexibility) for mediolateral rather than dorsoventral mobility and an increase in mediolateral stiffness in the lumbar region, both of which directly correspond to vertebral measurements. Thus, morphometric parameters appear to have the power to predict vertebral mechanics in modern crocodiles and (with caution) in their extinct relatives. Comparison of the functional profiles between *C. niloticus* and *P. richardsoni* shows that the lumbar region of *P. richardsoni* has several characteristics that are associated with increased dorsoventral flexibility, including more vertically oriented pre-zygapophyses, an increase in centrum width, and more laterally extending transverse processes. These results support the notion that the vertebral column of early crocodylomorphs favoured dorsoventral lumbar motion (necessary for bounding/galloping gaits) to a degree exceeding that in extant Crocodylia. This work provides an objective basis for reconstructing the locomotor evolution of crocodile-line archosaurs, and also provides clues about the anatomical basis for the remarkable locomotor abilities of modern crocodylians.

Romer Prize Session (Thursday, October 18, 11:15 am)

STABLE ISOTOPE ECOLOGY OF VERTEBRATES IN ARID ENVIRONMENTS: ARCHIVES OF ENVIRONMENT AND CLIMATE IN THE FOSSIL RECORD

MONTANARI, Shaena, American Museum of Natural History, New York, NY, United States

Terrestrial paleoenvironmental archives contained in biogenic materials provide essential information for examining past climates in arid locations where other types of records may not be available. Fossilized remains, such as teeth and eggshell, can be analyzed for stable isotopes (carbon and oxygen) to determine the environment and ecology of species-rich localities. During the Cretaceous in Central Asia and the Pliocene of Australia, environments were becoming increasingly arid, leading to dramatic faunal and floral turnovers. To understand the paleoecology of these systems, it is vital to track how environments and fauna change on a local scale in response to large-scale climatic change. Here, geochemical methods are used to evaluate the biogenic archives contained in dinosaur and marsupial remains from the Cretaceous of Mongolia and the Pliocene of Australia. Carbon isotope values of vertebrate remains record the diet of the organism, while oxygen isotope values indicate the type of water source from which the individual was drinking Tooth enamel from the ubiquitous *Protoceratops* and fragments of oviraptorid eggshell from three localities in the Gobi Desert are analyzed for carbon and oxygen isotopes to constrain understanding of the environment of this locality roughly 80 million years ago. The stable isotope values of these biogenic minerals shows that these localities, which supported a rich species level diversity of dinosaurs and other vertebrates, were arid with xeric plants (estimated $\delta^{13}C$=~22.0‰) and small, isolated bodies of water. During the Pliocene in southeastern Queensland, Australia grasslands were hypothesized to have been spreading across Australia, providing rich fodder for the diverse large bodied marsupial community. The tooth enamel of kangaroos such as *Macropus* and the extinct giant herbivorous marsupial *Euryzygoma* indicates that the environment of the early Pliocene locality Chinchilla Sands consisted of a range of microhabitats, from woodlands to grasslands, with $\delta^{13}C$ of enamel ranging between -15.8 and -3.5‰. Grasslands thus had spread across eastern Australia by this time, but were not the sole source of plant fodder at this locality. Without these biogenic archives, we would be unable to determine the vegetation and hydrologic structure of these ancient arid environments. Stable isotopes are a tremendously powerful tool for examining the paleoenvironments and ecology of these extinct vertebrates and make it possible to unite environments and communities in deep time.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

RECORD OF TAYASSUIDS IN ?PLIOCENE-QUATERNARY DEPOSITS IN VENEZUELA

MONTELLANO, Marisol, Instituto de Geologia, UNAM, Mexico, Mexico; RINCÓN, Ascanio D., Instituto Venezolano de Investigaciones Cientificas, Caracas, Venezuela; SOLORZANO, Andres, Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela

Today the Tayassuidae is represented by at least four extant species distributed throughout the Americas, from south-western United States to north-central Argentina. It is one of the immigrants that entered South America during the Great American Biotic Interchange, the oldest unquestionable records date to the beginning of the middle Pliocene in Argentina. Three genera are recognized in South America:*Platygonus* (middle Pliocene-early Pleistocene), *Catagonus* (late Pliocene-Recent), and *Tayassu* (middle Pleistocene-Recent), most of the South American records come from Argentina, Uruguay and Brazil.

In the last decade, discoveries of fossiliferous tar pits in northern Venezuela revealed a rich and diverse vertebrate fauna that includes remains of mammals, reptiles, amphibians and birds. Tayassuid material was discovered in different trenches during the excavation for an oil pipeline. Each trench was numbered and studied separately because its faunal association suggest they are not contemporaneous. Remains of *Platygonus* sp. had been already reported from the tar pit known as Orocual (ORS-16, ?Pliocene-middle Pleistocene). *Platygonus* was very common and diverse in Argentina during late Pliocene and dissappeared during the early-middle Pleistocene. This Venezuelan find represents the northernmost record in South America and is intermediate between the northern and southern populations of the continent. Recently, 10 partial lower jaws with teeth in different stages of wear were recovered, as well as isolated upper molars and fragments of maxilla bearing teeth, from another trench, ORS-20 (?late Pleistocene). The material is identified as *Tayassu pecari*, because of the molarization of premolars, development of cingula and additional accessory cusps. In this sample there is a partial lower jaw with pm4 and alveoli for pm3, pm2, which is quite similar to *Pecari tajacu*, the trigonid is larger than the talonid, and is more quadrangular in shape. In the western part of the country there is another tar pit known as “Mene de Inciarte” dated 28,000 years, a fragment of a maxilla with M1-M3 of *Pecari tajacu* was collected. Remains of *Tayassu pecari* had been recovered from several caves of Pleistocene-Holocene age, which are located in the northern part of the country.

Until now, three forms of tayassuids had been recovered from different regions of the country: *Platygonus* sp.,*Tayassu pecari* and *Pecari tajacu*. The last two now co-occur in large areas in Venezuela, but differ in the mode of resource exploitation. The Venezuelan tayassuid fossil record represents the first of these lineages in northern South America, and provides information to understand the distribution and diversity of the group in South America during the ?Pliocene-Quaternary.

Technical Session VIII (Thursday, October 18, 4:00 pm)

WHITE RIVER GROUP MAMMALS EXHIBIT ECOLOGICAL RESPONSE TO THE EARLIEST OLIGOCENE CLIMATE TRANSITION

MOORE, Jason R., Dartmouth College, Hanover, NH, United States

The earliest Oligocene marks one of the most major climate transitions in the Cenozoic. High latitude marine temperatures indicate a temperature drop of 4-5°C over the course of 300,000 years, associated with the formation of a permanent Antarctic ice sheet. Climate change in the mid-latitudes, particularly in terrestrial environments is more difficult to resolve, although there are indications of both cooling and drying, and associated faunal and floral turnover. In North America, mammalian response to this climate shift, as recorded in the classic outcrops of the White River Group, is enigmatic. Extensive museum collections show apparently little, if any, evolutionary response (extinction or origination) of the fauna during this period.

In order to determine whether, instead of an evolutionary response, the White River Group fauna exhibited an ecological response to this climate transition, new, temporally constrained samples were collected spanning the interval of the climate transition in and around Badlands National Park, SD. Extensive taphonomic data were assembled for each collected specimen, and used to establish isotaphonomy among samples. Changes in the abundances of different taxa among isotaphonomic samples indicate true ecological changes, rather than potential artefactual shifts caused by varying taphonomic bias. Analysis of the faunal structure of isotaphonomic samples across the climate transition shows a directional shift in the abundances of several taxa with time (including *Palaeolagus* and *Merycoidodon*). This is interpreted to represent an ecological response to the climate shift, as paleoenvironments become drier and more open. This is the first time such a change in faunal structure has been demonstrated using vertebrate taxa in a quantifiably isotaphonomic framework.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

INTRA-INDIVIDUAL VARIATION OF CARBON AND OXYGEN ISOTOPES WITHIN THE MIOCENE HORSE *PARAHIPPUS LEONENSIS* AND IMPLICATIONS FOR DIET

MORAN, Sean M., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

The early Miocene horse, *Parahippus leonensis*, represents an important species in the evolution of equids from browsers to grazers. Preliminary hypsodonty, dental microwear, and stable isotope data support the hypothesis of *P. leonensis* as an incipient grazer. However, the relative paucity of these data does not allow for the interpretation of dietary variation within the mineralization of an individual tooth, an individual, or an assemblage. These variations may impact conclusions drawn from any individual sample. Additionally, seasonal or ontogenic influences on diet may have been an underlying mechanism in the shift from browsing to grazing affinities in ancient horses. Stable carbon and oxygen isotope data can help to elucidate any variations in the relative proportions of C4 and C3 plant intake in diet. This study employs stable carbon and oxygen isotope data from associated, serially sampled cheek teeth of *Parahippus leonensis* to investigate intra-individual variation in diet and test the hypotheses that ontogeny and/or seasonality played a role in these variations.

Using a micromill, enamel of six associated mandibular cheek teeth was serially sampled from a *Parahippus leonensis* mandible collected from the Hemingfordian Thomas Farm site located in Gilchrist County, Florida. Approximately 50 samples were collected and analyzed for carbon and oxygen isotope values using the H_3PO_4 digestion method. The data were statistically analyzed to investigate whether there was a correlation of oxygen and carbon isotope data supporting a seasonal influence on diet. In addition, with the assumption that the general pattern of enamel mineralization is similar to that observed in modern equid teeth, a continuous curve of the individual’s oxygen and carbon isotope signatures was constructed using oxygen isotopes as a proxy for seasonality and, therefore, time. This allows for the interpretation of ontogenic influences on diet variation and the reconstruction of timing and patterning of enamel mineralization.

Preliminary data indicate intra-individual variation of $\delta^{13}C$ values of up to 4‰, with individual teeth showing variations of up to 3‰. The samples also indicate a positive correlation between stable oxygen and carbon isotope values and a possible influence of seasonality on diet. Ontogenic changes in diet, as indicated by carbon isotopes, however, were not observed.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:15)

NEOTROPICAL LATE MIOCENE-EARLY PLIOCENE VERTEBRATES FROM THE CASTILLETES FORMATION, NORTHERN COLOMBIA

MORENO-BERNAL, Jorge W., Smithsonian Tropical Research Insitute, Panama, Panama; FEDERICO, Moreno, Smithsonian Tropical Research Insitute, Panama, Panama; CARRILLO, Juan D., Smithsonian Tropical Research Insitute, Panama, Panama; VALLEJO-PAREJA, Maria C., Smithsonian Tropical Research Insitute, Panama, Panama; JIMENEZ-CAMPOS, Ludwig, Smithsonian Tropical Research Insitute, Panama, Panama

In 2010 and 2011 we undertook an initial exploratory survey of the late Miocene-early Pliocene Castilletes Formation (Eastern Guajira Peninsula, Colombia). The Castilletes is composed of deltaic and shallow marine deposits, with an abundant continental fauna in some intervals. These new findings will contribute to a better understanding of the neotropical vertebrate communities and paleoenvironments during a time of high tectonic activity and global climate change. The fauna includes sharks (Carchariniformes), rays (Myliobatiformes), catfish (Siluriformes), dogtooth tetras (Cynodontidae), fresh water turtles (Podocnemidae), and one of the oldest records of *Crocodylus* in the Americas. The mammal assemblage comprises five orders and ten families. Xenarthrans include megatheriid and nothrotheriid sloths and the cingulates *Boreostemma pliocena* (Glyptodontinae), *Neoglyptatelus sp*. (Glyptatelinae), cf. *Holmesina* and cf. *Pampatherium* (Pampatheriidae). Rodents are represented by *Chapalmatherium* (Hydrochoeridae), cf. *Neoepiblema* (Neoepiblemidae) and *Paramyocastor sp*. (Echymidae). Indigenous South American ungulates include horse-like protherotheriids (Litopterna), rhino-like toxodonts (Notoungulata), and astrapotheres (Astrapotheria). Associated fossil wood is found in some localities. Overall, the Castilletes fauna and flora indicates the presence of extensive water bodies, in a delta complex with moderate to high rates of rainfall during the late Miocene-early Pliocene. Considering that today the Guajira peninsula is characterized by a very dry climate with xerophitic vegetation, the inferred paleoenvironment for the Castilletes Formation indicates that the region has suffered a drastic climatic change over the last 4 million years.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ISOTOPIC VARIATION AND NICHE SPACE IN MIDDLE AND LATE MIOCENE SIWALIK MAMMALS FROM PREDOMINANTLY C3 ECOSYSTEMS

MORGAN, Michele E., Harvard University, Cambridge, MA, United States; BARRY, John C., Harvard University, Cambridge, MA, United States; CERLING, Thure E., University of Utah, Salt Lake City, UT, United States; NELSON, Sherry V., University of New Mexico, Albuquerque, NM, United States; PILBEAM, David, Harvard University, Cambridge, MA, United States

The Siwalik Group of northern Pakistan preserves a rich Neogene terrestrial fossil record. Recent studies have focused on detailing mammalian community structure and faunal change in the late Miocene starting around 8.5 Ma, coincident with the appearance and influence of C4-dominated grassland habitats. Here we focus on the period between 13.7 and 8.5 Ma to examine variation within stable carbon and oxygen isotopic signatures of mammalian species in predominantly C3 ecosystems. A number of ubiquitous herbivore species present for three or more million years in the Chinji Formation are replaced in the younger Nagri Formation between 11 and 10.3 Ma by larger-sized, closely related and possibly descendant, species in bovids, sivatheres, suids, and anthracotheres. We present stable carbon and oxygen isotope data collected on a suite of species between 13.7 and 8.5 Ma (n >450 specimens) including primates, proboscideans, artiodactyls and perissodactyls, and focus on comparisons between several closely related artiodactyl species pairs to look for differences in isotopic niche space. Despite body-size increases of more than 50% (based on body mass estimates derived from astragular and other postcranial measurements), little isotopic change is seen within families. Thus substantial body-size increases are not associated with dietary change, at least as reflected isotopically, in the early late Miocene. Isotopic separation between species from different families is observed in carbon and/or oxygen both before and after the observed faunal change.

Although most herbivores are almost exclusively consuming C3 vegetation prior to 8.5 Ma, equids, which are first documented in the Siwaliks at 10.8 Ma, incorporate C4 vegetation in their diet by 10.1 Ma. Equid species sampled span the range from pure C3 to pure C4 diets before 8.5 Ma.

Between 13.7 and 8.5 Ma, the stable carbon and oxygen isotopic signature of many Siwalik artiodactyl lineages remains essentially constant. The ecological conditions that selected for larger body-size within these lineages around 10.5 Ma may have included slightly more open habitats. However, neither artiodactyl nor proboscidean taxa sampled show any evidence of significant C4 vegetation consumption until after 8.0 Ma. This pattern may reflect preferences for C3 forage and more closed habitats, due to factors including diet quality, relatively low-crowned teeth, and social structure. In contrast, the earliest Siwalik equids appear to have been versatile generalists that exploited both C3 and C4 dietary resources.

Technical Session IV (Wednesday, October 17, 3:00 pm)

FROM ENDOCAST TO BRAIN: ASSESSING BRAIN SIZE AND STRUCTURE IN EXTINCT ARCHOSAURS USING GROSS ANATOMICAL BRAIN REGION APPROXIMATION (GABRA)

MORHARDT, Ashley C., Ohio University, Athens, OH, United States; RIDGELY, Ryan C., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Cranial endocasts have potential for elucidating qualitative and quantitative trends in brain evolution through the fossil record. However, recovery of these trends relies on the endocasts studied being adequate proxies for the brain, which depends on the extent to which the bony endocranial cavity is filled with neural tissue in life. Whereas the brain tissue in certain groups (e.g., mammals, birds) fills the endocranial cavity, that of other reptiles (e.g., squamates, crocodilians) often does not, making their endocasts less informative. Extinct archosaurs are generally thought to span this range, with some taxa (e.g., pterosaurs, maniraptorans) having more brain-like endocasts and other taxa (e.g., most nonavian dinosaurs) resembling extant reptiles. We present Gross Anatomical Brain Region Approximation (GABRA), a technique developed to address these concerns that tests 3D digital hypotheses of reconstructed brain size and shape based on a set of validated comparative anatomical criteria. Homologous endocast features and associated osteological correlates observed for hundreds of taxa provided the basis for hypothesized GABRA criteria (e.g., neurovascular canals, semicircular canals, dural sinuses, bony fossae). We validated these criteria using dissection and CT scanning of extant outgroup specimens (e.g., ostrich, turkey, alligator, iguana) with iodine-soaked soft tissues. Criteria were used to delimit brain regions (cerebrum, cerebellum, optic tectum, etc.), which were modeled as 3D ellipsoids within the digital endocast using Maya modeling software. Validation by direct comparison with the extant brain structure shows these virtual models to be credible, testable hypotheses of the size and shape of the underlying brain. We applied these validated criteria to generate GABRA brains for certain nonavian dinosaurs (*Camarasaurus*, *Diplodocus, Euoplocephalus, Pachyrhinosaurus, Majungasaurus, Stegosaurus*), providing novel insights into the cranial contents and their inferred functions in these taxa. For example, sauropod dural sinuses are extensive compared to other groups, *Stegosaurus* brain volume was approximately twice that of previous estimates, and the optic lobes of *Majungasaurus* were large relative to other fossil taxa studied, suggesting that vision was important to its lifestyle. GABRA advances previous endocast studies of fossil taxa by providing testable information about the brain itself. Thus, GABRA permits testing of hypotheses of neurological mosaic evolution of different brain regions and puts quantitative scaling analyses of brain and brain-region size on a sounder biological footing, both of which are future directions of the larger project.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

RECONSTRUCTION AND MORPHOMETRIC ANALYSIS OF JUVENILE *EDMONTOSAURUS* SP. FROM THE LOWER MAASTRICHTIAN (CRETACEOUS) PRINCE CREEK FORMATION OF NORTHERN ALASKA

MORI, Hirotsugu, University of Alaska Fairbanks, Fairbanks, AK, United States; DRUCKENMILLER, Patrick S., University of Alaska Museum, Fairbanks, AK, United States; PRIETO-MARQUEZ, Albert, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; JOSHI, Shantanu, University of California Los Angeles School of Medicine, Los Angeles, CA, United States

The occurrence of juvenile *Edmontosaurs* sp. material from the Liscomb Bonebed of northern Alaska has great paleobiological significance given its occurrence in high paleolatitudes (82°N). An abundance of disarticulated cranial remains from multiple individuals of a single size cohort provides a wealth of data on the skull anatomy of this taxon.The Alaskan edmontosaur material has not been previously described, nor has its relationships to stratigraphically younger (*E. annectens*) and older (*E. regalis*) species from lower latitudes been established, in part because of its early ontogenetic state. Here, we provide the first formal reconstruction of the skull of the Alaskan *Edmontosaurus*, using new data from the collection housed at the University of Alaska Museum. To better understand its systematic position, we conducted morphometric analyses of *Edmontosaurus* with the new Alaskan reconstruction using landmark and semi-landmark based relative warp analysis and Geodesic Distance Analysis (GDA). For the landmark and semi-landmark based morphometric analysis, Relative Warp (RW) 1 shows high correlation with size and is therefore disregarded, while score 2 clearly separates *E. regalis* from *E. annectens*. Plotting RW2 versus RW3, the Alaskan *Edmontosaurus* clusters most closely to *E. annectens*. Results from the GDA also cluster the Alaskan specimen closer to *E. annectens* than to *E. regalis*, mainly on the basis of the second eigenshape axis. These results indicate that juvenile Alaskan *Edmontosaurus* is morphologically most similar to adult *E. annectens*. Assuming that the morphometric analysis is truly independent of ontogenetic changes, the Alaskan *Edmontosaurus* could represent the stratigraphically oldest, least-mature and northern-most occurrence of *E. annectens.* Alternatively, the Alaskan material could represent a juvenile form of either an unrecognized new taxon or *E. regalis*, indicating neotenic evolution of *E. annectens*.

Technical Session XIV (Saturday, October 20, 11:15 am)

HISTOLOGICAL VARIATION SUGGESTS UNUSUAL LEVELS OF DEVELOPMENTAL PLASTICITY IN THE STEM ARCHOSAUR *VANCLEAVEA*

MORRIS, Zachary, The University of Texas at Austin, Jackson School of Geosciences, Austin, TX, United States; WERNING, Sarah, The University of California at Berkeley, Berkeley, CA, United States

Bone histology has been used to study growth and physiology of extinct archosaurs at individual, ontogenetic, and phylogenetic scales, but few studies have examined how histology varies within a species among specimens of comparable ontogenetic stage. When all individuals of a taxon share a similar growth trajectory, minimal sampling of like-sized individuals that have nearly identical histological profiles reduces destructive sampling of specimens. Conversely, if individuals of a taxon are developmentally plastic, conservative sampling will obscure variation and may miss histological differences that result from evolutionary, environmental, or geographic change. We report a potential case of such developmental plasticity in the stem archosaur (non-archosaur archosauriform) *Vancleavea campi*. This taxon, from the Late Triassic of the American Southwest, persisted with little morphological change for over 20 million years. We reanalyzed a previously sampled femur, and sampled an additional five femora and three humeri (seven individuals) from five localities, to assess potential variation in *Vancleavea's* growth regime. Our sampling covered as much of its stratigraphic range as possible, but we restricted our study to specimens diagnosed using a unique combination of femoral/humeral characters and association with apomorphic osteoderms. Four femora and all humeri are of nearly identical size, but the dominant bone tissue type is highly variable within our sample. One individual displays woven bone with no apparent cessation of growth until its death; another is dominated by lamellar bone with many lines of arrested growth; and other specimens exhibit various permutations of these patterns. These data reveal at least three growth trajectories to achieve common adult size: rapid growth to adult size in 1-2 years; slow, prolonged growth lasting several years; and one highly unusual growth trajectory beginning with 4-5 years of very slow growth, followed by a year of very fast growth in which half the cortex is deposited, and then 10 or more years of slow growth to adult size. We hypothesize that paleoenvironmental variability may have contributed to the observed differences, because all specimens are from localities that experienced highly seasonal semi-arid conditions. Given the long stratigraphic range of this taxon, our sample may represent more than one species, but the morphological similarity among individuals makes this impossible to determine at this time. Whether or not we are dealing with more than one species, we hypothesize that developmental plasticity may have played an important role in the formation of the observed histological differences in this taxon.

Technical Session XV (Saturday, October 20, 10:45 am)

PHYLOGENETIC SIGNIFICANCE OF *AURORACERATOPS RUGOSUS* (ORNITHISCHIA: CERATOPSIA) AND THE PHYLOGENY OF BASAL NEOCERATOPSIA

MORSCHHAUSER, Eric M., University of Pennsylvania, Philadelphia, PA, United States

Basal neoceratopsian dinosaurs have experienced a remarkable growth in known diversity, with 13 new species named since 2002. Many of these species have not been included in phylogenetic analyses to date. *Auroraceratops rugosus* was named in 2005 and is now one of the most abundant dinosaurs known. Over 80 specimens have been recovered from Lower Cretaceous strata of the Yujingzi Basin, northwestern Gansu Province, China. Complete cranial and postcranial material provides a clearer picture of the mosaic of basal and derived characters in this genus. *Auroraceratops* shares the following plesiomorphies with *Liaoceratops* and more basal forms: lack of a surangular shelf; extensive rugose ornamentation of the jugal, surangular, and dentary; and three premaxillary teeth. *Auroraceratops* also bears several derived features, including an epijugal, a vaulted premaxillary palate, and an angular process of the dentary. We present the first phylogenetic analysis of basal Neoceratopsia to include *Auroraceratops* and the first major taxonomic revision of basal Neoceratopsia in ten years. The species *Breviceratops koslowskii* and *Graciliceratops mongoliensis* were found to lack autapomorphies or unique combinations of characters and were excluded. Safe taxonomic reduction was used on the initial matrix of 36 taxa and 277 characters, but no taxa were indicated for removal. Heuristic analysis recovered 1990 most parsimonius trees with a length of 750. Our analysis recovers *Auroraceratops* in a polytomy including a clade composed of *Yamaceratops* and *Helioceratops*, a monophyletic Leptoceratopsidae, and Coronosauria. When temporally calibrated, our cladogram indicates that the age uncertainty bars on several key Asian taxa determine the divergence times of Leptoceratopsidae and a clade including *Auroraceratops*, *Yamaceratops*, Leptoceratopsidae, and Coronosauria. Future work in Asia should concentrate on improving the known ages of Early Cretaceous neoceratopsian localities.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ARCTOCYONID DIVERSITY DURING THE PALEOCENE-EOCENE THERMAL MAXIMUM OF NORTH AMERICA

MORSE, Paul E., University of Florida, Gainesville, FL, United States; BLOCH, Jonathan I., University of Florida, Gainesville, FL, United States; SECORD, Ross, University of Nebraska-Lincoln, Lincoln, NE, United States; CHESTER, Stephen G., Yale University, New Haven, CT, United States; BOYER, Doug M., Brooklyn College, City University of New York, New York, NY, United States

The Arctocyonidae are a family of extinct "condylarth" mammals that were abundant and speciose during the Paleocene and declined in diversity and number during the early Eocene in North America, Europe, and Asia. Arctocyonids have been reconstructed as primitive omnivorous condylarths and may be the sister group to Artiodactyla. This study focuses on arctocyonids within the Paleocene-Eocene Thermal Maximum (PETM), ~56 Ma, when global temperatures increased by ~5-10° C. Three species were initially identified in the PETM faunal zone Wasatchian-0: (1) *Thryptacodon barae*, characterized by a centralized paraconid equal in size to the metaconid on M_2 and a distinct hypoconulid on the lower molars; (2) *Chriacus badgleyi*, characterized by the absence of a metaconid on the P_4, an anteriorly placed molar paraconid, and a highly reduced hypoconulid; and (3) *Princetonia yalensis*, characterized by a lingual molar paraconid and a low, shallow, anteroposteriorly compressed trigonid with rounded cusps and crests compared to *Chriacus*. The latter two species have been difficult to distinguish in part because the holotype of *C. badgleyi* contains only C_1, P_2–P_4, whereas the holotype of *P. yalensis* contains only M_2–M_3. These species were recently synonymized under the name *C. badgleyi* (based primarily on a poorly-preserved specimen). We report a large collection of arctocyonid specimens from the PETM, collected in the southern Bighorn Basin, Wyoming. The number of specimens includes ~100 molars, numerous premolars, and deciduous teeth. It also includes the most complete specimen of a PETM arctocyonid known: a partial dentary of *C. badgleyi* with alveoli for C_1–P_2, crowns of P_3–M_3, and a preserved ascending ramus and mandibular condyle. The measurements and morphology documented in this sample clearly separate specimens of *Thryptacodon*, while supporting a second morphological group (*Chriacus*) in which body size range exceeds that normally observed in extant mammal species. When placed in stratigraphic context, *C. badgleyi* body size is found to correspond well with inferred temperature during the PETM, similar to recent findings for the earliest equid *Sifrhippus*. These results support the classification of two species: the less abundant *T. barae* (in contrast with the northern Bighorn Basin), and *C. badgleyi*. While the morphotype described for *P. yalensis* is present in the collection, it is rare and observed only in worn specimens. These findings, coupled with a lack of discrete tooth dimensions in the temporal series, suggest that the *P. yalensis* morphotype results from wear to the molars of *C. badgleyi* and support the synonymy of these taxa.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST RECORD OF FOSSIL CHELYDRIDAE AND TRIONYCHIDAE FROM THE PLEISTOCENE OF SONORA, MEXICO

MOSCATO, David A., East Tennessee State University, Johnson City, TN, United States; JASINSKI, Steven E., East Tennessee State University, Johnson City, TN, United States

The Pleistocene of northern Mexico is relatively poorly understood, represented by only a few fossil localities. One such locality is the Late Pleistocene fossil site of Térapa, located in east-central Sonora. The site dates to between 43,000 and 40,000 years old and yields a rich fossil fauna of over 60 identified taxa, dominated by birds and large mammals. The geologic evidence at the site indicates a marshland with permanent sources of calm freshwater, which is supported by the presence of fossil remains of freshwater invertebrates, fish, frogs, and turtles. The fossil turtle fauna of Térapa has received relatively little attention in the past. Previous studies have reported fossil turtles representing two families: Emydidae (*Trachemys* and *Terrapene*) and Kinosternidae (*Kinosternon*). The family Testudinidae is also present at Térapa; this study is the first report of this family from this locality. All three of these families are also represented in the extant fauna of Sonora. Here, we present the remains of two additional families of turtles from the Térapa locality, Chelydridae and Trionychidae, both of which are notable for being absent today in the naturally-occurring fauna of Sonora. The only other comparable Late Pleistocene fossil locality in Sonora is Rancho La Brisca, located north of Térapa. Rancho La Brisca preserves a similar fossil assemblage, including Emydidae and Kinosternidae, but Chelydridae and Trionychidae are absent, making Térapa the only record of these turtles in Sonora. Previous studies of Térapa have noted the unusual presence of Crocodylidae in the fossil assemblage, and proposed that their presence might be the result of dispersal into interior Sonora from the south. We suggest that the same situation might explain the presence of chelydrids and trionychids at this site. The turtles may have retreated to their modern distribution when the marshland gave way to the arid thornscrub of present-day Sonora.

Technical Session XIV (Saturday, October 20, 11:45 am)

ABSENCE OF SUCTION FEEDERS AMONG ICHTHYOSAURS AND IMPORTANCE OF MECHANISM-BASED QUANTIFICATION IN FUNCTIONAL INFERENCES

MOTANI, Ryosuke, University of California, Davis, Davis, CA, United States; JI, Cheng, Peking University, Beijing, China; TOMITA, Taketeru, University of California, Davis, Davis, CA, United States; JIANG, Da-Yong, Peking University, Beijing, China

Suction feeding in Mesozoic marine reptiles has attracted little attention despite of its potential implications to the evolution of prey community and its environments. A recent study suggested that diverse suction feeders evolved among ichthyosaurs in the Triassic, based on their superficial resemblance to beaked whales. However, the suggestion requires mechanical reasoning and quantitative tests. We quantified two features that are closely linked to suction feeding mechanisms in jawed vertebrates, namely hyoid robustness and mandibular bluntness. We measured the hyoid bones of 14 species of Triassic and Early Jurassic ichthyosaurs, including the presumed suction feeders. Statistical analyses suggest that: (1) variation in hyoid robustness is limited among ichthyosaurs, unlike in whales or sharks; (2) ichthyosaurian hyoid bones are significantly more slender than in suction-feeding

sharks or cetaceans but similar to those of ram-feeding sharks; (3) two of the postulated suction feeders, namely *Shastasaurus* and *Shonisaurus*, possessed the two most slender hyoid bones among the ichthyosaurs examined. Most importantly, ossified hyoid corpus to which hyoid retractor muscles attach is unknown in any ichthyosaur, whereas a strong integration of the ossified corpus and cornua of hyoid has been identified in the literature as an important feature of suction feeders. Therefore, hyoid elements suggest that all ichthyosaurs were 'ram feeders'. We also found that the highest mandibular bluntness (width/ramus length) value in ichthyosaurs was about 0.45, which is not very blunt in the cetacean standard; published data suggest that most suction-feeding cetaceans have much blunter mandibles, with the ratio ranging between 0.58-0.86. Most of the cetaceans in the range near 0.45 are 'ram feeders', except some beaked whales that have extra superficial tissues around the corner of the gape that shortens the gape in effect. There is no evidence that ichthyosaurs had such 'cheek-like' soft tissues. In conclusion, it is most likely that there was no suction feeder among Triassic and Early Jurassic ichthyosaurs. Our study illuminates the risk of qualitative functional inferences in paleontology, and reemphasizes the importance of quantitative assessment of mechanism-related morphology.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:30 am)

EXAMINING CHARACTER CONGRUENCE AND COMPATIBILITY OF VERTEBRATE CLADISTIC DATA - EMPIRICAL APPROACHES APPLIED COMPARATIVELY ACROSS CLADES

MOUNCE, Ross, University of Bath, Bath, United Kingdom; WILLS, Matthew A., University of Bath, Bath, United Kingdom

Previous phylogenetic work using conventional character partition homogeneity tests has often revealed significant incongruence between cranial and postcranial character data. We extend this approach by applying pairwise character compatibility tests across a sample of more than 60 pseudo-independent vertebrate data sets. We contrast 'fuzzy' compatibility, boildown bootstrap and clique approaches. In particular, we find that the Le Quesne probability (LQP) has several desirable properties. The LQP is simply the probability that a randomly permuted character will have incompatibility with other characters in the matrix as low or lower than that of the original character. Within recent analyses of Sauropod taxa we find that characters related to neural arches often conflict with dental characters in some datasets but it is difficult to generalise; we are still exploring possible causative mechanisms for this. In contrast, other vertebrate groups such as ratites appear to have relatively little character conflict between morphological characters. Pairwise tests of character compatibility work well with binary data and ordered multistate characters, but can only give an indication of 'potential compatibility' with unordered multistate characters. Composite 'higher' taxa and polymorphic codes are also problematic for existing compatibility software, typically creating artificial incompatibilities. We recommend that composite taxa are decomposed into their constituents in order to remove ambiguity for the purpose of these tests, or else that polymorphic states are treated as missing data.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

MELANOSOMES....OR MICROBES?

MOYER, Alison E., North Carolina State University, Raleigh, NC, United States; SCHWEITZER, Mary H., North Carolina State University, Raleigh, NC, United States

Elongate microbodies associated with feathers were originally attributed to microbial biofilms, but recently, in a series of papers, they have been reinterpreted as intracellular, pigment-containing organelles (melanosomes). Based upon this interpretation, coloration in non-avian and avian dinosaurs has been hypothesized. The only support presented for either hypothesis is morphological. Because melanosomes and microbes overlap in size, distribution and morphology, morphological data is insufficient to robustly support either claim. Here, we re-evaluate both hypotheses using chemical and molecular analyses. Melanin is highly resistant to degradation, with high preservation potential, but the intracellular organelles storing the melanin have not been shown to be equally resistant. Microbes, however, as well as the exoplymeric substance they secrete, are known to persist in the fossil record.

We have applied scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), and elemental transmission electron microscopy (TEM) to fully characterize melanosomes in extant feathers, and we conducted degradation experiments to visualize microbial growth on pigmented feathers from chicken (*Gallus gallus*). Melanosomes are intracellular and limited to internal regions surrounded by and embedded in the keratinous matrix of the feather. Microbes, on the other hand, grow across the surface of feathers. If analytical data support a melanosome origin for these microstructures, we hypothesize that feather specific ß-keratin will also be identified using immunohistochemical methods. If these microbodies are melanosomes, they should reflect characteristics of melanin, including localized levels of S and transition metals such as Cu, Ca, Mn and Zn. Microorganisms in a biofilm should demonstrate elevated C, N, and P because of the high protein and phospholipid content in their membranes and associated exopolysaccharide (EPS) matrix. We will compare these data with published and unpublished results for fossil feathers.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW DREPANOSAURID (ARCHOSAUROMORPHA: DREPANOSAURIDAE) MATERIAL FROM THE LATE TRIASSIC DOCKUM GROUP OF WEST TEXAS

MUELLER, Bill D., Museum of Texas Tech University, Lubbock, TX, United States; CHATTERJEE, Sankar, Museum of Texas Tech University, Lubbock, TX, United States

Drepanosauromorphs are best known from the Late Triassic of Europe. They are represented by the genera *Vallesaurus, Drepanosaurus*, and *Megalancosaurus*. North American drepanosauromorphs are less represented by a number of specimens of the genus *Hypuronector* from the Newark Group of Eastern North America. In the southwestern United States only a single specimen of *Dolabrosaurus* and five indeterminate drepanosaurid vertebrae from the Chinle Formation have previously been described. A recent review of drepanosaurids reprised many of the previous drepanosaurid publications. Drepanosaurid material from the Triassic Dockum Group of Texas has not been formally described previously.

The Museum of Texas Tech has over 300 drepanosaurid elements from five localities from the Dockum Group in their collection. The collection represents a variety of skeletal elements and multiple taxa. The collection includes an ontogentic series of the terminal caudal spines and a series of three-dimensional cervical vertebrae. The collection includes some of the oldest drepanosaurid specimens from the lower portion of the Tecovas Formation (Otischalkian) through the Revueltian Cooper Canyon Formation. The majority of the drepanosaurid elements were collected at two localities; however, the distribution of material geographically and stratigraphically illustrates that drepanosaurids were more widely distributed and taxonomically diverse than previously described.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

THE ROLE OF ELEVATION IN UNDERSTANDING THE BIOGEOGRAPHIC DISTRIBUTION OF THE EXTINCT LEMURS OF MADAGASCAR

MULDOON, Kathleen M., The Geisel School of Medicine at Dartmouth, Hanover, NH, United States; GODFREY, Laurie R., University of Massachusetts, Amherst, Amherst, MA, United States; CROWLEY, Brooke E., University of Cincinnati, Cincinnati, OH, United States

The subfossil record of Madagascar demonstrates that several extant species currently restricted to humid forests once had more widespread geographic distributions. Furthermore, an east–west distance effect in extant mammal distributions has been interpreted as evidence that faunal exchange routes once crossed portions of the central highlands. In this paper, we examine the biogeographic distributions of the extinct lemurs of Madagascar, and their effects upon lemur community composition in the late Quaternary, using the statistical techniques and mapping capabilities of a Geographic Information System (GIS). We assembled a database of extinct lemur occurrences at 40 subfossil localities across Madagascar. Variables collected for each locality include species occurrence, geographic coordinates, elevation, radiocarbon dates, and paleoenvironment (pollen and stable isotope data). These data were analyzed using ArcGIS software.

Our results indicate that several extinct lemur taxa are shared among southern localities and Christmas River, the only known site from the south-central highlands, including inferred southern forest-dwelling animals such as *Archaeolemur majori, Pachylemur insignis*, and *Megaladapis edwardsi*. This lemur assemblage is fundamentally different from those recovered from a string of subfossil sites forming a corridor crossing the central highlands well to the north of Christmas River, through the Antananarivo Province (especially the Vakinankaratra and Itasy regions). The only characteristically southern giant lemur that is unequivocally found within this mid-central highlands corridor is *Hadropithecus stenognathus*, which is rare. Other primate taxa from the mid-central highlands include the extinct lemurs *Archaeolemur edwardsi*, *Megaladapis grandidieri*, *Archaeoindris fontoynontii*, *Mesopropithecus pithecoides*, *Pachylemur jullyi*, and *Palaeopropithecus maximus*, as well as the extant lemurs *Prolemur simus*, *Indri indri*, *Propithecus diadema*, *Eulemur fulvus*, and *Cheirogaleus major*, among others. Sites in the more northern corridor are higher in altitude than those in the south. Our results indicate that the higher elevational distribution of subfossil sites in the mid-central versus the south-central highlands may have acted as a filter to limit the species that may have dispersed across the island in the past. It has been suggested that watersheds with sources at high elevation may have maintained mesic conditions during Quaternary climate shifts, due to orographic precipitation. For forest-dependent mammals, such mesic conditions may have allowed dispersal across the mid-central passage, but limited dispersal of moisture-restricted animals in the south.

Technical Session XIV (Saturday, October 20, 9:30 am)

THE ENIGMATIC REPTILE *KADALIOSAURUS* FROM THE LOWER PERMIAN OF GERMANY AND THE MONOPHYLY OF ARAEOSCELIDIAN DIAPSIDS

MÜLLER, Johannes, Museum für Naturkunde Berlin, Berlin, Germany; DANTO, Marylène, Museum für Naturkunde Berlin, Berlin, Germany

The Araeoscelidia are considered the oldest clade of diapsid reptiles and the sister group to all other members of Diapsida, comprising several taxa from the Late Carboniferous and Early Permian of North America and Europe. The European forms in particular have never been studied in detail, and the monophyly of Araeoscelidia has not been tested within a modern phylogenetic framework. In the present study we reinvestigated *Kadaliosaurus priscus* from the Lower Permian of Saxony, Germany, a poorly known taxon which had

remained unstudied since its first description in the late 19th Century. The taxon is based on a single specimen that only preserves the trunk vertebral column and parts of the the fore- and hindlimbs, as well as some caudal vertebrae. The specimen is notably deteriorated in comparison to the original description, but new preparation nevertheless revealed additional details, such as the morphology of the zeugopodia of both fore- and hindlimbs and the shape of the caudal vertebrae. *Kadaliosaurus* superficially shares the elongate morphology of the limbs with the araeoscelidians *Araeoscelis* and *Petrolacosaurus*, but the proportions of the individual limb elements are different in these taxa. Also, there is currently no evidence for swollen neural arches in *Kadaliosaurus*, in contrast to *Araeoscelis* and *Petrolacosaurus*. In order to assess the phylogenetic position of *Kadaliosaurus* and to test if Araeoscelidia is monophyletic, we scored all supposed members of the clade into a phylogenetic data matrix for early amniotes and eureptiles and analyzed the data using parsimony and Bayesian methodology. The results reveal that there is no support for a monophyly of araescelidians and that only *Araeoscelis* and *Petrolacosaurus* are unequivocally part of Diapsida, whereas the remaining taxa variably group along the stem of diapsid reptiles together with the "protorothyridids" *Protorothyris, Anthracodromeus* and *Cephalerpeton*. Our results suggest that the elongation of fore- and hindlimbs is not an unambiguous apomorphy of Diapsida but either evolved earlier or several times within early Eureptilia. Also, based on the current evidence it remains questionable if the presence of only a single temporal fenestra in *Araeoscelis* is secondary and it cannot be ruled out that the evolution of temporal fenestrations might have evolved in a stepwise manner. In conjunction with recent findings that also the "Younginiformes" are not monophyletic but merely a grade of early diapsids, the falsification of araeoscelidian monophyly indicates that the early history of Diapsida is far more complicated than previously thought.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

FIRST RECORD OF A PONTOPORIID CETACEAN (ODONTOCETI: INIOIDEA) FROM LATE MIOCENE OF CHIBA, JAPAN

MURAKAMI, Mizuki, Waseda University, Tokyo, Japan; HIRAYAMA, Ren, Waseda University, Tokyo, Japan

Pontoporiidae is represented today only by one relict species *Pontoporia blainvillei* restricted to the eastern coastline of South America. The fossil record of the family, however, is more diverse and is known from eastern and western South America, eastern North America, and the North Sea back to the late Middle Miocene. Here we report the first pontoporiid fossil from the upper-most Miocene Senhata Formation (6.3-5.7 Ma) of Chiba, central Japan. The specimen WU SILS (Waseda University, School of International Liberal Studies) 408 was discovered in a quarry owned by Towa Stone Limited in a medium sandstone layer in the lower part of the formation and includes a right neurocranium, an isolated tooth, and a rib. The specimen shares with pontoporiids the following characteristics: well-developed premaxillary eminence; frontal wedging of the nasal; vertex occupied by a dorsally protruding nasal and frontal; and nasal that tapers posteriorly. Compared to other pontoporiids, the specimen resembles *Stenasodelphis*, *Pliopontos*, *Pontistes*, and *Auroracetus* in having a low or absent maxillary crest. The premaxilla contacts the nasal in the specimen, similar to *Pontistes*, *Protophocaena*, and *Brachydelphis*. Presence of a clearly asymmetrical vertex on WU SILS 408 is shared with that of *Stenasodelphis*, *Protophocaena*, and *Brachydelphis*. The specimen is similar to *Brachydelphis* in having the posterior edge of the bony nares locating at the level of the postorbital process. The specimen is similar to *Pontistes* in having obvious medial and lateral lobes of the premaxilla and a tooth without the bulbous part of the root. At the same time, WU SILS 408 has several apomorphies: right premaxillary eminence with pronounced overhang on the right maxilla (maximum 6.5 mm); right premaxilla that extends posterior to the right nasal; very short or absent posterolateral sulcus; relatively short nasal; relatively conical tooth (the crown diameter 2.9 mm) with several perpendicular striations; and a short zygomatic process of the squamosal. This mosaic, unique combination of characters, and large skull size of WU SILS 408 (the neurocranium length over 180 mm) indicates that the taxon is a new genus and new species of pontoporiid. The occurrence of a pontoporiid in our report is not only the first fossil record of its kind from Japan but also the North Pacific. This new discovery greatly extends the paleogeographical distribution of the family.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THREE NEW BASAL ACANTHOMORPH FISHES FROM THE LATE CRETACEOUS OF MOROCCO

MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada; WILSON, Mark V., University of Alberta, Edmonton, AB, Canada

Acanthomorph fishes first appear in the fossil record in the earliest part of the Late Cretaceous, in deposits from both the Western Interior Seaway of North America and the Tethys Sea between Europe and northern Africa. The earliest acanthomorphs are from the early Cenomanian of Canada and Mexico, and from various Tethyan localities of Cenomanian age in Lebanon. Although more than 20 acanthomorph species are known from Cenomanian deposits, fewer Turonian acanthomorphs have been described, with only four genera known from Tethyan deposits and two or three from Western Interior Seaway deposits. Recently, three new acanthomorphs of Turonian age were recovered from the Agoult locality, which samples marine carbonates of the Akrabou Formation on the Cretaceous North Saharan Platform, deposited during an incursion of the Tethys Sea into this area of Africa. Isotopic data confirm a normal marine paleoenvironment, with no evidence of brackish or freshwater influence, and a paleotemperature of approximately 24.8º C. The associated flora and fauna from the deposits indicate that the platform waters were likely very shallow and near shore. Two of the new acanthomorphs represent different species allied with the Aipichthyoidea based on the high supraoccipital crest, the caudal skeleton with a reduced neural spine on the second preural centrum and 19 principal caudal fin rays, and the predorsal formula, but they cannot be included in either of the named aipichthyoid families (Aipichthyidae and Aipichthyoididae). The third new species is allied with the Polymixiiformes based on having a caudal skeleton with a full spine on the second preural centrum and 18 principal rays. The three new species contribute to the unique nature of the Agoult fauna at the generic and specific level, while reinforcing similarity at higher taxonomic levels to other early Late Cretaceous Tethyan faunas.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

JAW MECHANICS OVER PROBOSCIDEAN EVOLUTION

NABAVIZADEH, Ali, Johns Hopkins University School of Medicine, Baltimore, MD, United States

Throughout proboscidean evolutionary history, cranial anatomy and mandibular anatomy have been highly integrated. Their feeding mechanisms presumably have modified the shape of the skull to maximize the forces exerted during mastication and minimize loads to vulnerable parts of the head. It has previously been stated that the temporalis muscle in modern elephants, with the main function of elevating the jaw while chewing as well as retraction of the jaw, originates just above the center of gravity of the proboscidean skull, directing force more or less vertically. Because of this, the coronoid process is angled rostrally directing the insertion for the temporalis rostrally, allowing for a vertical line of action. This forms a sling for the jaw to be able rock rostrocaudally relative to the cranium. In more archaic proboscideans, such as the long-jawed gomphotheres, the temporalis was directed more horizontally with a rostrocaudally longer basicranium. The coronoid process in these more archaic forms was more vertically oriented compared to modern short-jawed elephants. This helped in major retraction of the jaw, however it likely impeded the powerful forward thrust seen in modern elephant chewing. The masseter musculature and medial and lateral pterygoid muscles in modern elephants are involved in elevation, mediolateral translation, and protraction of the jaw. These muscles are very robust, originating from the anterior portion of the zygomatic arch and from either side of the lateral pterygoid plate, respectively, and extending to insert around the entire rounded angle of the mandible. These muscles produce the powerful thrust needed for the rostral proal motion of the jaw in modern elephants. Although assertions have been made about when the transition of jaw mechanisms occurred in the history of proboscideans, it has not been quantified. Lever arm mechanics analyses are performed, using lateral views of the skulls, to compare different proboscidean jaw mechanisms to observe transitions of coronoid process angle as well as temporalis, masseter, and medial pterygoid muscle angle. Results agree with previous hypotheses of mechanical advantage transitioning from a caudal thrust to a proal thrust of the mandible in the transition to modern proboscideans with a vertical temporalis and large masseters and pterygoids. The differences in mastication between proboscidean taxa, in addition to giving insight into changes in their dietary ecology, also provide suggestions as to evolution of morphological changes of the proboscis. As the mandibular symphysis elongated, so did the narial region, with later retraction of the symphysis in some lineages. Thus jaw mechanics were likely a significant driving factor in proboscidean evolution.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

THE FIELD BOOK PROJECT: CONNECTING FIELD BOOKS WITH THE WORLD

NAKASONE, Sonoe, Smithsonian Institution, Field Book Project, Washington, DC, United States; PYENSON, Nicholas D., Smithsonian Institution, Washington, DC, United States

Field books and notes are primary sources that document scientific research during fieldwork. In vertebrate paleontology, field books and associated documentation can be rich in details about localities, stratigraphy, specimens, collecting methods, and personal correspondence that may not be recorded in the scientific literature nor in electronic databases. Thus, they constitute a kind of "hidden collection," with poorly understood, yet large potential value that requires care and stewardship. The mission of the Field Book Project, based at the Smithsonian Institution's National Museum of Natural History, is to centralize, organize and digitize these "hidden collections" online for scholars and others to visit when searching for field books and other research materials. It is a pan-institutional project within the Smithsonian, and it interfaces with the Smithsonian Institution Archives, the Smithsonian Institution Libraries, and the Office of the Chief Information Officer. Among its goals, the Field Book Project aims to create a national Field Book Registry. Its' unique online location would serve scientists worldwide. The registry would also be a tool for professionals in other academic disciplines, helping to inspire emerging new generations of scientists, as well as citizen-scientists and life-long learners. This poster will provide an informative overview of the Field Book Project by depicting paleontological field notes as use cases and explaining how the Field Book Registry's levels of description will allow researchers to more easily assess relevant field book content. The poster will also briefly discuss future goals including transcriptions from oral archives. The authors will also display the Field Book Project Blog, Flickr sets, website, and a demo of the Field Book Registry.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RARE EARTH ELEMENT GEOCHEMISTRY OF CALVERT CLIFFS (MIOCENE, CHESAPEAKE GROUP): A PRELIMINARY REPORT

NANCE, John R., Calvert Marine Museum, Solomons, MD, United States; SYMISTER, Chanika D., Florida Museum of Natural History, Gainesville, FL, United States; MACFADDEN, Bruce J., Florida Museum of Natural History, Gainesville, FL, United States; GODFREY, Stephen, Calvert Marine Museum, Solomons, MD, United States

Vertebrate bone incorporates rare earth elements (REE) during early diagenesis. Elemental uptake varies with pore-water chemistry, water depth, and diagenetic influence. REE data are presented from Miocene vertebrate fossils from Calvert Cliffs, Maryland. The cliffs along the Chesapeake Bay comprise one of the largest and best studied successions of Miocene shallow marine sediments exposed on the eastern U.S. The Calvert, Choptank, and St. Marys formations of the Chesapeake Group span roughly 10 million years of geologic time from 18-8 Ma. Many important fossils have been collected as float on the beaches below Calvert Cliffs. A REE profile of the formations that comprise the cliffs was produced to allocate a float-collected fossil to a specific bed within the cliffs based on matching REE profiles. Twenty seven samples, including 10 from the Calvert Formation, 12 from the Choptank Formation and 5 from the St. Marys Formation, were obtained from vertebrate remains collected along Calvert Cliffs. Shark teeth, as well as cetacean and teleost bones were primarily used for sample extraction. The specimens were sampled using a cordless slow-speed Dremel™ rotary drill. They were then acid digested and diluted using University of Florida Department of Geological Sciences' laboratory protocol. The samples were finally analyzed for their bulk REE concentrations on a Thermo Finnigan ELEMENT2 Inductively Coupled Plasma Mass Spectrometer (ICPMS). REE concentration patterns indicate that, on average, the Calvert Formation represents the deepest water paleo-environment. REE analyses of fossils from the Choptank and St. Marys formations were nearly identical and suggest a similar depositional paleo-environment of shallower water within the overall Miocene regression. The REE analyses of vertebrate fossils have great potential to allocate fossils of uncertain origin to specific stratigraphic beds and thus age and provenience.

Technical Session IX (Friday, October 19, 9:30 am)

DERIVATION OF THE AETOSAUR OSTEODERM CARAPACE: EVIDENCE FROM A NEW, EXCEPTIONALLY PRESERVED "STEM AETOSAUR" FROM THE MIDDLE TRIASSIC (ANISIAN) MANDA BEDS OF SOUTHWESTERN TANZANIA

NESBITT, Sterling J., University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; SMITH, Roger M., South African Museum, Cape Town, South Africa; PARKER, William, Petrified Forest National Park, Petrified Forest National Park, AZ, United States

Phylogenetic estimates of the relationships and diversification of Triassic archosaurs predict that subclades known exclusively from the Late Triassic (e.g., aetosaurs, ornithosuchids, phytosaurs) originated in the Early or Middle Triassic. Because these subclades are morphologically divergent from the plesiomorphic archosaur body plan, potential early members have not been identified with confidence thus far. Here we report on a nearly complete skull and partial skeleton of a new Middle Triassic pseudosuchian from the diverse Manda beds archosaurian assemblage of Tanzania. The new form bears an elongated skull with a rugose skull table; small antorbital fenestra surrounded by a large antorbital fossa; laterally compressed, recurved teeth; and osteoderms down the back, on the belly, and on the limbs. This suite of character states includes aetosaur-like morphologies (e.g., maxilla fits into jugal) and plesiomorphic suchian character states (e.g., dorsally directed upper temporal fenestra). Consequently, we reconstruct the new form as the sister taxon of *Revueltosaurus callenderi* + aetosaurs, making it the first pre-Late Triassic suchian that is more closely related to aetosaurs than to other pseudosuchians. Additionally, our phylogenetic analysis identifies *Turfanosuchus dabanensis*, a Middle Triassic archosaur from China known since the 1970s, as the earliest member of the lineage leading to aetosaurs. The discovery of "stem aetosaurs" allows us to hypothesize the sequence of character changes and neomorphies that constitute the origin of the aetosaur osteoderm carapace. The earliest "stem aetosaur" had a set of leaf-shaped paramedian osteoderms down the back (the plesiomorphic state among pseudosuchians). In the lineage leading to Aetosauria, paramedian osteoderms widened, added articular facets on the anterior edge, and flattened. Appendicular and ventral osteoderms were added to the carapace. Aetosaurs added two lateral rows of osteoderms and the ornamentation of the osteoderms across the carapace became more intricate and disparate. It was only after the formation of the full carapace that aetosaurs diversified and increased in abundance. The presence of a "stem aetosaur" in the Anisian reinforces the emerging view that the Triassic radiation of archosaurs is older than previously thought, and likely was an important part of the recovery from the end-Permian mass extinction. The occurrence of early aetosaur relatives in Tanzania and China contrasts with the predominantly American and European fossil record of the later members of the clade.

Technical Session IX (Friday, October 19, 12:00 pm)

EXPLORING CROCODYLIAN DIVERSITY IN AN ENVIRONMENTAL CONTEXT: IMPLICATIONS FOR THE FOSSIL RECORD

NESTLER, Jennifer H., University of Iowa Department of Geoscience, Iowa City, IA, United States; WILBERG, Eric W., University of Iowa Department of Geoscience, Iowa City, IA, United States; PATTERSON, Judd M., National Park Service South Florida and Caribbean Network, Palmetto Bay, FL, United States

Modern crocodylians are semiaquatic predators that are relatively restricted in morphospace compared to their past diversity, yet they inhabit a diverse range of biomes today, including broadleaf forests, savannas, and marine environments. Digitally mapping the species ranges of extant crocodylians using Geographic Information Systems (GIS) allows for the ecological parameters of these ranges to be calculated. We can test assumptions of crocodylian ecology that are often applied to the fossil record. With the exception of alligatorines, minimum annual temperatures below freezing are the most significant restriction on extant species ranges. Minimum monthly precipitation levels do not restrict crocodylian species ranges, although mean annual precipitation must be high enough that a marked wet season exists. This indicates that crocodylians tolerate arid conditions quite well for portions of the year. Increased sympatry is associated with increased precipitation levels. GIS analyses also reveal that the most commonly utilized biome of crocodylians is tropical and subtropical moist broadleaf forest; followed by tropical and subtropical grasslands, savannas, and shrublands; and deserts and xeric shrublands. In contrast, the highest species richness is found primarily in flooded grasslands and savannas and secondarily by mangroves. Because snout shape is so often used as a proxy for ecology, we performed an outline analysis and model-based cluster analysis to quantify snout shape in fossil and modern Crocodylia. This results in two shape categories that are characterized primarily by differences in snout length and width. In contrast to species richness, the highest morphological richness is found in tropical and subtropical moist broadleaf forests. Morphospace occupation confers no restriction on whether extant species can inhabit a biome, and all but one biome occupied by at least one morphotype is occupied by both morphotypes. Additionally, the areas of highest extant species richness and highest morphological richness do not coincide. This leads to the likelihood that morphologically similar sympatric fossil species coexisted as well, creating a potential source of underestimation in fossil crocodylian diversity. Although feeding and niche habitats are often inferred from snout shape in fossil crocodylians, there are multiple modern instances of morphologically similar crocodylians co-occurring. These results indicate that niche partitioning is more complex than any ecological differences conferred by snout shape, and that making inferences in the fossil record based solely on this feature is tenuous.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MAMMALIAFORM TAXONOMIC DIVERSITY AND TURNOVER THROUGH THE MESOZOIC

NEWHAM, Elis, University College London, London, United Kingdom; GOSWAMI, Anjali, University College London, London, United Kingdom; BENSON, Roger B., University College London, London, United Kingdom; UPCHURCH, Paul, University College London, London, United Kingdom

Recent morphological, ecological and phylogenetic analyses of Mesozoic mammaliaformes have shed light on their unappreciated diversity. However, the taxonomic diversity of Mesozoic mammals has not been analysed with the same quantitative rigor of modern methodological tools. Here, we present a comprehensive statistical analysis of global mammaliaform taxonomic diversity and generic turnover from the Carnian (Late Triassic) to Maastrichtian (end Cretaceous). Collections data for 282 Mesozoic mammaliaform genera were updated in the Paleobiology Database and then taxonomic diversity was assessed using raw counts, residual diversity estimates based on mammaliaform-bearing collections, and shareholder quorum subsampling. Mammaliaform subclades were also analysed separately through the Mesozoic to assess changes in clade dominance, both globally and in individual geographic regions. Origination and extinction rates were estimated using the three-timer method, and the results of all of these approaches were combined to provide a robust picture of Mesozoic mammaliaform diversity. Mammaliaform taxonomic diversity is punctuated by multiple significant peaks and troughs through the Mesozoic. Statistically robust falls occur through the Callovian-Oxfordian, Valanginian-Hauterivian and Aptian, while significant increases in diversity are observed over the Triassic-Jurassic boundary, Jurassic-Cretaceous boundary and in the Campanian. Results for the Triassic and Jurassic periods are necessarily more tentative that those for the Cretaceous, as they are dominated by a few well-studied faunas. Turnover analyses identified peaks in extinction rates through each decline in diversity, although the relationship between increases in diversity and origination or extinction rates is more complex. Analysis of mammaliaform subclades shows that the Cretaceous diversity signal is dominated by a few mammalian subclades, with multituberculates and eutriconodonts driving Early Cretaceous diversity. Indeed eutriconodonts are most consistently successful through the Middle Jurassic to Early Cretaceous, repeatedly radiating following declines in overall mammaliform diversity before giving way to eutherians and metatherians in the Late Cretaceous. Spatial signals are markedly affected by preservation bias, but some general patterns are clear, such as Asian endemism during the Jurassic. Lastly, comparison with stable isotope proxies of paleoclimate suggests that Mesozoic mammaliaform diversity and turnover may have been affected by abiotic factors, such as Late Callovian-Oxfordian cooling and mid-Oxfordian warming pulses.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PARSIMONY ANALYSIS OF ENDEMICITY (PAE) OF LUNGFISH GENERA

NGASALA, Sifa E., Michigan State University, East Lansing, MI, United States

This study applied Parsimony Analysis of Endemicity (PAE) to a comprehensive sample of distributional data including all continent-level geographic units containing members of the Order Dipnoi, in order to assess the importance of unit area for explaining observed distribution patterns for these sarcopterygian fishes. PAE is one of several methodologies

used to assemble biogeographic reconstructions for vertebrate clades. Despite some of the inherent weaknesses of this method in failing to account for certain events that could be responsible for a given species distribution pattern (such as geodispersal, or removal of barriers to permit gene flow), PAE remains a highly useful method for formulating testable hypotheses about the processes responsible for observed biogeographic patterns.

Distributional data were obtained from more than 100 published articles and other references in order to construct a georeferenced records database. Geographic distribution maps for each taxon were assembled from distributional data using ArcGIS 10 software. Next, a presence - absence matrix was generated to detail lungfish generic distribution across all continental units. Binary cluster analysis was applied to the data using the R statistical package (version 2.14.0), and the biogeographic relationships of lungfish genera were examined in PAUP (version 4.0) using the Jacard coefficient of similarity. Twenty six most parsimonious cladograms were recovered, and summarized in a single consensus tree. Six areas (representing six continents) of endemism were identifed: Africa, Asia, Australia, Europe, North America and South America. Results in part suggest a pattern of vicariance between African and South American landmasses, recovering a close relationship between lungfish clades from those regions to the exclusion of those inhabiting other areas, consistent with findings obtained in other studies. The present analysis expands upon previous phylogenetic and biogeographic studies of lungfish that have either included subsets of this taxonomic sample, or fewer of the possible zoogeographic regions.

Technical Session III (Wednesday, October 17, 2:00 pm)

STABLE ISOTOPE DATA FROM THE CHILGA BASIN, ETHIOPIA, AND THEIR IMPLICATIONS FOR RESOURCE PARTITIONING AMONG LATE PALEOGENE AFRICAN ENDEMIC MAMMALS

NORET, Jordan, Southern Methodist University, Dallas, TX, United States; TABOR, Neil L., Southern Methodist University, Dallas, TX, United States; JACOBS, Bonnie F., Southern Methodist University, Dallas, TX, United States; SANDERS, William J., Museum of Paleontology, University of Michigan, Ann Arbor, MI, United States; KAPPELMAN, John, University of Texas, Austin, TX, United States

Herbivorous mammals in modern tropical ecosystems are characterized by a high degree of specialization, resulting in the systematic division of food resources among them. In order to test whether this also occurred within ancient tropical ecosystems, and to understand better the ecology of endemic Afroarabian mammals, $\delta^{13}C$ and $\delta^{18}O$ data were collected from carbonate in fossil herbivore tooth enamel apatite among orders Proboscidea, Hyracoidea, and Embrithopoda from the Chilga Basin, Ethiopia. Weight percent carbonate of each sample was calculated as a test for diagenesis and the samples yielding values outside the expected range were not included for interpretation. The entire $\delta^{13}C$ dataset ranges between -16‰ and -6‰ (Vienna Pee Dee Belemnite, or V-PDB). Excluding the possibility of diagenesis, this large range most likely indicates that the landscape was heterogeneous, and likely included areas similar to modern closed-canopy forests. There are taxon-specific peculiarities among the enamel $\delta^{13}C$ values which indicate that systematic division of food resources may have existed: the Proboscidea, on average, yielded the lowest values (-12.39‰, V-PDB) and the Hyracoidea yielded the highest (-9.73‰, V-PDB). It is not clear whether these data indicate that herbivore diets were different with regard to food types (e.g., legumes vs. palms), food source locations (e.g., canopy vs. ground, more closed vs. more open canopy areas), or whether these differences reflect seasonal variability. Nevertheless, the Embrithopoda $\delta^{13}C$ values varied the least (1S = 1.35‰), indicating that their diet was the most restricted of the taxa studied. This is consistent with the current understanding of the genus *Arsinoitherium* as a specialized feeder. Variation in $\delta^{18}O$ values within each taxonomic group was high (1S > 2‰). Excluding the possibility of diagenesis, and assuming that local surface waters did not vary greatly, this indicates none of these groups was semi-aquatic, in contrast to the widely held view of the habitat of *Arsinoitherium* (Embrithopoda).

Technical Session XI (Friday, October 19, 2:15 pm)

WHAT BIG CLAWS YOU HAVE: IMPLICATIONS OF MORPHOLOGICAL VARIATION IN THEROPOD MANUAL UNGUALS

NOTO, Christopher R., University of Wisconsin-Parkside, Kenosha, WI, United States

In order to understand the functional morphology of theropod forelimbs and interpret their use in behavior it is necessary to study the role played by the manual unguals. Among living vertebrates claws have a diversity of uses, including locomotion and food acquisition, and it has been shown that claw shape varies systematically with function. Among living birds, research shows a strong correlation between claw shape and such factors as substrate used for locomotion or predatory preferences and behavior. A similar approach to theropod unguals may yield insights into their behavior, predatory or otherwise. Theropod manual unguals vary greatly in overall morphology (size, length, curvature). While most had a likely predatory role, the claws of some taxa are thought to have had other functions, such as locomotion. Applying what we know about the correlation between shape and function in living vertebrates we may expect that differences in claw shape will follow ecological and/or evolutionary patterns in dinosaurs. A series of 14 coplanar landmarks were applied to photographs and published figures representing taxa from all major theropod clades, including birds. Over 200 individual claws are in the sample, representing over 80 taxa. Procrustes superimposition and thin-plate splines were used to quantify shape differences while principal components analysis (PCA) was used to explore patterns of shape variation. PCA results show that most of the shape variation is explained by changes in two areas: the degree of nail curvature and nail size relative to the ungual body. In many taxa, the first digit is strongly differentianted from the remaining digits. Certain features of shape variation have an evolutionary significance. Coelurosaurs differ significantly from non-coelurosaurs in claw shape, filling a much larger proportion of shape space suggesting greater ecological diversification. The claws of non-coelurosaurs were almost exclusively predatory in function, likely being used as piercing gaffes to hold prey. Within different coelurosaur clades, the evolution of ecological specializations is recorded in the changing claw shape as one move towards more derived members of the group. This includes the evolution of gaffe-like claws in giant predatory tyrannosaurids and elongated, straight claws in herbivorous ornithomimids. Some small paravians, including birds, are notable for having a claw shape that falls far outside all other groups, which may be a specialization for climbing. This novel approach allows one to explore ecological differences between theropod species and higher taxa, including food preference and predatory behavior. Furthermore, these results may aid in understanding the evolution of the theropod manus, its functional changes, and yield important character data useful for cladistic analyses.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

LIZARDS AND SNAKES OF THE TERLINGUA LOCAL FAUNA (LATE CAMPANIAN), AGUJA FORMATION, TEXAS, AND THE DISTRIBUTION OF PARACONTEMPORANEOUS SQUAMATES IN WESTERN NORTH AMERICA

NYDAM, Randall L., Midwestern University, Glendale, AZ, United States; ROWE, Timothy B., Jackson School of Geosciences, University of Texas, Austin, TX, United States; CIFELLI, Richard L., Oklahoma Museum of Natural History, University of Oklahoma, Norman, OK, United States

The late Campanian-aged squamates from the Terlingua local fauna of the Aguja Formation of southern Texas are represented by numerous isolated specimens of fragmentary jaws, vertebrae, and osteoderms. The fauna includes four scincomorphans: a new taxon referable to Xantusiidae that has massive teeth with crown morphology similar to that of more delicate teeth of contogeniid lizards; a second new taxon with robust teeth, but of indeterminate scincomorphan affinities; and two, unnamed scincomorphan morphotypes. Anguimorphans in the fauna include the ubiquitous anguid *Odaxosaurus piger*, the varanoid cf. *Parasaniwa wyomingensis*, and specimens referable to Xenosauridae. Ophidian jaw fragments confirm the presence of a snake in the fauna. The Aguja squamate assemblage is one of the most southerly of a series of paracontemporaneous squamate faunas that extends from central Alberta to northern Mexico. Comparison of these faunas reveals that, while two taxa are endemic to the Aguja Formation, others show some latitudinal trends. *Odaxosaurus* and *Parasaniwa* are components of all well-sampled late Campanian faunas from Alberta to Texas, indicating a broad plasticity in environmental preference. Polyglyphanodontini and snakes are found only in faunas from southern Utah to Texas and Mexico, and may have been intolerant of the climates in the north. Chamopsiids were likely intolerant of the southern climate, as they have a rapid decrease in diversity in progressively southern faunas and are absent in faunas south of northern New Mexico. Sole representative species of Contogeniidae and Xantusiidae are restricted to southern Utah and southern Texas, respectively. These hypotheses of distributional patterns must continue to be tested through ongoing investigations of all of the relevant faunas from the late Campanian of the Western Interior.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE ROLE OF FOSSIL EVIDENCE IN INFERRING ANCESTRAL CHARACTER STATES: A CASE-STUDY USING ARTIODACTYL THERMOREGULATORY CRANIAL VASCULATURE

O'BRIEN, Haley, Ohio University, Athens, OH, United States

This study investigates the evolutionary history of thermoregulatory cranial vascular structures in Artiodactyla using ancestral state reconstruction. The carotid rete is an arterial meshwork that, in conjunction with the maxilloturbinates, enables a physiological phenomenon known as selective brain cooling (SBC). SBC is effective in protecting brain tissues from heat damage, conserving water by cooling the hypothalamus, and delaying exhaustion in exercising animals. By functioning in these capacities, structures that enable SBC may be key innovations in the context of shifting environmental landscapes, especially across long-term trends of climate warming and aridification. Here, the evolutionary history of the carotid rete and patterns for cranial arterial supply in artiodacyls is inferred using ancestral state reconstruction. Ancestral character state reconstruction methods have become increasingly utilized and useful in the field of evolutionary biology. The primary function of ancestral state reconstruction is to trace the evolutionary history of morphological or ecological characters based on the distribution of observed characters in extant organisms. Many models of evolutionary processes have been used to generate these inferences including maximum parsimony, maximum likelihood, and, more recently, a Bayesian framework.

Osteological correlates for the carotid rete and internal carotid artery were scored for the skulls of more than 60 extant artiodactyl species. Six patterns of cranial arterial supply were identified and mapped as discrete characters onto an artiodactyl supertree. Divergence estimates were used to determine branch lengths. Maximum parsimony, maximum likelihood, and Bayesian ancestral state reconstructions were generated. All methods revealed different interpretations of nodal character states, with some reconstructions leading to inferences of convergent evolution and others indicating gradualistic evolution. These ancestral states were then compared with character states of fossil artiodactyl specimens, including fossil ruminants, camelids, and oreodonts. This study underscores the necessary

and complementary role of fossil data in the light of recent advances phylogenetic comparative methods.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

AIR SPACE PROPORTION IN A DORSAL VERTEBRA OF A NEW TITANOSAUR (DINOSAURIA: SAUROPODA) FROM JORDAN

O'CONNELL, Taryn L., University of Michigan, Ann Arbor, MI, United States; WILSON, Jeffrey A., University of Michigan, Ann Arbor, MI, United States; ZALMOUT, Iyad S., University of Michigan, Ann Arbor, MI, United States

Postcranial skeletal pneumaticity is present in birds and many fossil archosaurs, and it is especially well developed in the vertebral column of sauropod dinosaurs. The degree of vertebral pneumatization varies along the vertebral column and among sauropod genera. The air space proportion (ASP) is a convenient measure of the percentage of the vertebra that is occupied by air. Two-dimensional measurements of ASP are typically made by importing Computed Tomography (CT) images of vertebrae into a photo-editing program, and counting the pixels representing both airspace and bone. We used a slightly different technique to measure ASP in a new titanosaur from Jordan. We selected a sample of CT slices in the horizontal, sagittal, and transverse planes, enhanced the images, and then outlined internal and external pneumatic spaces using the image-processing program ImageJ. Internal pneumatic spaces are those enclosed within the vertebra and typically only visible in damaged regions or in CT images. External pneumatic spaces are fossae that are visible on the outside of the vertebra. Both internal ASP (iASP) and total ASP (tASP; sum of external and internal ASP) varied among different CT slice orientations and within sections in a single orientation. Horizontal CT sections had the most variation of both iASP and tASP, in addition to having the highest tASP value. These sections had an average iASP of 67.3% and ranged from 66.5% to 74.2%. Average tASP for these sections was 78.6% and ranged from 67.7% to 85.9%. Sagittal cross-sections displayed the least variation of iASP and tASP, as well as the lowest iASP values. The iASP values range between 62.7% and 69.3%, with an average of 66.2%. The tASP values were between 70.4% and 78.9%, with an average of 73.4%. Transverse sections presented little variation in iASP (63.5–67.8%), but great variation in tASP (65.5–81.4%; average 74.0%). The average iASP for the Jordanian dorsal vertebra is 67.1%, and tASP is 75.3%. From this study, it is clear that ASP values can vary considerably within a single vertebra. Patterns of variation within and between vertebrae along the column may provide insights into vertebral mechanics and function.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DIETARY EVOLUTION IN MESOZOIC BIRDS

O'CONNOR, Jingmai K., Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Neornithine birds are all edentulous and the horny bill that covers the rostrum is one of the most characteristic features of living birds. Basal birds, however, retain teeth and show diversity of dental arrangements and tooth morphologies. Tooth reduction is a common trend observed among basal birds (e.g. Jeholornithiformes, Sapeornithiformes) and the loss of teeth all together is known to have occurred several times in both Enantiornithes and Ornithuromorpha, the clade that includes living birds, as well as in more primitive taxa (e.g. Confuciusornithiformes). Despite an overall avian trend towards tooth reduction, Enantiornithes, the sister group to Ornithuromorpha, shows a high diversity of dental patterns and morphologies that suggests active selective pressures. One enantiornithine even preserves ornamented tooth enamel, the first recognized occurrence in class Aves. Teeth provide indirect clues to the diet of extinct birds; direct evidence in the form of preserved stomach contents are rare, but are preserved in several specimens from the Jehol Group lagerstätten, representing several clades – but not Enantiornithes. This difference is not considered preservational, given the large number of specimens representing the dominant Cretaceous clade, but interpreted as reflecting a major difference in diet between this clade and Ornithuromorpha. Potentially, this may have been a factor in the extinction of the enantiornithines at the end Cretaceous.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:30 am)

MORPHOLOGICAL EVOLUTION IN BASAL MESOEUCROCODYLIANS: TRACKING BODY SIZE AND DENTAL TRENDS IN NOTOSUCHIA

O'CONNOR, Patrick M., Ohio University, Athens, OH, United States; HIERONYMUS, Tobin L., Northeast Ohio Medical University, Rootstown, OH, United States; STEVENS, Nancy J., Ohio University, Athens, OH, United States; SERTICH, Joseph J., Denver Museum, Denver, CO, United States

Notosuchian crocodyliforms recovered from Cretaceous-age deposits in Gondwana reveal a level of morphological diversity not exhibited by crown crocodylians, nor by other extinct members of the clade. This diversity manifests in both postcranial and cranial portions of the skeleton, with the latter being the primary focus of most studies to date. Whereas many notosuchians represent relatively small forms (e.g., total skull length ranging from 7-15 cm), select members of the clade (e.g., baurusuchids) exhibit skull lengths exceeding 40 cm in length. In this study we examined exemplars from all notosuchian subclades in order to characterize morphological trends throughout the group and considered these data within the context of both body size evolution and inferred diet and habitat preferences. The following cranio-dental features were examined: craniomandibular organization, orientation of the pterygoid complex, total number of teeth, regionalization of the dental arcade (i.e., relative size and shape heterodonty), degree of occlusal complementarity, and tooth crown complexity. Regarding the latter, teeth range in shape from simple conical (i.e., "typical" crocodylian) crowns to biconvex, serrated forms to multicusped, complex molariforms. Trends related to increased heterodonty and increased occlusal complexity are anatomically focused on the posteriormost teeth of the maxilla and dentary. An elongate craniomandibular joint, increased size and shape heterodonty, and increased occlusal complexity are preferentially exhibited by smaller members (skull length </ 15 cm) of the clade. Importantly, these correlated trends appear to have evolved at least twice within Notosuchia, once within a southern African clade consisting of *Pakasuchus* and *Malawisuchus* and variably within a diverse assemblage of forms from South America. Morphology of the elongate craniomandibular joint provides evidence of the specialized nature of jaw mobility in these forms, with modeled movements consisting of both rotation and rostrocaudal translation of the lower jaw. Interestingly, the two independent examples of sustained increases in body size correspond with increasing shape homodonty and craniomandibular movements constrained primarily to rotation. In both cases (baurusuchids, peirosaurids), members exhibit varying degrees of biconvex, serrated teeth positioned within both the maxilla and dentary. Small-bodied, heterodont notosuchians have been characterized as mammalian analogs, occupying a terrestrial niche with inferred dietary preferences that include obligate herbivory to varying types of omnivory/insectivory. By contrast, large-bodied forms have been interpreted to occupy top predator roles in their respective ecosystems, whether these are terrestrial or semi-aquatic.

Technical Sesssion XII (Friday, October 19, 2:00 pm)

THE ONTOGENY OF THE SHOULDER IN *POLYCOTYLUS LATIPPINUS* (PLESIOSAURIA: POLYCOTYLIDAE) AND ITS BEARING ON PLESIOSAUR VIVIPARITY

O'KEEFE, Frank R., Marshall University, Huntington, WV, United States; BYRD, Christina J., Marshall, University, WV, United States

Understanding ontogenetic change in shoulder morphology in plesiosaurs is critical to proper taxonomic identification of embryonic plesiosaur material. The first known gravid plesiosaur was described in 2011, a large, Late Cretaceous polycotylid (*Polycotylus latippinus*), that provided evidence for viviparity in plesiosaurs. One main supporting argument for viviparity in this fossil was the taxonomic identity of the adult and embryo, an attribution based primarily on humeral morphology. Comparison of the embryonic material with another juvenile polycotylid skeleton described here demonstrates that the embryonic scapulae were misidentified as humeri, and the embryonic clavicles were misidentified as scapulae, in the original paper on plesiosaur vivaparity. In this study, the scapulae and clavicles of the embryo are compared with the juvenile polycotylid mentioned above, as well as with those of an adult *Dolichorhynchops osborni* and with the *Polycotylus* adult. The scapulae of the embryo and juvenile possess ossifications that resemble the scapulae of basal nothosaurs and pistosaurs much more than they resemble those of adult plesiosaurs. As polycotylids grow, however, progressive ossification produces scapular ossification similar to adult basal plesiosaurs, such as *Plesiosaurus*. At full adulthood the scapula is maximally derived, with a large and well-ossified ventral ramus. Therefore, the ontogeny of the polycotylid scapula recapitulates its sauropterygian phylogenetic history. The morphology of the scapula is too ontogenetically variable for reliable classification of the embryo; however, the triradiate morphology and concavities of the embryonic clavicles are maintained throughout ontogeny, and are diagnostic to Polycotylidae. While the embryo cannot be directly attributed to the genus *Polycotylus*, it is attributable to a large polycotylid. Therefore, the taxonomic identity of the embryo continues to support the *in utero* relationship with the adult *Polycotylus,* and the general conclusions concerning plesiosaurian viviparity are unchanged.

Technical Session X (Friday, October 19, 10:15 am)

DETERMINATE GROWTH IN *MORGANUCODON WATSONI*

O'MEARA, Rachel N., University of Cambridge, Cambridge, United Kingdom; ASHER, Robert J., University of Cambridge, Cambridge, United Kingdom

Dating from the Triassic-Jurassic boundary, *Morganucodon* is among the geologically oldest mammaliaforms. Several mammaliaform apomorphies are first observed in *Morganucodon*, including diphyodont tooth replacement and determinate growth of the skull. The co-occurrence of these characters in *Morganucodon* has led to the hypothesis that their evolution is related to the origin of lactation. The current evidence for determinate skull growth in this genus is based on linear measurements reported from a limited number of adult skulls of the Chinese species *Morganucodon oehleri*. The extent to which other *Morganucodon* species exhibit determinate growth has previously not been investigated. To test for the extent of determinate growth across species of *Morganucodon*, we investigated lower jaw metrics for several hundred specimens of the European species *M. watsoni*. Dentary depth at the anterior of the coronoid process was measured in a sample of 531 specimens of *M. watsoni* from Rhaeto-Liassic fissure deposits of Great Britain. Homologous dentary measurements were taken from small extant mammals known to have determinate growth patterns (e.g., *Erinaceus europaeus*, *Mustela ermina*). Mandibular measurements were also taken from the sea turtle (*Chelonia mydas*) and compared with lepidosaur jaws of comparable size to, and from the same fissure deposits as, the *M. watsoni* specimens. The distribution of the data for each species was analysed and found to be platykurtic for those species with determinate growth (*E. europaeus*: g_2=-0.98, t_{g2}=-2.00, $p<0.05$; *M. ermina*: g_2=-0.89, t_{g2}=-1.99, $p<0.05$). In these animals, growth ceases once a maximum size has been reached, and the right tail of the data distribution is truncated relative to the normal distribution, accounting for the observed

platykurtosis. Conversely, no significant kurtosis was found in the distribution of data for those species with indeterminate growth (*C. mydas*: g_2=-0.57, t_{g2}=-0.90, p<0.4; lepidosaur: g_2=-0.11, t_{g2}=0.23, p<0.5). The distribution of dentary data for *M. watsoni* was found to be platykurtic (g_2=-0.54, t_{g2}=-2.55, p<0.02), supporting the hypothesis of determinate growth in this animal. Additionally, the coefficients of variation (CV) of dentary depth were found to be less in the extant mammals than in those species with indeterminate growth patterns. The CV for *M. watsoni* was found to lie within the range of the extant mammals, further supporting the conclusion that growth was determinate in *Morganucodon.* This conclusion is consistent with evidence for diphyodonty in both *M. oehleri* and *M. watsoni*, and the hypothesis that the evolution of determinate growth and diphyodonty in basal mammaliaforms were interlinked and possibly related to the origin of lactation.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PALEOGENE ICHTHYOFAUNA OF THE IMO AND AMEKI FORMATIONS, SOUTHEASTERN NIGERIA

ODUNZE, Shirley O., Department of Biological Sciences, Athens, OH, United States; STEVENS, Nancy J., Department of Biomedical Sciences, Athens, OH, United States; COOPER, Lisa N., Ohio University, Athens, OH, United States; OBI, Gordian C., Department of Geology, Uli, Nigeria

The Paleocene-Eocene strata of southeastern Nigeria collectively represent a rich and relatively underexplored source of fossil vertebrates. Recent expeditions have focused on expanding the Paleogene ichthyofauna of this vast geological sequence. Deposits are represented by the upper part of the Nsukka Formation (Danian), the Imo Formation (Paleocene) and the Ameki Formation (Eocene). A transgressive erosional surface separates the Nsukka facies from the overlying Imo Formation that begins with estuarine clay, shale and limestone, and grades upward into fossiliferous/calcareous shoreface facies. The Imo Formation-Ameki Formation contact is marked by the transition from fossiliferous/ calcareous shoreface facies at the upper levels of the Imo Formation, into the overlying coarse grained tidally-influenced fluvial sandstones that form the basal units of the Ameki Formation. Fossiliferous facies of the Ameki Formation consists of phosphate-bearing estuarine mudstone and coquinoid limestone that pass upward into shoreface and coastal plain sandstones and clays. Recovery of vertebrate fossils has long been limited to the estuarine facies of the Eocene Ameki Formation. More recently, an actinopterygian, five chondrichthyans and the enigmatic taxon *Cylindricanthus* were recovered from newly discovered Paleocene Imo Formation localities in the Bende district. Additional field exploration to the region has revealed two additional fossil localities, Umunze (in the Imo Formation) and Ameke (in the Ameki Formation). Study of the fauna collected from these new localities revealed three chondrichthyans at Umunze, and one chondrichthyan together with two actinopterygians from Ameke. Sustained work in the region documents a diverse ichthyofauna containing at least six taxa. Five chondrichthyan taxa are represented by two ray species and four shark species, the latter including *Galeocerdo sp*, a taxon hitherto undocumented in the Imo formation of southeastern Nigeria.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

GIANT FELID POSTCRANIA & THE EARLY EVOLUTION OF NORTH AMERICAN CATS

ORCUTT, John D., University of Oregon, Eugene, OR, United States; DAVIS, Edward B., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States

The Late Miocene is a critical interval in felid evolution in North America, falling at the end of the "Cat Gap" and encompassing the immigration of the saber-toothed *Machairodus* from Eurasia, the evolution of the enigmatic, endemic *Nimravides*, and the appearance of the continent's first true conical-toothed cats. Much of the research on felids from the Late Miocene has focused on cranial and dental remains, using those skeletal systems to infer evolutionary trends and behavior. However, this cranial focus ignores the extensive record of felid postcrania in this interval, and the larger sample of postcranial elements can be a powerful tool for reconstructing diversity and ecology. In particular, humeri and ulnae from the Northwest United States and the Great Plains indicate the presence of an aberrantly large felid during the Hemphillian North American Land Mammal Age. The morphology of these bones is consistent with *Machairodus coloradensis*, the most common species of machairodontine on the continent at the time; however, they are up to 35% larger than known specimens of North American *Machairodus*. A complete humerus from McKay Reservoir, Oregon yields a body mass estimate of well over 200 kg, making it more massive than all but the largest captive individuals of extant lions and tigers. Machairodontine forelimbs are extremely robust, and as such, body mass regressions that take into account only simple length measurements may overpredict body size. Consequently, we have reconstructed body mass using a multiple regression drawing from three or more linear dimensions of each limb element. Regardless of its precise mass, though, the McKay felid was undoubtedly much larger than its contemporaries, and was in a size class otherwise unoccupied on the continent until the appearance of *Panthera atrox* in the Pleistocene. It is unlikely that the difference in size between the large felid and *M. coloradensis* reflects regional variability, as both have been recovered from the same sites (most notably Coffee Ranch, Texas). The large felid may indicate the presence of sexual dimorphism in *M. coloradensis*, or it may indicate the presence of an as-yet unrecognized species of machairodontine. In either case, it has important implications for the diversification of felids in North America and underscores the importance of postcrania in understanding taxa previously described mainly from skulls.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 10:30 am)

EVOLUTION OF SEX CHROMOSOMES IN DINOSAURS

ORGAN, Chris, University of Utah, Park City, UT, United States; JANES, Dan, NIH, Washington DC, DC, United States

Sex determination by chromosomal inheritance (genotypic sex determination) is common in amniotes and plays an important role in life history. Although sex chromosomes are often homomorphic, structural differences between homologous chromosomes is widespread. Inheritance of the heterogametic sex chromosome produces females (by inheriting the W; the ZW system) or males (by inheriting the Y; XY system). The ZW system is found in birds, snakes, and some other reptiles, while the XY system is found in mammals and some non-avian reptiles, like skinks. Generally, the heterogametic sex chromosome (W or Y) is smaller, heterochromatic, and gene poor in comparison to its partner. Although different information is genetically encoded in W versus Y chromosomes, their degradation suggests a consistent general trend in the evolution of sex chromosomes. Theory suggests that heterogametic sex chromosomes decay rapidly, perhaps completely vanishing within 10 million years in some cases, through the accumulation of deleterious mutations in the non-recombining region. However, a comprehensive large scale, phylogenetically-grounded analysis of chromosomal degradation within amniotes has never been performed. Moreover, it is unknown how the phylogenetic decay rates differ between the XY and ZW systems. Here we present a large-scale phylogenetic analysis of XY and ZW sex chromosome evolution using a large catalogue of karyotypic measurements. We discuss the rates and first appearance of sex chromosomes in the dinosaur lineage and present a novel Bayesian comparative method to make phylogenetically-informed univariate predictions.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

FLUVIAL SEDIMENT AND EGGSHELL INTERACTIONS: A METHOD FOR ASSESSING TRANSPORT IN FOSSIL EGGSHELL ACCUMULATIONS

OSER, Sara E., Montana State University, Bozeman, MT, United States

Assessment of transport history of fossil eggshell remains problematic given the complex taphonomic processes acting on fragments (e.g., breakage by trampling, dissolution, soil bioturbation). Previous studies focus on eggshell shape and orientation (concave up/down) to assess whether a fossil assemblage represents an in situ or allochthonous deposit. However, these studies are not applicable to all eggshell accumulations. At the Egg Mountain locality (Museum of the Rockies locality 006) near Choteau, Montana, hadrosaur eggshell occurs on multiple, poorly defined horizons, limiting the applicability of fragment orientation ratios. Thus, taphonomic studies require a different means for assessing possible transport. In a previous study I used a rock tumbler as a partial analogue of fluvial transport, and noted that sediment-eggshell interactions quickly induced distinctive wear on the edges of chicken (*Gallus gallus domesticus*) eggshell fragments. My current study investigates whether the presence or absence of edge wear provides a reliable means to distinguish allochthonous from in situ fossil eggshell accumulations.

Eggshell from three localities that represent an in situ nesting site (Wayan Formation, Idaho) and high energy environments (i.e., crevasse splay and channel sandstone) provide a baseline for comparing the Egg Mountain material. The fossil eggshells from all localities are of similar thickness (1 mm) and size (10 mm). Scanning Electron Microscopy (SEM) imaging reveals that eggshell deposited in high energy paleoenvironments display edge wear similar to that on chicken eggshell in the rock tumbler experiments (i.e., substantial rounding and loss of surface detail). In contrast, in situ eggshell from the Wayan Formation collected both as surface float and during excavation shows no evidence of edge wear. Further, this also demonstrates that short term subaerial exposure of untransported material will not produce wear. Eggshell from the Egg Mountain locality does not display edge wear, consistent with an in situ assemblage.

This study provides a more broadly applicable method to identify transported eggshell than previous techniques. However, this method is limited because it is an assessment of sediment interaction, which may not a direct indicator of transport. Flume studies reveal that some abrasion of modern eggshell occurs in place. Nevertheless, the absence of edge wear in fossil eggshell assemblages supports the interpretation of an in situ deposit.

Technical Session XV (Saturday, October 20, 9:00 am)

PHYLOGENY, HISTOLOGY AND INFERRED BODY-SIZE EVOLUTION IN A NEW RHABDODONTID DINOSAUR FROM THE LATE CRETACEOUS OF HUNGARY

OSI, Attila, MTA-ELTE Lendület Dinosaur Research Group, Budapest, Hungary; PRONDVAI, Edina, MTA-ELTE Lendület Dinosaur Research Group, Budapest, Hungary; BUTLER, Richard J., GeoBio-Center, Ludwig-Maximilians-Universität, Munich, Germany; WEISHAMPEL, David B., Center for Functional Anatomy and Evolution, Johns Hopkins University, Baltimore, MD, United States

Following 12 years of extensive excavations and screen-washing, the Iharkút locality, the only site in Hungary that has yielded Mesozoic vertebrates, has become one of the most important Late Cretaceous vertebrate sites in Europe. Remains of at least 30 species have been identified and document a Santonian continental–freshwater faunal assemblage that is generally similar to, but in some aspects distinct from, other European Late Cretaceous assemblages. The dinosaur assemblage is composed of basal tetanuran, abelisaurid, and

paravian theropods, nodosaurid ankylosaurs, coronosaurian ceratopsians, and a new species belonging to the endemic European ornithopod clade Rhabdodontidae, which is represented by both cranial and postcranial remains. A global phylogenetic analysis of ornithischian dinosaurs including all known rhabdodontid genera supports the rhabdodontid affinities of the Hungarian form. In addition to the Hungarian taxon, Rhabdodontidae comprises *Rhabdodon* spp. from the early Campanian–Maastrichtian of France and Spain, a poorly-known rhabdodontid from the lower Campanian of Austria, and *Zalmoxes* spp. from the Maastrichtian of Romania. Based on characters of the dentary, an element that is known in all rhabdodontid species, the Hungarian species is most similar to the Austrian rhabdodontid. This close affinity is further supported by their close temporal as well as spatial proximity. The Hungarian rhabdodontid also shows similarities to *Zalmoxes*, a genus that is approximately 15 million years younger in age, but the morphologies of the quadrate, dentary, and some limb bones clearly indicate important differences between the two forms. Histological study of limb bones has allowed estimation of adult body size for all genera of Rhabdodontidae. Samples from the Hungarian and Austrian species indicate a similar adult body length of 1.6–1.8 m that is in accordance with the morphological similarities between these two rhabdodontids. In contrast, the French specimens of *Rhabdodon* had a much larger, 5–6 m, adult body length, indicating a substantial difference in body size between the western and eastern European taxa. However, phylogenetic mapping of body size onto the results of the phylogenetic analysis calls into question the hypothesis that insular dwarfism accounts for the small body size of the eastern rhabdodontids. These results imply a deep divergence (prior to the Santonian) between a western rhabdodontid lineage represented by at least two species of *Rhabdodon* in Spain and France and an eastern lineage consisting of the *Zalmoxes* and the Austrian and Hungarian rhabdodontids.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PHYLOGENETIC RELATIONSHIPS OF *MUSSAURUS PATAGONICUS*: TESTING THE EFFECT OF ONTOGENETICALLY VARIABLE CHARACTERS ON TREE TOPOLOGY

OTERO, Alejandro, Museo de La Plata, La Plata, Argentina; POL, Diego, Museo Egidio Feruglio, Trelew, Argentina; POWELL, Jaime, Instituto Miguel Lillo, Tucumán, Argentina

Mussaurus patagonicus is a basal sauropodomorph dinosaur from the Upper Triassic Laguna Colorada Formation, Patagonia, Argentina. This taxon is known from multiple individuals of different ontogenetic stages, including hatchlings, juveniles, and adult specimens, providing a case study of ontogenetic changes in a basal sauropodomorph. Skull morphology is known from hatchlings and juveniles whereas postcranial remains are known from all ontogenetic stages.

Here we test the effect of ontogenetic changes on inferences of phylogenetic position of *M. patagonicus*, scoring specimens from different ontogenetic stages as separate operational taxonomic units: only adult specimens (lacking cranial characters), only non-adult specimens (including cranial characters), and a mixture of non-adult (cranial) and adult (postcranial) characters in the same data matrix in order to test the impact of ontogenetic variations in the retrieved tree topology.

The results depicted *M. patagonicus* as the sister group of massospondylids when only juvenile specimens, when only juvenile cranial characters, and when only juvenile postcranial characters, are scored. On the other hand, when we scored characters solely from adult individuals, all MPTs depict *M. patagonicus* as a basal member of Anchisauria, being the sister group of the clade comprising *Aardonyx* + more derived sauropodomorphs. *M. patagonicus* is therefore placed in a more derived position forming part of the basal sauropodomorph-sauropod transition. The same results are retrieved when we scored a mixture of juvenile cranial and adult postcranial characters.

Certain characters related to limb proportions in the juvenile specimens, such as the skull/femur length and humerus/femur length ratios show derived states, like those present in the quadrupedal clade (i.e., Eusauropoda) suggesting putative quadrupedal locomotion. Those characters, however, present plesiomorphic states in the adult specimens, suggesting, at least, facultative bipedal locomotion. In contrast, most character states related to the manus in the juvenile specimens show no changes when compared to adult specimens, depicting this structure as a conservative module through ontogeny.

The results show the character states that vary through ontogeny and such variation does not always represent plesiomorphic states in early ontogenetic stages, but instead a mixture of apomorphic and plesiomorphic states reflected in different tree topologies. These changes are shown to be relevant for determining the phylogenetic position of *M. patagonicus*, as its affinities change if adult morphology is ignored, suggesting that a careful evaluation of ontogenetic stages is needed for testing the phylogenetic relationships of basal sauropodomorphs.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

COMMUNICATING SCIENCE IN THE DIGITAL ERA: THE PCP-PIRE E-NEWSLETTER

OVIEDO, Luz H., Florida Museum of Natural History, Gainesville, FL, United States; GRANT, Claudia, Florida Museum of Natural History, Gainesville, FL, United States; ELLIS, Shari, Florida Museum of Natural History, Gainesville, FL, United States; MACFADDEN, Bruce J., Florida Museum of Natural History, Gainesville, FL, United States

Increasingly scientists are required to include an outreach or communication component in their research projects, especially those funded by government agencies. The Panama Canal Project (PCP) Partnerships in International Research and Education (PIRE) is an international partnership among several institutions from United States and Panama. PCP PIRE students created a bi-lingual (English/Spanish) e-newsletter to keep participants and partners informed about the different project activities and to engage new potential stakeholders.

E-newsletters have numerous advantages over other media, including printed newsletters, list-serves, and even web sites. These include ease of targeted distribution via email, reduced costs, active engagement, and rapid transmission. Our PCP PIRE e-newsletter, published monthly (10 times per year), has grown over the past 15 months to a readership of more than 200 including students, faculty, educators, funding agencies, and partner institutions. Our monthly readership continues to grow as new stakeholders are added to our mailing list. During the initial development, formative feedback indicated that, given the barrage of e-communications, some readers wanted the e-newsletter to be short with "snippets" organized in a way similar to the screen that appears in hand-held devices like iPhones. If readers want to delve more deeply into a particular subject they can link to the longer article. PCP-PIRE students write the e-newsletter stories. Articles are typically 250 to 450 words. Stories are organized in four sections: People, International, Research and Education. All of the e-newsletters are archived on our PCP PIRE web site.

The PCP-PIRE e-newsletter open rate (42-58%) is higher compared to other newsletters with a similar scope. Also, 25% of recipients click on the links to learn more about the stories (click rate). People, International and Research sections are preferred by the recipients (23-27%), while 15% of recipients read complete stories in the Education section. The variety of sections in the e-newsletter and the Spanish version of every story meet the needs of the different stakeholder demographics. Other similar projects may benefit from lessons learned such as how to write for a diverse audience, understanding readership reports, and avoiding being reported as a spammer.

Technical Session IV (Wednesday, October 17, 2:30 pm)

META-ANALYSIS OF REPORTED PTEROSAUR TRACKWAYS: TESTING THE CORRESPONDENCE BETWEEN SKELETAL AND FOOTPRINT RECORDS

PADIAN, Kevin, University of California, Berkeley, CA, United States; FALLON, Brenna, University of California, Berkeley, CA, United States

It is sometimes remarked that there is a "landslide of evidence" for ubiquitous trackways of pterosaurs in the Jurassic and Cretaceous Periods. We performed a meta-analysis of nearly 100 reports and reviews of alleged pterosaur tracks. We first focused on the redundancy of works that attributed trackmakers based on referrals of previous authors, but that provided no first-hand justification for the attribution. More than a third were redundant reports; fewer than 10% examined the evidence for attribution. There was a significant correlation among (1) attribution of trackways to pterosaurs, (2) no consideration of alternative hypotheses of trackmakers, (3) lack of anatomical or kinematic evidence for the attribution, and (4) referral of justification for the attribution to two (or a very few) recurrent publications. We then focused on the justification for the attribution of trackways to pterosaurs. We found no skeletal anatomical apomorphies of pterosaurs reflected in any diagnosis of trackways, including reformulations of the original diagnosis of *Pteraichnus saltwashensis*. In almost all cases of trackways referred to pterosaurian trackmakers (with the notable exception of the tracks from Crayssac, France) there is no evidence of pterosaurian apomorphies. Some of these assigned trackways, such as *Purbeckopus*, show clear crocodilian apomorphies reflected in their diagnoses. Others, such as *Haenamichnus*, show no discernible anatomical features. Over 90% of the ichnological literature contains no analysis of skeletal or functional features that an assignment to a pterosaurian trackmaker requires. Because no trackways assigned to pterosaurs are well enough preserved to determine either a manual or pedal phalangeal formula, it is impossible to reconstruct the skeletal manus and pedes of the trackmakers assigned to any Pteraichnidae (traditionally presumed to be tracks of pterosaurs). Nearly all trackways attributed to pterosaurs show (1) a gleno-acetabular ratio lower than commensurate with known pterosaurs, (2) a length-width ratio of the pes (metatarsals + phalanges) incommensurate with known pterosaurs, and (3) a preservation so poor as to make attribution of a trackmaker impossible. The Crayssac tracks differ in derived respects from all other attributed trackways, despite deficient preservation, because they show true pterosaurian apomorphies; they should be systematically separated, as other authors have advocated. It is difficult to assign most tracks referred to Pteraichnidae to pterosaurs or any taxon. We propose morphological and preservational criteria by which to evaluate alleged pterosaur tracks. Our analysis has important implications for paleoecological and taxonomic assesments of ancient communities.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ON THE POSTORBITAL AND SUPRAORBITAL OSSIFICATIONS OF SNAKES: NEW INSIGHTS FROM OLD BONES

PALCI, Alessandro, University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada

Some snakes have two circumorbital ossifications that in the current literature are usually referred to as the postorbital and supraorbital. We review the arguments that have been proposed in the past in order to justify this interpretation and provide counter-arguments that reject those conjectures of homology. After examining the skulls of several lizards and snakes, both extant and fossil, we provide evidence, based on both topology and

structural similarity, for a reinterpretation of the homology of the dorsal and posterior orbital ossifications of snakes. First of all, we note that the postorbital of lizards is typically an ossification that takes part in the formation of the upper temporal bar, and has little or no contribution to the posterior margin of the orbit. As a consequence of this, squamates that lost the upper temporal bar also lack a postorbital (e.g., *Heloderma*, *Lanthanotus*, *Anniella*); the only possible exception could be represented by the Gekkota, where the postorbital may be retained if fused with the postfrontal, but this is still debated. Therefore, considering that snakes primitively lack an upper temporal bar, there is no reason to consider the postorbital as present in snakes. Moreover, considering that the posteroventral margin of the orbit is typically formed by the jugal, we conclude that the posterior orbital ossification of snakes is topologically more consistent as a homologue of the jugal of lizards. On the other hand, based on its topological relationship with the jugal and the frontoparietal suture, the dorsal orbital ossification that appears in some snakes (e.g., pythons, *Loxocemus* and *Calabaria*) should be considered as the homologue of the lacertilian postfrontal. These primary homology statements are consistent with the observed anatomy of the fossil snake *Dinilysia patagonica,* and with a new interpretation of the jugal and postfrontal morphology and articulations for the fossil snakes *Pachyrhachis problematicus* and *Eupodophis descouensis.* As a consequence of our observations, we propose that the terms postorbital and supraorbital be abandoned when talking about the circumorbital bones of snakes, and that they should be replaced with the terms jugal and postfrontal respectively. This re-interpretation of the circumorbital bones of snakes may have important repercussions on future phylogenetic analyses and consequently on our understanding of the origin and evolution of snakes.

Technical Session II (Wednesday, October 17, 10:45 am)

A MICRO-CT INVESTIGATION OF MODES OF TOOTH IMPLANTATION AND REPLACEMENT IN EARLY TETRAPODS

PARDO, Jason D., University of Calgary, Calgary, AB, Canada; ANDERSON, Jason S., University of Calgary, Calgary, AB, Canada

Although tooth development and evolution is a potentially rich source of information on the origin of modern tetrapod groups, little is actually known about the morphology, histology, and development of teeth in early tetrapods. This is especially important because tooth morphology and succession are used to inform phylogenetic hypotheses, especially hypotheses concerning heterochronic processes, but without a solid baseline for comparison. Thus, comprehensive study of tooth morphology, histology, and succession in early tetrapods plays a critical role in contextualizing novel tooth morphologies and successional patterns in lissamphibians and amniotes, as well as informing debates on the relationships of modern groups to Paleozoic forms.

In order to investigate the evolution of the dentition in early tetrapods, we used a micro-CT approach to investigate morphology, implantation, and tooth succession on marginal tooth-bearing elements in a survey of early tetrapod taxa. We focused sampling on temnospondyls and lepospondyls, focusing primarily on dissorophoids and recumbirostrans, while also sampling representative reptiliomorphs. Along with gross morphology, we were able to reconstruct the alveolus, pulp cavity, canals within the bone housing the mandibular branch of the trigeminal and alveolar nerves, and tooth resorption zones associated with development of replacement teeth. Histological sectioning was performed on voucher specimens in order to confirm morphology imaged with micro-CT.

Teeth in small temnospondyls typically attach to the medial surface of the dentary with a dentine stalk and are replaced lingual to the tooth row. Teeth of recumbirostran lepospondyls attach to either the lingual or occlusal surface of the dentary and lack a dentine stalk entirely, and the enamel cap directly attaches to the underlying dentary, and are replaced from a lingual successional lamina. Teeth in the embolomere *Archeria* are housed within deep sockets, but are replaced from a successional lamina lingual to the tooth row, with implantation into the alveolus occurring after replacement of the crown, in contrast to true thecodonty, where the successional lamina is housed within the alveolus. Replacement, when it occurs, is constrained to pairs, triplets, or series of teeth, and may occur in either an anterior or posterior direction, depending on the taxon and position within the jaw. Replacement modes are inconsistent with a global zahnreihe model of tooth replacement, and we identify hidden diversity of tooth implantation and replacement among early tetrapods.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE FOSSIL CALIBRATION DATABASE: A NEW BIOINFORMATIC TOOL FOR DATING DIVERGENCES OF EXTANT LINEAGES BY SYNTHESIZING PALEONTOLOGICAL AND MOLECULAR SEQUENCE DATA

PARHAM, James F., Dr. John D. Cooper Archaeological and Paleontological Center, Santa Ana, CA, United States; KSEPKA, Daniel T., North Carolina State University, Raleigh, NC, United States; POLLY, P. D., Indiana University, Bloomington, IN, United States; VAN TUINEN, Marcel, University of North Carolina at Wilmington, Wilmington, NC, United States; BENTON, Michael J., University of Bristol, Bristol, United Kingdom

Our ability to correlate biological evolution with climate change, geological evolution, and other historical patterns is essential to understanding the processes that shape biodiversity. The use of fossil to calibrate molecular phylogenies represents a rapidly expanding approach to dating the divergence of extant lineages. The development of fossil calibrations represents a significant challenge because it combines temporal and anatomical data from the fossil record with molecular systematics. These classes of data are traditionally used by researchers in separate fields and published in discrete specialist journals. Not surprisingly, many fossils used to calibrate divergence times are not phylogenetically constrained and/or have incorrect ages assigned to them. The development of rigorous methods for using paleontological data for divergence dating has lagged behind the development of statistical methods for analyzing genetic sequences. A working group consisting of paleontologists, molecular systematists and bioinformaticians, has developed protocols, platforms, and incentives that will facilitate broader community involvement to meet this challenge. The recently published "best practices" for justifying and reporting calibrations serves as the foundation for a searchable online database of vetted fossil calibrations that are explicitly tied to museum specimens. Incentivising community contribution is key to keeping the database active and up to date and so the Fossil Calibration Database is paired with a rapid publication outlet for fossil calibration data through partnership with an open access online journal (*Palaeontologia Electronica*).

Education and Outreach Poster Session (Posters displayed October 17 – 20)

JURASSIC JOURNEY: INTRODUCING THE PUBLIC TO "SCIENCE-IN-PROGRESS" AT AN ACTIVE DINOSAUR QUARRY

PARKS, Hillary L., Burpee Museum of Natural History, Rockford, IL, United States; WILLIAMS, Scott A., Burpee Museum of Natural History, Rockford, IL, United States; RAWLINGS, Sheila, Burpee Museum of Natural History, Rockford, IL, United States; CARLSON, Elizabeth C., Burpee Museum of Natural History, Rockford, IL, United States; FIVECOAT, Sue, Utah Bureau of Land Management, Hanksville, UT, United States

Jurassic Journey is an innovative program that introduces the general public to science-in-progress at an active dinosaur quarry through guided tours and engages students in hands-on paleontological field work. Since 2009 Burpee Museum has collaborated with the Utah Bureau of Land Management and the town of Hanksville, Utah to introduce the general public to the science behind the Hanksville-Burpee Dinosaur Quarry and promote the importance of fossil resources on public lands. The Hanksville-Burpee Dinosaur Quarry, located outside the town of Hanksville, Utah, was first excavated by Burpee crews in the summer of 2008, though the area had long been known to be rich in dinosaur fossils and petrified wood by local residents. The quarry is a sauropod dominated, Morrison Formation (Brushy Basin Member) locality. This locality has a high-density, bone bearing layer and has yielded fossils from *Diplodocus*, *Camarasaurus*, *Apatosaurus*, *Allosaurus* and potentially *Barosaurus*.

The first goal of the Jurassic Journey tours is to introduce the general public to the basics of field paleontology, but also to what one aspect of science "looks" like. Since 2009, the active quarry has been open for educational tours led by Burpee Museum education staff. The tours are the core of the Jurassic Journey project. For many visitors, these tours are their first visit to an active paleontological quarry. The tours cover a wide range of disciplines, including the geology, paleoecology and paleobiology of the quarry, as well as paleontological field work techniques. During the tour the Burpee lab staff, volunteers and students are encouraged to share with the group what they are working on and the techniques they are using.

The second goal of the Jurassic Journey project is to engage, in particular, undergraduate students in outreach education as they share their experience and knowledge with the tour groups that come through. Each dig season the quarry is worked by Burpee Museum lab staff, volunteers, and undergraduate students from as many as three universities. In the past three years the Hanksville-Burpee Quarry hosted over 1200 people including: school groups, visitors from nine countries and 20 other states. An additional 600 people are expected to visit the quarry during the 2012 dig season.

Very few institutions currently bring the general public in contact with science-in-progress at an active dinosaur quarry in North America. Fewer still, are the groups that pair exposure to science-in-progress with an educational experience. The Jurassic Journey project has the strong potential to serve as a framework for other projects to bring the general public in contact with science-in-progress at other active paleontological quarries and promote fossil resources on public lands.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 9:15 am)

A FIELD GUIDE TO THE BIRDS (VOLANT VERTEBRATES) OF THE CRETACEOUS OF APPALACHIA

PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States; CLEMENTS, Donald, New Jersey State Museum, Rocky Point, NC, United States; LAUGINIGER, Edward, New Jersey State Museum, Boothwyn, PA, United States; HOPE, Sylvia, California Academy of Sciences, San Francisco, CA, United States

Although considered uncommon, bird and pterosaur specimens of Appalachia have accumulated in sufficient numbers as to permit more general analyses of the volant vertebrates. Avian specimens come primarily from the New Jersey greensands, closely associated with the Cretaceous/Paleogene boundary, and typically are analyzed as a group regardless of precise age. The taxa represented generally have a modern aspect, and most can be identified with extant bird orders (Neornithes). This contrasts with Laramidian birds, which also include specimens of Enantiornithes and Hesperornithiformes, taxa not closely related to extant forms. Bird specimens from both subcontinents have been found primarily in sediments from aquatic paleoenvironments, but the Laramidian specimens come primarily from freshwater deposition and estuarine channel fills of clastic material, while the greensands of Appalachia are marine shelf deposits of authigenic minerals. Consequently, although the avifaunas of both subcontinents appear to be dominated by birds of powerful

flight associated with aquatic environments (including Anseriformes and Charadriiformes), the birds of Appalachia appear to be somewhat more so. As might be expected,the bird groups with strong flight capabilities populated both subcontinents, so that greater faunal similarity would be expected for birds than for non-volant vertebrates. However, the same cannot be said for the pterosaurs of the later Cretaceous, which have a rather meager record of primarily localized taxa. Even the apparently widespread Pteranodontidae have no certain record of a genus occurring on both subcontinents. The flight capabilities that enabled birds to populate large areas across continental borders seem to have been lacking in pterosaurs, even those of great size and strength. A corollary to this observation is the likelihood that pterosaurs were less capable of surviving the Cretaceous/Paleogene boundary catastrophe, which indeed they did not.

Technical Session I (Wednesday, October 17, 11:45 am)

THE FIRST INTACT SCAPULAR GLENOID REGION OF *DEINONYCHUS ANTIRRHOPUS* AND THE CONSEQUENT RE-INTERPRETATION OF DROMAEOSAURID FEATURES THAT ENHANCED THE EVOLUTION OF AVIAN FLIGHT

PARSONS, William L., Buffalo Museum of Science, Buffalo, NY, United States; PARSONS, Kristen M., Buffalo Museum of Science, Buffalo, NY, United States

Within Dromaeosauridae, the morphology of the glenoid region of the scapula is the key to understanding the overall mobility of the shoulder and thus the extent to which this joint functioned to enhance the evolution of avian flight. The discovery of the proximal ends of two scapulae of *Deinonychus*, each possessing a shallow, posterolaterally facing glenoid, helps to elucidate this understanding. The dorsal edge of the glenoid possesses a considerably curved embayment that would have presented no obstacle to the raising of the forelimb above the horizontal plane of the shoulder girdle; rather, it would have facilitated such upward arcing movement. Within this embayment there is a robust scapulohumeral ligament fossa. The humerus was held within the glenoid by a combination of the acrocoracohumeral ligament and the scapulohumeral ligament. The positioning of the scapulohumeral ligament fossa is at a pivot point along the rostral/caudal axis of the dorsal edge of the glenoid; this fossa is an anchoring point for the upward movement of the forelimb. The morphology of the glenohumeral joint of *Deinonychus* differs considerably from that of *Velociraptor mongoliensis*. Along with the fusion of the scapula/coracoid suture on *Velociraptor*, the posteroventral orientation of the glenoid of *Velociraptor* is secondarily derived from the more primitive posterolateral orientation as is found in *Deinonychus* and a number of other dromaeosaurids. Also, the embayment of the glenoid of *Velociraptor* is deeper than that on *Deinonychus*, and the movement of the humerus would have been restricted by a rostral coracoidal tuber and a less robust caudal scapular tuber. Various features of the *Deinonychus* shoulder joint can be interpreted as possessing all the necessary elements for the evolution of the triosseal canal. This current reinterpretation of the mobility potential of the shoulder joint of *Deinonychus* along with the unfused mobile suture between the coracoid and scapula and the relationship between the acrocoracohumeral ligament, M. deltoideus clavicularis, and M. supracoracoideus present a combined mechanical morphology that would allow for an alternative form of "wing-flapping" without humeral rotation. Additionally, it raises questions as to the functional aspects of other features that enhanced the evolution of flight, such as the flexibility of the cervical vertebral articulations and the caudal modular muscular contribution to mobility possessed by this and other taxa within Dromaeosauridae.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

TAPHONOMIC COMPARISON OF MODERN EAST AFRICAN OWL PELLETS AND THE KANAPOI FOSSIL MICROMAMMAL ASSEMBLAGE

PATTERSON, David B., The George Washington University, Washington, DC, United States; DU, Andrew, The George Washington University, Washington, DC, United States; BOBE, René, The George Washington University, Washington, DC, United States; BEHRENSMEYER, Anna K., National Museum of Natural History, Washington, DC, United States; REED, Denné, University of Texas, Austin, TX, United States

Micromammals have long been recognized for their value in the reconstruction of hominin paleoenvironments, but they are relatively understudied in East Africa in comparison to large mammals. When concentrations of micromammal fossils are recovered, avian predators usually are invoked as the accumulating agent, even though other taphonomic processes—alluvial processes, catastrophic events, mammalian predation, etc.— could also play a role in concentrating small bones and teeth. This actualistic study tests the avian predator hypothesis by focusing on the taphonomy of micromammal assemblages. We compare a sample of East African micromammal fauna collected from modern owl roost localities to a fossil micromammal assemblage from East Africa hypothesized to have been accumulated by avian predators. The extant micromammal sample (> 4,000 NISP) was collected from five roost localities to the east of Lake Turkana in northern Kenya and nine roost localities from the Serengeti in northern Tanzania, while the fossil assemblage (> 600 NISP) is from Kanapoi in northwestern Kenya. Skeletal element and portion representation are compared between the modern and fossil samples to determine the degree of similarity between modern owl-accumulated and fossil micromammal assemblages from East Africa. Results indicate that skeletal element representation is consistent between the modern and fossil sample, however the portion of each element preserved is significantly different. These findings suggest that the primary taphonomic filter (i.e., avian predation) is consistent between the two samples, but postdepositional processes (i.e., diagenesis and excavation) drastically altered the taphonomic characteristics of the fossil assemblage. The implications of this pilot study can be used in conjunction with other taphonomic signatures (i.e., surface etching, degree of rounding/abrasion, mortality and age profiles, etc.) to improve interpretations of the biological and geological processes that formed micromammal assemblages in the fossil record and increase understanding of taphonomic processes that may bias reconstructions of hominin paleoecology.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

FIRST INSIGHTS INTO THE DICRAEOSAURID (SAUROPODA: DIPLODOCOIDEA) INNER EAR: THE ENDOCRANIAL MORPHOLOGY OF *AMARGASAURUS CAZAUI* STUDIED USING CT SCANS

PAULINA CARABAJAL, Ariana, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina

The braincase of the sauropod dinosaur *Amargasaurus cazaui* from the Lower Cretaceous of Neuquen Province, Argentina represents the only dicraeosaurid neurocranial material known from South America (with the probable exception of a partially preserved natural endocast recently recovered from the Lower Cretaceous Mulichinco Formation, also in northern Patagonia). Furthermore, the morphology of the inner ear has not previously been described for any of the four known genera of this sauropod clade. The braincase of *Amargasaurus* has been CT scanned, allowing for a three-dimensional digital reconstruction of the endocranium (represented by the forebrain, midbrain, and hindbrain, plus the spaces related to the pineal and postparietal fenestrae) and inner ear. The labyrinth is dorsoventrally longer than the lagena, which is simple, conical, and relatively short compared to that of other sauropods. The anterior semicircular canal (ASC) is larger than the posterior semicircular canal (PSC), and the lateral semicircular canal (LSC) is markedly smaller than the PSC, similar to the morphology described for *Diplodocus.* In dorsal view, the angle formed by the ASC and PSC is approximately 90°. When the braincase is oriented with the LSC positioned in the horizontal plane, the occipital condyle is not as ventrally projected as had previously been stated, suggesting that the habitual posture of the head was similar to that reconstructed for *Nigersaurus,* with the muzzle pointing downward. However, further studies of the cranial anatomy, myology, and cervical vertebral morphology of *Amargasaurus* are needed before the range of head and neck movements in this taxon can be defined.

Technical Session XIV (Saturday, October 20, 10:45 am)

A NEW SILESAURID DINOSAURIFORM FROM THE MIDDLE TRIASSIC (ANISIAN) NTAWERE FORMATION OF ZAMBIA REINFORCES PATTERNS OF ASSEMBLAGE DISSIMILARITY ACROSS SOUTHERN PANGAEA

PEECOOK, Brandon R., University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States; NESBITT, Sterling J., University of Washington, Seattle, WA, United States; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; STEYER, J. S., Museum National d'Histoire Naturelle, Paris, France

The oldest diagnosable members of Dinosauria appear in the early Late Triassic (Carnian) of Argentina and Brazil. Successive sister taxa of Dinosauria, the non-dinosaurian dinosauromorphs, historically have been found in slightly older rocks of the late Middle Triassic (Ladinian), but in the same general area as the earliest Dinosauria. However, recent discoveries have been made in other parts of the world showing that non-dinosaurian dinosauromorphs had stratigraphic ranges extending tens of millions of years into the Late Triassic. Perhaps most surprising was the blossoming of Silesauridae, a clade that is currently recognized as the sister group to Dinosauria, contains at least seven species, was unbeknownst to paleontologists before 2003 and only named in 2010. A suite of features characterizes the clade including a long limbed, quadrupedal bauplan, and a skull equipped with a beak and plant-eating teeth in more apomorphic members.

We present the first silesaurid and archosaur from the upper portion of the Ntawere Formation of the Luangwa Basin, Zambia. The upper Ntawere has been correlated with both the *Cynognathus* Assemblage Zone, subzone C (CAZ-C) of the Karoo Basin in South Africa and the Manda Beds of the Ruhuhu Basin in Tanzania, the latter of which yielded the silesaurid *Asilisaurus kongwe*. A phylogenetic analysis including new pelvic characters, places the Zambian silesaurid with Late Triassic silesaurids such as *Silesaurus*, *Sacisaurus*, and *Eucoelophysis* rather than sister to coeval *Asilisaurus*. With the later forms the Zambian silesaurid shares a laterally oriented brevis fossa on the ilia and transversely thin ischia in cross section, though both the Zambian silesaurid and *Asilisaurus* have high ilial blades relative to the acetabulum. The discovery of a silesaurid bonebed in 2011 likely contains referable material. Bird-line archosaurs, and silesaurids in particular, were more diverse than previously suspected in the Anisian. The new Zambian silesaurid and *Asilisaurus* can be regarded as the two oldest known members of the bird-line archosaurs.

The discovery of a silesaurid, as well as a number of other distinct archosaur taxa, increases the taxonomic similarity between the upper Ntawere and archosaur-rich Manda Beds, to the exclusion of CAZ-C. Despite the increased time and effort put into sampling the Karoo Basin relative to the Luangwa and Ruhuhu basins, the CAZ-C contains no diagnostic members of crown-Archosauria. These results suggest enhanced Triassic terrestrial provinciality, implying that the Karoo Basin may not be a representative model system for Triassic terrestrial faunas. To test this we applied theoretic methods to track assemblage heterogeneity across southern Pangaea during the first 15 million years of the Triassic.

Technical Session XV (Saturday, October 20, 8:00 am)

GEOMETRIC MORPHOMETRIC STUDY OF THE EVOLUTION OF THE HIND LIMB IN NON-AVIAN DINOSAURS

PEI, Rui, American Museum of Natural History, New York, NY, United States

Non-avian dinosaurs were the dominant terrestrial vertebrate group during the middle and late Mesozoic, and they developed a large diversity of body plans and skeletal morphologies indicative of varied ecologies. Here we use geometric morphometrics to study evolutionary and ecological patterns in the foot morphology of non-avian dinosaurs, and compare the distribution of taxa in hind limb morphospace on the basis of phylogeny and function. A preliminary analysis including over 120 samples from all major non-avian dinosaurian groups was conducted to study disparity among the hind feet. Results show that the feet of dinosaurs differ primarily from each other in relative robustness and patterns of asymmetry. Saurischians exhibit a higher level of disparity in the metatarsals than ornithischians, which is probably related to the wider range of ecological niches occupied by saurischian dinosaurs. On a PC1 vs PC2 figure, most theropod dinosaurs are tightly clustered, while sauropodomorphs and ornithischians partially share this morphospace. Non-carnivorous saurischian taxa, such as therizinosaurids and sauropodomorphs primarily fall out in regions of morphospace close to, or even overlapping with, the herbivorous ornithischians. Quadrupedal and bipedal taxa generally cluster in different regions. Other information can be inferred from these results. For instance, different lineages of arctometatarsalian theropods occupy dissimilar morphospaces, and functional differences may occur along with the morphological variance. Additional analysis also reveals a correlation between body size and robustness of the feet of non-avian dinosaurs. Ancestral state reconstruction shows that ancestors of different lineages are distributed in a more restricted morphospace than their descendants. The distribution of non-avian dinosaurs in morphospace is correlated with both phylogeny and behaviors such as diet and stance. These results imply that behavior and phylogeny both played important roles in the evolution of the metatarsals of non-avian dinosaurs.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

A 1:1 POSTCRANIAL RECONSTRUCTION OF THE BASAL EUPELYCOSAUR AEROSAURUS WELLESI

PELLETIER, Valerie, California State University, San Bernardino, San Bernardino, CA, United States

The basal eupleycosaurian family Varanopidae has the longest fossil record of the Paleozoic amniotes, extending from the Late Carboniferous to the Late Permian and ranging from North America to Russia and South Africa. It appears to have been a highly conservative lineage, surviving Permian climatic changes and coexisted with therapsids in both Laurasia and Gondwana while other pelycosaurian-grade families were replaced. Unfortunately, varanopids are rare fossils in lowland aquatic ecosystems, the most common of Permian sites. They appear to have been more prominent members of upland terrestrial ecosystems where they were the top predators. Only two of these sites are known at this time, resulting in our understanding of this important group being based on usually one, often poorly preserved, specimen per locality. *Aerosaurus wellesi*, from the Lower Permian Abo/ Cutler Formation of New Mexico is one of the best preserved varanopids. A thorough study of *A. wellesi* adds to our understanding of this long-lived, widespread group. A complete reconstruction of the postcranial skeleton has been done in both dorsal and lateral view, along with a comparison of the individual postcranial elements with those of other known members of the Varanopidae. The dorsal centra of *Aerosaurus* are similar to other varanopids. The height of the neural spines is greater than those of *Archaeovenator* or *Mycterosaurus*, but shorter than either *Watongia* or *Varanops*. The overall shape of the clavicle is more similar to *Varanops* than other varanopids, the head is more expanded than in *Watongia* or *Pyozia*, but slightly less so than in *Varanops*. The proximal head of the humerus is similar in shape to those of *Watongia* and *Varanops*, but more robust than either *Archaeovenator* or *Mycterosaurus*. Distally the humerus is less robust than *Varanops* and the angle of twist of distal upon proximal ends is greater in *Aerosaurus* than in the other varanopids. The shaft of the femur is straight unlike *Mycterosaurus* and *Archaeovenator* in which the shaft is more sigmoidal. Adding postcranial data to pre-existing phylogenetic data sets recovers a monopyletic Varanopidae with the following relationships: [Reptilia [Caseosauria [Ophiacodontidae [*Archaeovenator* [[*Mycerosaurus*, *Mesenosaurus*] [*Elliostsmithia* [*Aerosaurus* [*Varanops* [*Varanodon*,*Watongia*]]]]]]]].

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

TAXONOMIC ATTRIBUTION OF THE DRYOPITHECINE TEETH (PRIMATES: HOMINIDAE) FROM THE MIDDLE MIOCENE OF LA GRIVE (FRANCE)

PÉREZ DE LOS RÍOS, Miriam, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; ALBA, David M., Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; MOYÀ-SOLÀ, Salvador, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain

The two isolated hominoid upper teeth—a third molar (FSL213981) and a central incisor (NMB G.a.9)—from the late Middle Miocene of La Grive-Saint-Alban (France) have been traditionally attributed to the fossil great ape *Dryopithecus fontani* (Primates: Hominidae). Such attribution has been mainly based on its MN7+8 age, and the assumption that no other dryopithecine genera were present in Europe by this time. After the description of two new genera (*Pierolapithecus* and *Anoiapithecus*) from similarly-age deposits in Spain, the taxonomic attribution of the La Grive teeth needs to be re-evaluated. Here we provide comparisons of dental proportions and occlusal morphology of this material with other large-bodied, Middle Miocene hominoids from Europe and Turkey. The I1/ displays a high, relatively spatulate and waisted crown, with a prominent lingual pillar and a marked basal swelling. The lingual pillar is surrounded by well-developed foveae, with moderated development of enamel wrinkling, and no distinct lingual cingulum can be discerned. The M3/ displays a subrectangular occlusal profile (broader than long) with four main cusps (the hypocone being distinct and relatively well developed) and a poorly-developed paraconule. Given the presence of a broad and triangular pillar, the La Grive incisor most closely resembles that of *Pierolapithecus*, as previously noted by other authors. However, it differs from that of *Pierolapithecus* in several features including the broader and more massive pillar, the more restricted foveae, the lesser-developed lingual crenulations and the straight to concave (instead of convex) mesiolabial crown profile, suggesting that they belong to different taxa. This contention is further strengthened by the morphology of the La Grive upper third molar, which differs from that of *Pierolapithecus* by displaying a less developed paraconule, a better-developed and well-individualized hypocone, finer cristae and less restricted occlusal basins. Among Middle Miocene taxa, the La Grive molar is most similar to that of *Dryopithecus*, although it further resembles in several regards the Late Miocene *Hispanopithecus crusafonti*. On the basis of the limited available sample, we conclude that an attribution of the La Grive material to *Pierolapithecus* can be discounted, its traditional assignment to *D. fontani* being more likely. However, given the lack of upper central incisors for both *Dryopithecus* and *Anoiapithecus*, and the high variability displayed by extant great apes in lingual incisor features and M3/ development, we prefer to provisionally leave the La Grive material unassigned at the genus level as Dryopithecinae indet.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

METHODS FOR ESTIMATING CHEWING MUSCLE SIZE, BITE FORCE AND GAPE IN FOSSIL PRIMATES

PERRY, Jonathan M., Johns Hopkins University, Baltimore, MD, United States; MACNEILL, Kristen E., Penn State University, Altoona, PA, United States; HECKLER, Amanda L., Penn State University, Altoona, PA, United States; HARTSTONE-ROSE, Adam, Penn State University, Altoona, PA, United States

Several methods have been used for estimating chewing parameters in extinct mammals. Usually muscle data from dissections inform estimates of chewing muscle size and bite force, but these are only informative if used correctly. Bite force estimates are generally derived from muscle cross-sectional areas and estimates of leverage from skulls, with occasional reference to muscle activity patterns. Often however, leverage estimates are derived from erroneous muscle maps and use incorrect moment arms. Another problem is that anatomical data on chewing muscles are usually incompatible with electromyographic data because different muscle units are analyzed in each method. We describe the conceptual problems in some popular methods and we provide suggestions for improving estimates of chewing muscle size and bite force by incorporating data on muscle cross-sectional area, muscle attachment sites, and skull geometry. Lastly, we evaluate new methods for inferring gape angle and gape adaptation, with reference to both theoretical and practical considerations. We present estimates of chewing muscle size, bite force, and gape in three groups of fossil primates. Our analyses suggest that whereas all chewing muscles were large relative to body size in Eocene adapines (based on correlates from extant strepsirrhines), several subfossil lemurs had a very large masseter and medial pterygoid, with a modestly sized temporalis. This suggests that different primate lineages, subject to different constraints, evolved different ways of increasing bite force. Thus broad, simple patterns of form-function relationship may be elusive, even when many sources of data are used to generate a paleobiological inference. Although our methods are applied to primates, they are also applicable to all vertebrates.

Technical Session XI (Friday, October 19, 1:45 pm)

ADAPTIVE CURSORIAL TRENDS AMONG THEROPOD DINOSAURS AND AN ATTEMPT TO LOOK BEYOND ALLOMETRY

PERSONS, Walter S., University of Alberta, Edmonton, AB, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

The relative lengths of limb bones have long been recognized as statistically significant (though not always strong) correlates of running ability in terrestrial tetrapods. That relationship offers the potential to examine the non-avian theropod lineage for evidence of large-scale adaptive trends in cursoriality. However, such potential examinations are undermined by the tremendous range of theropod body sizes and the potentially confounding allometric effects on limb proportions. Based on a sample of 61 theropod specimens, all with complete hind limbs and each representing a distinct genus, we confirm that the lengths of the distal limb bones are negatively affected by allometric factors, and we develop a method to correct for these factors. This allows limb-proportion adaptations to be recognized and compared between theropods that differ by several magnitudes in body size. Results show that ontogenetic changes in limb proportions observed in many theropods (including *Albertosaurus* and *Gorgosaurus*) do not differ from the limb proportion changes that would be predicted based strictly on the changes in body size. The relative limb proportions of the possible juvenile theropod "*Raptorex*" are found to be consistent with those of adult specimens of *Tarbosaurus* and other tyrannosaurs, but the relative proportions of *Nanotyrannus* strongly differ from those of other tyrannosaurs, including *Tyrannosaurus*. Evidence of an adaptive trend towards improved cursoriality is confirmed among several theropod groups for which such a trend has previously been speculated (including troodontids and tyrannosauroids). A trend towards reduced running ability is found among

dromaeosaurids, which is contrary to the widespread view that dromaeosaurids were among the most cursorially adapted of all predatory dinosaurs.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

IMPLICATIONS FOR MUSCLE RECONSTRUCTION IN FOSSILS FROM HISTOLOGICAL EVIDENCE FOR MUSCLE INSERTION IN EXTANT AMNIOTE FEMORA

PETERMANN, Holger, University of Bonn, Freital, Germany

Identification of muscle attachment sites has been important for muscle reconstructions in fossil tetrapods ever since the 19th century. Therefore, numerous biological and paleontological studies focused on the subject. In histological thin sections, Sharpey's fibers have been the sole reliable feature for identification of tendon-bone or muscle-tendon-bone interactions at the microscopic level. However, muscles are not restricted to indirect attachment with tendons, but attach also directly with muscle fibers. The question of the identifiability of direct muscle attachment has not been addressed by previous studies. However, histological identification of direct muscle attachments is important as these attachments do not leave visible marks on the bone surface (e.g. scars and rugosities). Other than Sharpey's fibers no indicators for muscle attachment have been provided. I dissected the right hind limb and mapped the muscle attachment sites on the femur of one rabbit (*Oryctolagus cuniculus*), one *Alligator mississippiensis*, and one turkey (*Meleagris cuniculus*). I then extracted the right femur and prepared 4 histological thin sections for the rabbit and the turkey and 5 histological thin sections for the alligator. I found that, additionally to Sharpey's fibers, vascular canal orientation and a frayed periosteal margin can be indicative of indirect and direct muscle attachments. Orientation of Sharpey's fibers to the cutting plane of the thin section can occur at high angles. Furthermore, two Sharpey's fibers orientations can occur in one area, possibly indicating a second force axis, e.g. from the action of a tendon or ligament. However, of the mapped attachment sites only about 60% could be detected in thin sections, and histological features suggestive of muscle attachment frequently occurred outside of mapped areas. While these insights are expected to improve our ability to successfully identify and reconstruct muscles in extinct species, the limitations of this approach are also apparent.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

DISTRIBUTIONS OF INJURIES IN PACHYCEPHALOSAURIDS USING FRONTOPARIETAL LANDMARKS

PETERSON, Joseph E., Department of Geology, University of Wisconsin Oshkosh, Oshkosh, WI, United States; DISCHLER, Collin, Department of Geology, University of Wisconsin Oshkosh, Oshkosh, WI, United States

The frontoparietal domes of pachycephalosaurids have long been hypothesized as weapons for agonistic bouts similar to the behavior of extant ungulates. This hypothesis has been supported by structural models and the recent identification of pathologies on the calvaria of frontparietal domes. However, a standardized analysis of the spatial distribution of lesions on frontoparietal domes remains absent. Presented here are the results of an evaluation of frontoparietal domes that possess indented lesions along the calvarium. Lesions were differentially diagnosed based on CT data and the presence of gross pathological characteristics consistent with cortical damage, such as irregular-shaped lesion surfaces, remodeling, and rounded lesion margins. In order to map the distribution of lesions on frontoparietal domes and analyze their spatial relationships, domes from the genera *Pachycephalosaurus*, *Sphaerotholus*, *Stegoceras*, *Hanssuesia*, and *Gravitholus* were studied. In total, 144 lesions were identified on nine frontoparietal domes. Homologous landmarks were utilized to partition frontoparietal domes into five regions to standardize lesion distributions, and include the sutural surfaces of the nasal, anterior supraorbital, posterior supraorbital, postorbital, squamosal, and frontoparietal suture. Lesions were classified based on their morphology and location in relation to homologous landmarks. The distributions of lesions on frontoparietal regions were compared for percent abundance and Kolomogorov-Smirnov Goodness-of-Fit tests ($p<0.01$). Based on these analyses, all specimens except *Gravitholus* illustrate a strong related distribution of lesions on the dorsal surface of the frontal region, regardless of dome mass, height, or taxon. Over 60% of all identified lesions occur on the dorsal surface of the frontal region, while nearly 30% occur along the frontoparietal suture on the dorsal surface. The strong clustering of lesions along the frontals and around the frontoparietal suture is in agreement with the expected location of injuries resulting from agonistic head-butting or shoving, suggesting that pachycephalosaurids sustained injury from such behaviors.

Technical Session III (Wednesday, October 17, 2:30 pm)

NEW DIMINUTIVE CERCOPITHECINE TEETH FROM KANAPOI, KENYA, AND IMPLICATIONS FOR THE EVOLUTION OF DIVERSITY IN GUENONS

PLAVCAN, J. Michael, University of Arkansas, Fayetteville, AR, United States; WARD, Carol V., University of Missouri, Columbia, MO, United States; MANTHI, Fredrick K., National Museums of Kenya, Nairobi, Kenya

Recent field work in Kanapoi, Kenya uncovered two small associated unworn second and third molar teeth of a primate. These molars show the bilophodont, quadritubercular morphology typical of cercopithecoid primates. Metric and morphological comparisons reveal that they are indistinguishable from those of the extant talapoin monkey (*Miopithecus talapoin*). The talapoin monkey is the smallest extant cercopithecoid, thought to be a phyletic dwarf associated with adaptation to dense riverine forest in West-Central Africa. Phylogenetically, talapoins are placed as the sister taxon to extant guenons (excepting *Allenopithecus*). Molecular phylogeny estimates the origin of extant guenons at approximately 11.5 million years ago. The Kanapoi site from which the specimen was found (*Australopithecus anamensis* type site) is dated to approximately 4.2 million years ago, making this the second oldest reported guenon fossil. The new fossils add to previously reported diminutive cercopithecine teeth from Koobi Fora, Kenya (minimally 3.4 million years ago), but are considerably older. Faunal and other analyses suggests open woodland habitat with patches of grasslands at Kanapoi. The paleosol yielding the new specimen also yields a rich fauna including rodents, anurans, bats, and hominins, with minimal evidence of transport. The small size and early age raise several intriguing and important possibilities about the evolution of African guenons. If truly *Miopithecus*, the specimen extends the geographic range of these monkeys to East Africa. Though extant *Miopithecus* is restricted to dense riverine rain forest habitat, the new specimens occur in dry, seasonal woodland habitat with open grasslands. The early age of the new fossils is consistent with the hypothesis that there was an early divergence between *Miopithecus* and other guenons (about 8.1 million years ago) as indicated by molecular evidence. The very small size suggests either that dwarfing occurred very early in this genus and small size has been maintained for than 4 million years, or that there have been separate dwarfing events within cercopithecines. Alternatively, the specimens may suggest that primitive guenon body size was small (about 1 kilogram), although this is contradicted by morphological evidence for dwarfing in modern talapoins and the fact that older fossil guenon teeth (5.4 million years ago) were the size of modern *Cercopithecus cephus*. Whichever is the case, the new specimens suggest that the modern diversity in guenon body size arose early in the history of the group, and that diminutive size is not uniquely associated with current talapoin habitat.

Technical Session XIX (Saturday, October 20, 2:15 pm)

DR JESTER AND MR QUEEN: SPECIATION IN MAMMALS WITH LARGE GEOGRAPHIC RANGES IS A BIOTIC AND ABIOTIC PROCESS THAT REQUIRES MANY GLACIAL-INTERGLACIAL CYCLES

POLLY, P. D., Indiana University, Bloomington, IN, United States

The impact of climate changes on geographic ranges ought to drive speciation, especially when ranges are fragmented into refugia that promote allopatric differentiation. If so, Quaternary glacial/interglacial cycles should have increased the rate of speciation across many groups. Previous studies have shown, however, that individual glacial cycles appear to have little or no impact on speciation. Here we examine a model species group, the *Sorex araneus-arcticus* complex (Soricidae, Mammalia), to study the impact of glacial refugia on speciation. The nine living species of this group are spread across Europe, northern Asia, and northern North America, with their deepest divergences in the late Miocene. One member, *Sorex araneus*, is genetically subdivided into more than 70 karyotypic groups, many of which are well studied. To study the history of differentiation in this group, we used phylogenetic data, the rich and well-dated European fossil record of the group, habitat modeling and paleoclimate data, an extensive morphometric data set from across the modern geographic range, and genetic data (karyotypes and molecular measures of gene flow).

We found an iterative cycle in which species were geographically fragmented into as many as ten different refugia during glacial cycles. The number and location of these refugia was estimated using more than 200 European fossil occurrences of *S. araneus* in combination with habitat models projected onto paleoclimates. The fossil distribution is substantially more compatible with the MicroC32 climate model for the last glacial maximum than the CCSM model. The geographic distribution of karyotype groups in *S. araneus* is consistent with these refugia. Gene flow between the karyotype groups is high in the modern world, with the chromosome differences forming only a minor barrier. Differentiation that accumulated allopatrically during the last glacial cycle is currently being lost; however the rate of gene flow is insufficient to homogenize the species during the roughly 15-20ka duration of an interglacial optimum. The climatic asymmetry of glacial-interglacial cycles means the species has spent more time fragmented into refugia than in its current conterminous state. Thus, phenotypic and genetic differentiation accumulates more than it dissipates with each cycle, resulting in an iterative process of differentiation. Speciation in the group occurred first at the strongest geographic breaks in the distribution.

Despite the role of climate cycles in fragmenting populations, eight out of nine species in the *S. araneus-arcticus* group have the same climatic envelopes, indicating little adaptation to changing climates. While speciation in the group appears to be driven by climate-driving reorganizations of geographic ranges (a "Court Jester" mechanism), evolutionary changes in morphology, behavior, and ecology are apparently driven by other randomly changing factors (a "Red Queen" mechanism).

Technical Session IV (Wednesday, October 17, 3:15 pm)

DINOSAUR CEPHALIC VASCULAR ANATOMY AND ITS PHYSIOLOGICAL IMPLICATIONS: EVIDENCE FROM THE FOSSILS

PORTER, William R., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Evidence of cephalic blood vessels is written into bone as osteological correlates (OCs). When these OCs are analyzed in the context of extant outgroups, we gain insight into vascular patterns in extinct taxa, which illuminate physiological processes. OCs found on dinosaur fossils were recorded, focusing on three sites (orbital, nasal, and oral cavities) that in extant outgroups are critical in thermoregulation. Most dinosaurs experienced high heat

loads due to their high surface-to-volume ratios, and we tested the hypothesis that dinosaurs exploited these same three sites of heat exchange. Vascular OCs in extant taxa (birds, crocodilians, iguanas) were used to formulate hypotheses of dinosaur vascular anatomy. To test these hypotheses, we characterized OCs on dinosaur fossils using direct observation, CT scanning, and the Extant Phylogenetic Bracket approach. Dinosaur vascular anatomy was reconstructed in Avizo and Maya. OCs relating to the orbital region were observed in theropods (e.g., *Rugops, Majungasaurus, Allosaurus, Carcharodontosaurus, Albertosaurus, Daspletosaurus, Tyrannosaurus*) as grooves traversing the postorbital bone. In the extant sample, an orbital plexus traverses the postorbital region. Grooves also traverse the ventral surface of the frontal, and then curve onto its dorsal surface in theropods, sauropods (*Camarasaurus, Diplodocus*) and *Stegosaurus*. In the extant sample, these grooves are formed by branches of supraorbital vessels supplying dorsal regions of skin on the head, which, in birds, correspond to brightly colored display surfaces. OCs relating to the nasal region were observed in theropods as grooves traversing the ventral surface of the nasals. In the extant sample, similar grooves correspond to vessels supplying the nasal region. Unique grooves found in the ventral aspect of the antorbital fossa in theropods indicate that the antorbital air sinus was well vascularized. OCs relating to the oral region were observed in theropods and sauropods as grooves on both the medial and lateral aspects of the maxilla. In extant taxa, these grooves correspond to branches of the dorsal alveolar vessels and palatal plexus. The large subnarial foramen between the maxilla and premaxilla in sauropods indicates that large volumes of blood passed between the oral and nasal regions. In the extant sample, these vessels connect these same two sites of thermal exchange, suggesting an emphasis on the vasculature of these regions in at least sauropod dinosaurs. In general, the OCs found within dinosaur fossils reflect patterns that, when properly constrained, offer a glimpse of regions of the head that may have been well vascularized and likely held important roles in key physiological processes.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

MEGAFAUNA EXTINCTION AND CLIMATIC CHANGE IN THE PAMPEAN REGION, ARGENTINA

PRADO, Jose L., Unuversidad Nacional del Centro, Olavarria, Argentina; ALBERDI, Maria T., Museo Ciencias Naturales, CSIC, Madrid, Spain; DOMINGO, Laura, Earth and Planetary Sciences Department. University of California, Santa Cruz, CA, United States

The extinction of megafauna in South America was particularly pronounced. This region witnessed one of the major extinction events that occurred at the end of the Pleistocene. The continent lost more genera of megafauna than any other, with most of the last appearances occurring at the end of the Pleistocene. The extinction event in South America seemed to have taken considerably longer than it did in North America. The last appearance of megafauna is distributed over the range between ca. 20,000 and 5,600 BP. The late Pleistocene to Holocene transition in South America is characterized first by a rapid, pronounced cooling (similar to the Younger Dryas), then by a rapid warming as the Holocene interglacial began. In the present study, we evaluated published radiocarbon dates and 30 new AMS dates for late Pleistocene-Holocene paleontological sites. Most of the dates are robust enough to assess correspondence between last-appearance records of megafauna and the Holocene climatic transition in different localities of Pampean Region. Also, we used stable isotope data ($\delta^{13}C$, $\delta^{18}O_{CO3}$ and $\delta^{18}O_{PO4}$) to characterize mammal paleoecology and the effects of the diagenetic alteration between stratigraphic levels. The extinctions in the region seem more common after the arrival of humans and during intensified climatic change between 11.2 and 13.5 ka. Nevertheless, even in these regions, some large mammals persisted for thousands of years during the Holocene and after the climate warming. These results highlight the need for future intensive dating efforts on megafauna remains in order to construct a more complete portrait of the sequence of events that gave rise to this extinction episode.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:00 am)

UNDERSTANDING MAMMALIAN DIETARY EVOLUTION USING A PHYLOGENETIC AND COMPARATIVE APPROACH

PRICE, Samantha A., UC Davis, Davis, CA, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States; BOTERO, Carlos A., North Carolina State University, Raleigh, NC, United States

Diet has played a critical role in the evolutionary history of mammals as evidenced by their extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the ability to generalize about the common processes affecting mammalian macroevolution. A large-scale, phylogenetic comparative approach can help elucidate these macroevolutionary dynamics. We have collected the largest existing dataset of primary observations on mammalian diets, covering over 1500 species have analyzed it using a phylogenetic comparative method that simultaneously estimates the rate of transition between dietary categories and speciation/extinction rates. Contradictory hypotheses have been proposed concerning the role of diet in large-scale diversification patterns, we show net diversification rate (the cumulative effect of speciation and extinction), differs significantly among living mammals, depending upon trophic strategy. Herbivores diversify fastest, about three times faster than omnivores which are the slowest and carnivores diversify at intermediate rates. Countering the slow diversification of omnivorous lineages, we find that the tempo of transitions between the trophic strategies is highly biased: the highest rates occur *into* omnivory from herbivory and carnivory. Thus, omnivore diversity evolves primarily through transitions into that strategy and rarely by diversification within omnivorous lineages, whereas herbivore and carnivore diversity is chiefly produced through diversification. These results suggests that, globally there are fewer niches available for omnivores and/or that speciation occurs more slowly or extinction more rapidly in omnivorous lineages. Ecologically, omnivory may be a strategy for surviving variability in resource availability, and, if lineages shift to omnivory during times of environmental perturbation, this may explain why diversification is low and transition rates are highest *into* not *out of* omnivory. Indeed, we find that worldwide omnivory is currently more prevalent in unpredictable climates using historical climate data and phylogenetic Markov Chain Monte Carlo Generalized Linear Mixed Models. It is however crucial to incorporate palaeontological data to fully understand the processes generating these macroevolutionary patterns, as well as how they have changed over time. For example the fossil record is the only way to is the only way to investigate the association between diet and speciation and extinction rates independently.

Technical Session XV (Saturday, October 20, 8:15 am)

LATE CRETACEOUS TECTONIC EVENTS TRIGGERED NORTH AMERICAN MEGAHERBIVORE DINOSAUR CLADOGENESIS

PRIETO-MARQUEZ, Albert, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; GATES, Terry A., Ohio University, Athens, OH, United States; ZANNO, Lindsay E., Nature Research Center, North Carolina Museum of Natural Sciences, Raleigh, NC, United States

Prior studies of Mesozoic biodiversity document a diversity peak for dinosaur species in the Campanian stage of the Late Cretaceous, but have yet to provide explicit causal mechanisms. We present evidence that geographic and ecological barriers created from incipient Laramide uplift, in combination with the presence of the Sevier Orogenic Belt and the Cretaceous Western Interior Seaway (KWIS), caused initial isolation of northern and southern megaherbivore dinosaurs (e.g., saurolophine hadrosaurids and chasmosaurine certopsids). Increasing topological complexity ultimately led to the establishment of geographically restricted evolutionary centers, with relatively rapid cladogenesis and increased taxonomic diversity. Detailed fossil occurrences document correspondence between the shift from Sevier-style, latitudinally arrayed basins to smaller Laramide-style, longitudinally arrayed basins, through decreased geographic range, and increased taxonomic diversity of hadrosaurian and ceratopsian species. Our hypothesis meets three predictive tests of speciation via tectonic processes. The first test requires that increased levels of endemism should be present in regions affected by tectonic speciation. In this regard, dispersal-vicariance analysis shows that the similar biogeographic histories of the hadrosaurian and ceratopsian clades are attributable to rapid diversification events within restricted basins, with isolation events that are contemporaneous with known tectonic activity. The second test requires that speciation rates should be greater in topographically complex regions. SymmeTree analysis establishes that hadrosaurids and ceratopsids experienced variations in diversification rates during the Campanian and Maastrichtian. Our data show that in a small window of the Campanian, when several topographic features (Sevier Orogenic Belt, KWIS, and Laramide structures) coincided, new megaherbivorous dinosaur species appeared at average rates of more than one species per million years, as opposed to the Maastrichtian rates of one species per several million years. The last test requires correspondence between tectonic activity and cladogenesis. We present evidence that clade divergence of megaherbivorous dinosaurs occurs contemporaneously with incipient Laramide uplift between southern Alberta and southern Utah at approximately 75 Ma. Furthermore, phylogenetic divergence estimates of fossil clades offer a new lower boundary on Laramide surficial deformation that precedes estimates based on sedimentological data alone.

Technical Session XIV (Saturday, October 20, 10:15 am)

A NEW DREPANOSAURID FROM THE LATE TRIASSIC OF NEW MEXICO: INSIGHTS INTO THE FORELIMB EVOLUTION AND BIOGEOGRAPHY OF DREPANOSAURS

PRITCHARD, Adam C., Stony Brook University, Stony Brook, NY, United States; TURNER, Alan H., Stony Brook University, Stony Brook, NY, United States; NESBITT, Sterling J., University of Washington, Seattle, WA, United States; IRMIS, Randall B., University of Utah, Salt Lake City, UT, United States; SMITH, Nathan D., Field Museum of Natural History, Chicago, IL, United States

Drepanosauridae is a clade of putatively arboreal diapsids from the Late Triassic of Europe and North America. They are known primarily from crushed, two-dimensional skeletons discovered in Italy and eastern North America, though isolated occurrences are known from the United Kingdom and western United States. Here we report on a new drepanosaurid taxon from the Late Triassic (middle Norian; ~212 Ma) Hayden Quarry (Petrified Forest Member, Chinle Formation) of New Mexico and its implications for understanding drepanosaurid evolution.

The new taxon is represented by multiple articulated forelimbs, several partial vertebral series (referred based on vertebrae associated with the forelimbs), and isolated claws. All elements are three-dimensionally preserved and largely undistorted. High-resolution CT scanning and imaging software was used to expose and digitally reconstruct the forelimb. The ulna is devoid of a normal shaft, instead consisting of a massive, crescentic olecranon process. The distal end of the ulna forms a rounded condyle and is offset at a right angle to the proximal humeral articulation. The ulnare is modified to form an analogue of the ulnar shaft, possessing a proximal cup for articulation with the distal ulna. The second manual

digit is extensively modified, with a dorsoventrally flattened and elongate distal phalanx. The second manual ungual is enormous and flattened in the pre-axial-post-axial plane. There are extensive flanges on the second manual ungual for the flexor musculature. This radical departure from the standard tetrapod forelimb condition is only shared with *Drepanosaurus unguicaudatus*.

A phylogenetic analysis of 250 characters and 40 basal diapsids and saurians, including a complete sampling of drepanosaurid taxa, strongly supports a clade including the Ghost Ranch drepanosaurid and the Norian-aged Italian taxon *Drepanosaurus* to the exclusion of all other drepanosaurids. This relationship is supported by characters relating to the forelimb and vertebral column. Another drepanosaurid taxon from the Petrified Forest Member of the Chinle Formation, *Dolabrosaurus aquatilis*, is resolved as basal to this clade. This topology suggests a complex biogeographic history for drepanosaurids, with multiple vicariance or dispersal events throughout their evolutionary history.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

SIMOJOVELHYUS, THE OLDEST MAMMAL FOSSIL FROM CENTRAL AMERICA, IS A PECCARY, NOT A HELOHYID

PROTHERO, Donald R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; BEATTY, Brian L., NYCOM, Old Westbury, NY, United States; STUCKY, Richard, Denver Museum of Nature and Science, Denver, CO, United States

Simojovelhyus pocitosense is based on a lower jaw fragment with three molars from the late Oligocene amber mine deposits near the village of Simojovel, Chiapas Province, Mexico. It is the oldest fossil mammal known from Central America. It was originally described as a helohyid, a group of primitive artiodactyls known from the Bridgerian and Uintan of North America (older than 37 Ma), yet it comes from early Arikareean deposits about 25-27 Ma, making it a very late helohyid living at least 10 m.y. after their Uintan extinction. We re-examined the specimen, and compared it to the large collection of recently described peccaries from the Chadronian (*Perchoerus minor*) and Orellan (*Perchoerus nanus*). Once the range of variation of characters in helohyids and peccaries is accounted for, *Simojovelhyus* shows more derived similarities to early peccaries, especially in the bunodont molars with inflated cusps, and none of the incipient lophodonty seen in helohyids, and the configuration of cristids and accessory cuspules. In fact, the only real similarity between *Simojovelhyus* and helohyids is its small size, but it is close to the size range of the small Chadronian peccary *P. minor*. Thus, based on both derived tooth characters and its age, it is much more parsimonious to regard *Simojovelhyus* as a Mexican peccary from the Arikareean, not a very late helohyid.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE MIOCENE VERTEBRATE FAUNAS OF ACHIRI, BOLIVIA

PUJOS, François, CCT-CONICET-Mendoza, Mendoza, Argentina; ANTOINE, Pierre-Olivier, ISE-M, UM2, Montpellier, France; MAMANI QUISPE, Bernardino, MNHN-Bol, La Paz, Bolivia; ABELLO, Alejandra, MLP, La Plata, Argentina; ANDRADE FLORES, Rúben, MNHN-Bol, La Paz, Bolivia

The paleontological locality of Achiri is located in the Bolivian Department of La Paz. The fossiliferous levels of the main locality, located hundreds of meters above the Ulloma Toba, are dated between 10.35 Ma (40Ar/39Ar, at Jankho Jakke Alto) and 8 Ma (K-Ar, west of San Andrés de Machaca). Late Miocene mammals identified in the last several decades include: metatherian hathliacynid *Borhyaenidium altiplanicum*, notoungulates *Plesiotypotherium achirense* and *P. majus* (Mesotheriidae) and *Hoffstetterius imperator* (Toxodontidae), and xenarthrans *Trachycalyptoides achirense* (Cingulata) and *Xyophorus villaroeli* (Tardigrada).

Recent research has improved our knowledge of this locality. Ten nearly complete skulls of *Plesiotypotherium* allow for more refined diagnoses of *P. achirense* and *P. majus* and for testing affinities to other Mesotheriidae. Isolated remains of the typothere *Hemihegetotherium* expand the notoungulate assemblage. A Macraucheniidae litoptern is also recognized. Rodents include a new large hystricognath dinomyid, a medium-sized octodontoid, two cavioids (a cardiomyine and a dolichotine), and the chinchillid *Prolagostomus*. Cingulates include the glyptodont *Trachycalyptoides*, the dasypodid *Chorobates*, and the pampatheriid *Kraglievichia*. A diversity of sloths include an early scelidotheriine (larger than *Proscelidodon*), a huge mylodontine, new remains of the peculiar nothrotheriid of uncertain affinities *Xyophorus,* and a small megatheriine similar in size to *Megathericulus*.

Field exploration in 2010-2011 resulted in the discovery of two older levels, below the classic locality. The upper one, with amphibians, birds, and rodents, testifies to the presence of a lacustrine environment prior to the deposition of the latter (located ~200m above it in the same section). The lowermost one, located ~500m below it and more remote, yielded notoungulate, rodent, and cingulate remains. The most remarkable specimen is an elongated and long-snouted skull of a haplodontheriine toxodontid, with a complete dental formula (3I-C-4P-3M).

Recognition of three successive fossiliferous levels in the vicinity of Achiri, the unexpected diversity of the assemblages, and the exceptional preservation of the vertebrate remains promise to contribute towards a better understanding of the evolution of vertebrates throughout the ?middle-late Miocene period in central Bolivia. Detailed study of these faunas, coupled with new field missions, will allow correlation with deposits farther south (Cerdas and Quebrada Honda, Bolivia; Maimara, Argentina) and north (LaVenta, Colombia; Acre, Brazil; Urumaco, Venezuela).

Technical Session V (Wednesday, October 17, 4:00 pm)

ROADSIDE WHALES IN THE ATACAMA: A MASS DEATH ASSEMBLAGE OF MARINE MAMMALS FROM CERRO BALLENA, A NEW LOCALITY OF THE BAHIA INGLESA FORMATION, ATACAMA REGION, CHILE

PYENSON, Nicholas D., Smithsonian Institution, Washington, DC, United States; GUTSTEIN, Carolina S., Universidad de Chile, Santiago, Chile; PARHAM, James F., Dr. John D. Cooper Archaeological and Paleontological Center, Santa Ana, CA, United States; RUBILAR-ROGERS, David, Museo Nacional de Historia Natural, Santiago, Chile; SUÁREZ, Mario E., Museo Paleontologico de Caldera, Caldera, Chile

Since the late Miocene, tectonic events in the South American Cordillera have created broad exposures of marine sediments in basins associated with the Humboldt Current System. In the Atacama Region of Chile, the Bahia Inglesa Formation preserves several sequences of marine rocks of late Miocene to Pliocene age, including fossiliferous units with marine vertebrates. Some of these taxa include extant lineages of marine mammals (phocid seals, rorqual whales) and seabirds (*Spheniscus* sp.), as well as completely extinct lineages, such as aquatic sloths (*Thalassocnus* sp.), giant bony-toothed seabirds (*Pelagornis chilensis*), and walrus-convergent dolphins (*Odobenocetops* sp.). In the upper Bahia Inglesa Formation, road construction expanding the Pan-American Highway in 2010 and 2011 uncovered a mass death assemblage of fossil marine mammals in a quarry with an area of 250 meters by 20 meters. This site, called Cerro Ballena, is dominated taxonomically and numerically by incomplete, although mostly intact skeletons of 44 rorqual whales (Balaenopteridae). These mysticete remains are also associated with one skeleton of a stem physeteroid, an incomplete pinniped postcranium, and a partial skull and skeleton of *Odobenocetops*. Notably, there are no less than four marine mammal-bearing horizons at the site within three meters of section, indicating that a recurring phenomenon created unique conditions for the preservation of large marine vertebrates. A range of death mechanisms can explain the sequence of assemblages at Cerro Ballena, although only a few are consistent with the sedimentologic evidence from the sandstone sequence, which suggests a quiescent embayment setting or a restricted lagoonal environment. Based on long bone orientation and the degree of skeletal articulation, the assemblage of multispecies marine mammal remains at Cerro Ballena most strongly favor taphonomic pathways where death was relatively rapid (hours to weeks in duration), and likely caused by an allochthonous mechanism. Modern analogs of marine mammal deaths caused by red tides and domoic acid, both associated with harmful algal blooms, outline a possible mechanism that occurred repeatedly at Cerro Ballena during the Pliocene.

Technical Session IX (Friday, October 19, 8:15 am)

THE HOMOLOGY OF THE BASIPTERYGOID PROCESS IN EUCRYPTODIRAN TURTLES AND ITS PHYLOGENETIC IMPLICATIONS

RABI, Márton, Eberhard Karls Universität Tübingen, Tübingen, Germany; WINGS, Oliver, Museum Für Naturkunde Berlin, Berlin, Germany; JOYCE, Walter G., Eberhard Karls Universität Tübingen, Tübingen, Germany

The articulation between the basisphenoid and the pterygoid is kinetic in the Triassic turtle *Proganochelys quenstedti*, the primitive condition for amniotes. All more derived turtles have an akinetic skull with locked basicranial joints. Remnants of the basipterygoid process of the basisphenoid have been reported for the early paracryptodires *Pleurosternon bullocki* and *Glyptops plicatulus* but these have been subsequently regarded as neomorphic structures based on topological considerations. Their interpretation therefore remains controversial. Our observations of published and new material of basal eucryptodiran taxa reveal that a laterally and slightly ventrally projecting process of the basisphenoid that fits into a pocket of the pterygoid is also present in numerous Asian Mesozoic forms, including *Annemys* spp., *Ordosemys* spp., *Dracochelys bicuspis*, *Hangaiemys hoburensis* and *Sinemys* spp. Contrary to some previous suggestions, this structure should be considered homologous with the basipterygoid process of basal turtles given its identical topological position relative to the posterior foramen of the cerebral branch of the carotid artery. Moreover, we were able to identify intermediate states in many basal turtles that record the transition between the ventrolaterally directed and prominent articular process of *P. quenstedti* and the reduced condition seen in basal eucryptodires. The loss of the basipterygoid process in turtles is tightly linked to the bony enclosure of the carotid system in the basicranial region. A review of eucryptodire basicrania reveals that the loss of the basipterygoid process is tightly connected to the reduction of the carotid fenestra (i.e., a fenestra located between the basisphenoid and pterygoid within which the split of the carotid artery into the cerebral and palatine branches is exposed). Surprisingly, even though the loss of the basipterygoid process is optimized to be a synapomorphy of crown Cryptodira, the presence of a reduced carotid fenestra in the stem-trionychian *Adocus* sp., the stem-testudinoid *Mongolemys elegans*, and the tentative stem chelonioid/kinosternoid *Judithemys sukhanovi* and *Macrobaena mongolica* indicate that the closure of the carotid fenestra occurred at least three times. The presence of a reduced carotid fenestra in the latter two taxa furthermore confirms the phylogenetic distinction between “true macrobaenids” and the eclectic group of basal eucryptodires traditionally referred to Macrobaenidae. A reduced carotid fenestra is furthermore present is plesiochelyids, eurysternids, and protostegids thereby hinting at a phylogenetic position derived to classic sinemydids or additional levels of homoplasy.

Technical Session XIII (Friday, October 19, 3:00 pm)

ADAPTIVE RADIATIONS AND ECOLOGICAL DIVERSITY OF EUROPEAN ADAPIFORMS IN WESTERN EUROPE

RAMDARSHAN, Anusha, Carnegie Museum of Natural History, Pittsburgh, PA, United States; MARIVAUX, Laurent, Institut des Sciences de l'Evolution de Montpellier, Montpellier, France; MERCERON, Gildas, Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, Lyon, France

From Darwin's finches to cichlid fishes, numerous examples of adaptive radiation can be seen in nature today. In these extant examples, ecological factors, such as differences in environment or competition for available resources, are known to have led to divergent natural selection. However, the influence of these ecological factors in past examples of adaptive radiation is difficult to characterize, due to the difficulty of reconstructing the ecology of extinct taxa. With 14 genera and over 40 species, Adapiformes were a particularly successful group of Primates. They colonized a wide array of ecological niches over the course of the Eocene, with a great diversity in activity cycle (diurnal and nocturnal), and body size (from 60 g to 5 kg). A better understanding of this radiation can only be accomplished by a detailed characterization of how ecological and morphological diversity evolved throughout the Eocene. For the first time, a wide scale dietary reconstruction is proposed for Eocene primates from the earliest to latest Eocene in Western Europe. In this study, dietary hypotheses are proposed for 20 primate communities (including adapiforms and omomyiforms) occurring in Europe during the Eocene using three different approaches: body mass estimation, shearing quotients and dental microwear analysis. Early adapiforms were most probably fruit-eaters, at a time when primate diversity was still low and competition had not yet driven them towards dietary specialization. By the middle Eocene, cercamonine adapids had diversified and occupied a wide array of ecological niches. Maximum diversity was also reached during the middle Eocene, with only the small insect-eater *Anchomomys* surviving to the early late Eocene. Small-bodied cercamonines, which were insect and fruit eaters, disappear from the fossil record by the middle Eocene. Conversely, Omomyiformes, such as *Pseudoloris* and *Necrolemur*, occupy a similar ecomorphospace in later primate communities. Medium to large bodied cercamonines (fruit- and leaf-eaters) also decline in the fossil record during the middle Eocene, as adapines first occur in the European primate communities. These mostly large-bodied primates seem to have filled the ecological niche left vacant by the disappearance of cercamonines during the middle Eocene. Indeed, adapines do show specialization towards leaf-eating, and fruit-eating was also common among this group. These results demonstrate this radiation followed some typical trends, similar to those seen in extant examples, such as an increasingly fine partitioning of available resources with the rise in the number of competing species and a generalized trend towards specialisation throughout the Eocene.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

USING THE EXTENDED PRICE EQUATION TO ANALYZE PATTERNS OF BODY SIZE CHANGE IN MAMMALS ACROSS THE PALEOCENE-EOCENE THERMAL MAXIMUM IN NORTH AMERICA

RANKIN, Brian D., University of Calgary, Calgary, AB, Canada; LUDTKE, Joshua A., University of Calgary, Calgary, AB, Canada; BARRÓN-ORTIZ, Christian R., University of Calgary, Calgary, AB, Canada; YANG, Xingkai, University of Calgary, Calgary, AB, Canada; FOX, Jeremy W., University of Calgary, Calgary, AB, Canada

The patterns of mammalian evolution across the Paleocene-Eocene Thermal Maximum (PETM) (approximately 56 million years ago) have become an important focus of research as interest in the response of mammals to dramatic climatic shifts during this interval has heightened. Among the most intriguing and often-cited of these patterns is the apparent dwarfing of many different taxa near the onset of the PETM, a phenomenon commonly attributed to elevated temperatures and/or higher carbon dioxide levels. Prior considerations of this pattern, however, have not been able to differentiate variations in body size into components attributable to separate evolutionary forces (e.g., natural selection). In this study, we use an innovative, extended adaptation of the Price equation to analyze patterns of body size change in mammalian communities from the middle Clarkforkian through middle Wasatchian North American Land Mammal Ages of the Bighorn and Clarks Fork Basins of Montana and Wyoming. The extended Price equation, a comprehensive description of evolutionary change under all conditions, provides valuable insight into body size change by partitioning variation into three meaningful components: changes resulting from non-random speciation and extinction of resident taxa (i.e., mammals whose ancestors preceded them in the specified area), changes owing to non-random immigration of taxa (i.e., those whose ancestors did not precede them in the area), and anagenetic changes (i.e., biased ancestor/descendant transmission). In agreement with other studies, our results document a remarkable decrease in mean mammalian body size during the earliest Wasatchian, a pattern that is principally driven by the considerable number of small-bodied taxa that make their first appearance in Bighorn and Clarks Fork Basins during this time interval, including primates, perissodactyls, artiodactyls, and hyaenodontid creodontans. Our results further reveal that non-random selection acting on resident taxa during the middle Clarkforkian to the middle Wasatchian generally favored smaller body sizes, while, in contrast, anagenetic changes favored larger body sizes over the same interval. Following the earliest Wasatchian, body size changes resulting from the non-random immigration of taxa was minimal. The application of the extended Price equation in this study represents a novel approach to discriminate the influences of distinct evolutionary forces on select traits, and further underscores the knowledge that can be garnered from temporally well constrained, geographically confined settings.

Technical Session XI (Friday, October 19, 2:45 pm)

A NEW BASAL TETANURAN THEROPOD FROM THE EARLY MIDDLE JURASSIC OF PATAGONIA, ARGENTINA

RAUHUT, Oliver W., Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; DIEGO, Pol, Museo Paleontológico Egidio Feruglio, Trelew, Argentina

The Tetanurae represent the largest clade of theropod dinosaurs, which also includes modern birds. The first certain tetanurans appear in the Middle Jurassic, but little is still known about the early evolution of the group, due to the fragmentary nature of most Middle Jurassic forms and a poor fossil record in the early Middle Jurassic. The Aalenian-Bajocian Cañadón Asfalto Formation in Chubut Province, Argentina, has yielded one of the most diverse terrestrial vertebrate faunas from this time, including partial skeletons of two basal tetanuran theropods, *Piatnitzkysaurus* and *Condorraptor*. A new specimen from this formation represents the most complete tetanuran from the early Middle Jurassic, preserving an almost complete skull, presacral vertebral column, pectoral girdles and forelimbs (missing only the furculae), a partial pubis, and partial hindlimbs. The skeleton of this *Allosaurus*-size animal (skull length c. 80 cm) shows numerous differences to *Piatnitzkysaurus* and *Condorraptor* and thus represents a new taxon. Although the specimen shows many tetanuran synapomorphies, including the presence of a maxillary fenestra, single pneumatic foramina in the cervical vertebrae, a fibular flange on the tibia that is offset from the proximal end, and a well-developed posteromedial process of the proximal articular end of Mt IV, its exact systematic position is difficult to establish, due to an unusual character combination. The taxon has a number of plesiomorphic characters unexpected in a tetanuran, such as apneumatic anterior dorsal vertebrae and a short and distally strongly expanded scapula. Within Tetanurae, the animal shows derived characters of both megalosauroids and allosauroids. The former include a medially closed maxillary fenestra, a U-shaped ventral process of the postorbital, a broad groove on the basioccipital below the occipital condyle, and a lack of a medial depression on the proximal fibula. Potential synapomorphies with allosauroids and subclades thereof include the presence of a large antorbital fossa with associated foramina in the nasal, raised lateral rims of the nasal, a well-developed lacrimal horn with two pneumatic recesses, a pneumatic foramen in the jugal, the presence of an antarticular in the mandible, and a metacarpal III that is less than 35 % in width in comparison with mc II. This unusual character combination in a basal tetanuran might represent support for a monophyletic Carnosauria (including Megalosauroidea and Allosauroidea), or reflect high levels of homoplasy in early tetanuran evolution.

Technical Session XIV (Saturday, October 20, 9:15 am)

NEW SMALL PARAREPTILES FROM THE LOWER PERMIAN OF RICHARDS SPUR, OKLAHOMA, AND THE EARLY DIVERSIFICATION OF PARAREPTILES IN LAURASIA

REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada; MACDOUGALL, Mark J., University of Toronto Mississauga, Mississauga, ON, Canada; MODEST, Sean, Cape Breton University, Sydney, NS, Canada

Early Permian parareptiles are restricted to a handful of taxa, and include *Mesosaurus* from Gondwana, the bolosaurids *Eudibamus* and *Bolosaurus* from Europe and North America, *Acleistorhinus,* and *Microleter* from the North American region of Laurasia. *Microleter* was discovered in the Dolese Bros Limestone Quarry, Oklahoma, and appears to represent the most basal known parareptile from Laurasia. Numerous new specimens from this locality have augmented recently the overall fauna of parareptiles. These include a new, very small parareptile with large, well developed caniniform teeth, several pivotal new specimens of the enigmatic *Colobomycter* that includes a new species of this genus*,* a new, undescribed species of *Delorhynchus*, and another new taxon that closely resembles the Middle Permian Russian parareptile *Nyctiphruretus.* Thus, the parareptilian fauna of Oklahoma now includes nine taxa of small parareptiles. Phylogenetic analysis of their interrelationships indicates a rather unusual distribution of taxa, with *Bolosaurus, Microleter,* and one of the undescribed new species along various position on the parareptile stem, while *Acleistorhinus,* the two species of *Delorhynchus,* the two species of *Colobomycter,* and another new taxon, form the clade of Acleistorhinidae. Thus, we are able to propose that the initial evolutionary history of parareptiles includes taxa that had a widespread Laurasian distribution, as characterized by bolosaurids, as well as taxa that formed a regionally restricted evolutionary radiation of small predators. The latter shows a surprising diversity of dental anatomy, ranging from the homodont dentition of *Delorhynchus* to the greatly exaggerated, large first incisiform and relatively large caniniform teeth of *Colobomycter.* This indicates that the initial stages of parareptile evolutionary history is much more complex than previously envisaged.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

AN ONTOGENETIC STUDY AND POPULATION HISTOLOGY OF THE CERATOPSID DINOSAUR *EINIOSAURUS PROCURVICORNIS*

REIZNER, Julie A., Museum of the Rockies, Montana State University, Bozeman, MT, United States

Histologic studies have been utilized in paleontology to determine rates of growth for several dinosaur taxa, but members of the otherwise relatively well-known family Ceratopsidae have largely been excluded. A monodominant bonebed containing remains of the centrosaurine ceratopsid *Einiosaurus procurvicornis*, ranging from juveniles to putative adults, has been found in the Upper Cretaceous Two Medicine Formation of northwestern Montana. This bonebed represents a drought-induced assemblage, and is hypothesized to represent a single population. The full available range of sizes of tibiae (N = 16) were sectioned and bone

histology examined. Tissue types and degrees of remodeling are discussed, and growth lines are used to determine ages at time of death of the individuals.

The rate of growth for *Einiosaurus* peaks at about 3-5 years of age, at which time growth slows, suggesting that this may be the age that reproductive maturity is reached. The nature of the bone tissue suggests that growth in *Einiosaurus* is still relatively rapid in even the largest specimens, indicating that a fully adult tibia has not been recovered from the studied bonebed, and this bonebed is biased toward juveniles and subadults. Since the bonebed is a snapshot of a standing herd, population dynamics of *Einiosaurus,* such as survivorship and behavior, are assessed. This information on growth dynamics and life histories of a species has implications for future taxonomic resolution and morphometric studies of ceratopsid dinosaurs, and marks the first study on population histology of a large-bodied herbivorous dinosaur.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

USING SCANNING ELECTRON MICROSCOPY TO RECONSTRUCT FEEDING ECOLOGY IN GROUND SLOTHS

RESAR, Nicholas A., Kent State University, Kent, OH, United States; GREEN, Jeremy L., Kent State University at Tuscarawas, New Philadelphia, OH, United States

Understanding the paleoecology of extinct xenarthrans, such as ground sloths, is complicated because they lack modern ecological analogues. Previous studies have applied functional morphology and biomechanical analyses to reconstruct the diet and lifestyle of ground sloths, yet the application of dental microwear as a proxy for feeding ecology in extinct xenarthrans remains understudied. Here, we hypothesize that dental microwear patterns can be used to reconstruct dietary niche partitioning among extinct ground sloths, thereby providing new evidence of feeding ecology in these animals. In this study, 17 second molariforms from 5 taxa [*Megalonyx*, *Acratocnus*, *Thinobadistes*, *Octodontotherium*, *Hapalops*] were molded and cast for dental microwear analysis. Using scanning electron microscopy, two non-overlapping digital images of microwear on the occlusal surface of each tooth were captured at 500x magnification. In a blind study, each image was independently analyzed using the semi-automated software package, Microwear 4.02, which allows microwear features to be digitally counted and measured. To examine the reproducibility of results, both intra- and interobserver error in microwear feature recognition was statistically assessed for two independent observers. As a baseline for reconstructing paleodiet, ground sloth microwear patterns were directly compared to microwear from living tree sloths and armadillos, which were analyzed in a separate study using the same experimental design. Results suggest that ground sloths can be statistically differentiated based on a combination of the number of scratches and width of features. Number of scratches and feature width suggest that *Megalonyx* and *Thinobadistes* form the ends of the browser-grazer spectrum, respectively. Additionally, *Acratocnus* and *Octodontotherium* are here predicted to be mixed feeders, while *Hapalops* appears to be a grazer. These results support scanning electron microscopic analysis of dental microwear as a tool for reconstructing paleodiet in ground sloths. Further investigation should focus on South American ground sloths to allow direct comparison with other methods of dietary reconstruction.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

CHRONOLOGY OF THE LATE JURASSIC DINOSAUR FAUNAS, AND OTHER REPTILIAN FAUNAS, FROM PORTUGAL

RIBEIRO, Vasco, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa & Museu da Lourinhã, Lisboa, Portugal; MATEUS, Octávio, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa & Museu da Lourinhã, Lisboa, Portugal

The chronostratigraphy of Late Jurassic vertebrates from Portugal, including those from the Lourinhã Formation, which is known for its rich vertebrate fauna, is poorly understood due to the continental nature of the sediments and the diachrony of the lithostratigraphic units. Recent results using $Sr^{87/86}$ isotopes confirmed the position of the Kimmeridgian-Tithonian boundary (150.8 Ma) in the Lusitanian Basin central sector. This boundary, within a marly layer representative of the more southernly limestone Farta Pão Formation, lies within the siliciclastic Lourinhã Formation and is assumed to be the transgressive upper Kimmeridgian -lower Tithonian event. The most productive vertebrate-bearing Upper Jurassic formations in Portugal are: the Alcobaça Formation, Lourinhã Formation (divided into the Amoreira-Porto Novo, Sobral, Bombarral, and Freixial (pars) members), and the Porto da Calada Formation.

The chronological range (given by biostratigraphy, eustatic curves, general regional context, and calibrated by strontium isotope curves) for important Portuguese specimens of chelonians, pterosaurs, dinosaurs, crocodylomorphs, and other reptilians is as follows:

Early (to late?) Kimmeridgian (Alcobaça Beds Formation): *Theriosuchus guimarotae*, *Machimosaurus hugii*, *Goniopholis baryglyphaeus*, *Lusitanisuchus mitrocostatus*, *Phyllodon henkeli*, *Parviraptor estesi*, *Marmoretta* sp., *Aviatyrannis jurassica.*

Late Kimmeridgian (Lourinhã Formation, Amoreira-Porto Novo Member): *Selenemys lusitanica*, *Plesiochelys* sp., *Cteniogenys reedi*, *Lusitanisuchus mitrocostatus*, *Rhamphorhynchus* sp., *Dracopelta zbyszewskii*, *Miragaia longicollum*, *Trimucrodon cuneatus*, *Camptosaurus aphanoecetes*, *Dinheirosaurus lourinhanensis*, *Turiasaurus* sp., *Ceratosaurus nasicornis*, *Torvosaurus* aff. *tanneri*.

Around the Kimmeridgian/Tithonian boundary (Sobral Member): *Selenemys lusitanica*, *Plesiochelys* sp., *Machimosaurus hugii*, *Rhamphorhynchus* sp., *Lourinhanosaurus antunesi*, *Lusotitan atalaiensis*, *Lourinhasaurus alenquerensis*, *Dryosaurus* sp., cryptoclidid plesiosaur.

Early Tithonian (Sobral Member): *Plesiochelys* sp., *Miragaia longicollum*.

Upper early Tithonian (Bombarral Member): *Plesiochelys* sp., *Allosaurus europaeus*, *Draconyx loureiroi*, *Stegosaurus* sp.

Late Tithonian (Freixial Member): *Plesiochelys* sp., *Theriosuchus* sp. B, Ornithopoda sp. B.

Around the Tithonian/Berriasian boundary (Porto da Calada Formation): *Stegosaurus* sp.

Despite the fragmentary occurrences of certain taxa, the chronology of some vertebrates seem to be age-restricted, and can thus be used for biostratigraphy. There is a peak of vertebrate fossil diversity and abundance near the Kimmeridgian/Tithonian boundary and a decline towards the end of the Tithonian. Is not yet understood if such trend represents true diversity/abundance in the Jurassic or if it is caused by any geologic and taphonomic bias.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

CHONDRICHTHYANS IN THE CARBONIFEROUS OF THE BRITISH DERBYSHIRE PEAK DISTRICT

RICHARDS, Kelly R., University of Cambridge, Cambridge, United Kingdom; CLACK, Jennifer A., University of Cambridge, Cambridge, United Kingdom

Productive Carboniferous marine deposits are found worldwide, including sites in North America, Poland, Russia, Belgium, Iran and Britain. Recent work in the Derbyshire Peak District of Britain has established a diverse chondrichthyan fauna, comparable with the rich diversity already well documented in North American sites. Derbyshire is already known for a typical and varied invertebrate fauna. Additionally, the vertebrae and scales of palaeoniscid actinopterygians have been recorded and previous reports of the Derbyshire chondrichthyans documented twenty five species, with recent publications adding a further seven species.

In this study, limestone material representing four localities was collected. Two of these have been documented to contain chondrichthyan remains and two are unreported localities, all localities are within ten km of each other. The material was acid digested and mechanically prepared and the micro and macro fossils were recorded. The microfossils typically consist of teeth, scales and dermal denticles, the macrofossils include teeth, a large fin spine and also, in the two new localities, a variety of skeletal material ranging from partially articulated to fragmented. The skeletal material includes several jaws, endocranial material, a scapulacoracoid and a probable pelvic fin arrangement including a clasper attributed to *Akmonistion zangerli*. The microfossils recovered and identified increase the known diversity of the Derbyshire palaeoenvironment by at least 9 taxa, including several taxa unknown from Derbyshire, such as *Akmonistion zangerli*, *Harpacodus dentatus*, *Heslerodus divergens* and *Mesodmodus*, or Europe, such as *Belantsea montana*, *Bransonella nebraskensis* and *'Denea wangi'*. Our data show that chondrichthyan microremains dominated three of the four near-shore sites- chondrichthyans represent two thirds of all microremains in the combined localities- and that the Derbyshire localities share many taxa with the localities in North America, such as *Bransonella nebraskensis*, *Heslerodus*, *Fissodus*, *Leiodus* and *Squatinactis*; and with localities across Europe, such as *Akmonistion zangerli*, *Denea*, *Thrinacodus*, *Petrodus* and *Orodus*. The data collected from a short sequence of cyclical beds within one of the localities expose faunal change on a shorter timescale. The persistent occurrence of particular taxa such as *Denea*, *Squatinactis*, *Harpacodus*, *Petrodus* and *Bransonella nebraskensis*, through the different localities reflects a close palaeoecological relationship between the study sites. We use data from existing boreholes in order to assess the relative importance of the temporal and spatial relationship between the localities.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

LATE PLEISTOCENE GIANT BEAVERS: THE PARALLEL EVOLUTION OF GIANT SIZE AND RIDGED ENAMEL IN TWO SPECIES

RINALDI, Caroline E., University of Missouri-Kansas City School of Medicine, Kansas City, MO, United States; MARTIN, Larry D., University of Kansas Natural History Museum and Department of Ecology and Evolutionary Biology, Lawrence, KS, United States; TIMM, Robert M., University of Kansas Natural History Museum and Department of Ecology and Evolutionary Biology, Lawrence, KS, United States; COLE, III, Theodore M., University of Missouri-Kansas City School of Medicine, Kansas City, MO, United States; KUMAR, Vandana, University of Missouri-Kansas City School of Dentistry, Kansas City, MO, United States

Skulls of two similar, but morphologically distinct, giant beavers from the late Pleistocene were studied using high resolution cone-beam computed tomography (CT). One specimen is from eastern Kansas and is assigned to *Castoroides ohioensis*. The other specimen is from the Cooper River of South Carolina and is currently assigned to *Castoroides leiseyorum*. The basicranium of *C. ohioensis* is characterized by a unique ladle-shaped depression in the basisphenoid bone called the mesopterygoid fossa. This unusual morphology is similar to that of the Pliocene beaver, *Procastoroides sweeti,* from the Broadwater Formation of Nebraska; however, the skull of *P. sweeti* is much smaller and the enamel of its incisor teeth do not have the ridges characteristic of late Pleistocene species. The late Pleistocene specimen referred to *C. leiseyorum* lacks a mesopterygoid fossa as does the early Pleistocene material from the type locality (Leisey Shell Bed), although the holotype is much smaller. Despite their differences, both late Pleistocene beavers are characterized by a choana that is divided into dorsal and ventral passages, a feature unique among mammals. In both

giant beavers, evolutionary expansion of the internal pterygoid muscles resulted in the primitive, single choana being divided into a dorsal and ventral choana by the expanded internal pterygoid plates, which form the origin for the enlarged muscles. However, CT studies and 3D reconstructions indicate that the two giant beavers differ substantially in the internal structure of their dorsal and ventral choanae. In *C. ohioensis*, the ventral choana is specialized as a resonation chamber and is not useful as the primary path for respiration, whereas the dorsal choana is the main respiratory pathway. In *C. leiseyorum*, the dorsal choana is too small to be effective as the primary path for respiration, and it is the ventral choana that functions as the primary pathway. The presence of divergent basicranial and respiratory morphologies, dating at least as far back as the Pliocene, suggests that both giant size and ridged incisor enamel evolved in parallel in the two late Pleistocene species.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 10:45)

THE EARLY MIOCENE LAS CASCADAS FOSSIL ASSEMBLAGE: BIOSTRATIGRAPHIC AND PALEOBIOGEOGRAPHIC SIGNIFICANCE OF THE OLDEST MAMMALS FROM THE PANAMA CANAL AREA, CENTRAL AMERICA

RINCON, Aldo F., University of Florida, Gainesville, FL, United States; BLOCH, Jonathan I., University of Florida, Gainesville, FL, United States; MACFADDEN, Bruce J., University of Florida, Gainesville, FL, United States; FOSTER, David A., University of Florida, Gainesville, FL, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Panama, Panama

Recently discovered early Miocene mammals from the Panama Canal offer a unique opportunity to understand the paleobiogeographic evolution of southern Central America prior to the formation of the Isthmus of Panama. The Las Cascadas fossil mammal assemblage is distributed throughout a ~35 m stratigraphic interval in the upper part of the Las Cascadas Formation, a volcaniclastic and tuffaceous sequence that includes the first evidence of land exposure in the Panama Canal Basin. Within the Panama Canal Basin, the new fossil assemblage not only includes the first records of primitive small parahippine equids, bothriodontine anthracotheres, and floridatraguline camels, but also the oldest occurrences of many other North American taxa such as amphicyonids, mustelids, sciurid and geomyoid rodents, bats, protoceratids, moschids, and peccaries. Recently improved biostratigraphy in the Panama Canal area suggests that this new assemblage represents a distinctive early Miocene faunal province characterized by the arrival of northern immigrants into a small continental basin connected with Mexico, the Texas Gulf Coast, and Florida. We propose a New World tropical origin for Floridatragulinae based on inferred primitive characters shared by the Las Cascadas camels (*Aguascalientia panamaensis* and *A. minuta*) and a small, unnamed camel from the earliest Miocene Buda Local Fauna (L. F.) from Florida. A new species of bothriodontine anthracothere (*Arretotherium*), closely related to Arikareean *A. acridens* from the Toledo Bend L. F. from Texas, represents the southernmost record of Anthracotheriidae in the New World tropics. While the presence of the European immigrant amphicyonine *Cynelos* sp. and the inferred biochronological relationships of the Floridatragulinae constrained the age of the fossil-bearing portion of the Las Cascadas Formation to ~20-23 Ma, a new age determination using U-Pb in magmatic zircons (20.93 +/- 0.17 Ma) of an interbedded tuff specifically places it at the beginning of the late Arikareean North American Land Mammal Age (Ar4). The apparent absence of *Aguascalientia* and primitive parahippine equids in the younger (~19 Ma) Centenario Fauna suggests that ungulates entered Central America by the earliest Miocene before dispersing northward from the New World tropics during the early Miocene, reaching Florida, Mexico, and the Gulf Coast by the Hemingfordian, likely a response to drastic paleogeographic changes related to the evolution of the Panamanian Seaway. Ongoing discoveries of more complete fossils from the Panama Canal will be critical to further evaluate this biogeographic hypothesis.

Technical Session V (Wednesday, October 17, 2:00 pm)

A NEW HALITHERIINE DUGONGID FROM THE EARLY MIOCENE OF ORANGE COUNTY, CALIFORNIA

RIVIN, Meredith A., Dr. John D. Cooper Archaeological and Paleontological Center, Santa Ana, CA, United States; VELEZ-JUARBE, Jorge, Department of Anatomy, Howard University, Washington, DC, United States; RHUE, Vanessa R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States

A new halitheriine dugongid from the Vaqueros Formation in Orange County, California, USA, is the first specifically identifiable occurrence of an early Miocene sirenian from the eastern North Pacific. This specimen is one of several other sirenian individuals from this formation and the only one so far, to include a partial skull in addition to associated ribs and vertebrae. The specimen is a halitheriine dugongid as it displays well-developed, dorsoventrally flattened supraorbital processes, a convex frontal roof, nasal processes of the premaxillae that are thin and tapering at their posterior ends, absence of a nasal incisure at the posterior end of the mesorostral fossa and large nasals that meet along a midline suture. It stands out among known Neogene halitheriines in its smaller dimensions and in the morphology of the nasal bones, which display the plesiomorphic condition otherwise seen in some late Eocene and early Oligocene taxa. This unique combination of characters establishes the Vaqueros halitheriine as a new taxon. The roughly contemporaneous record of sirenians in the eastern North Pacific is from the Nye Mudstone of Oregon and was the previously known earliest occurrence of sirenians in this region. The Nye Mudstone dugongid is also a relatively small taxon, but does not share diagnostic elements with the Vaqueros halitheriine, thus preventing further comparison between the two.

The Vaqueros Formation in Laguna Canyon of the San Joaquin Hills of Orange County, California, has yielded a diverse and unique assemblage of early Miocene marine mammals. Arikareean/Hemingfordian transitional terrestrial mammals and paleomagnetic dates bracket the fauna as Burdigalian in age. Thus, the Vaqueros Formation has currently produced some of the earliest sirenians from the early Miocene in the eastern North Pacific and the first specimen that can be identified to the specific level.

Technical Session XVI (Saturday, October 20, 9:30 am)

PALEOBIOLOGY OF PREVIOUSLY UNEXAMINED DIRE WOLVES (*CANIS DIRUS*) FROM THE EARLIEST EXCAVATIONS OF THE LA BREA TAR PITS

RIZK, Oliver T., University of California Berkeley, Berkeley, CA, United States; CARR, Monica M., University of California Berkeley, Berkeley, CA, United States; HLUSKO, Leslea J., University of California Berkeley, Berkeley, CA, United States

The earliest excavations of the late Pleistocene fossil deposits at the La Brea tar pits in southern California were led by J. C. Merriam of the University of California, Berkeley. From 1906 to 1915, nearly two million specimens of large animals were collected from the tar pits and divided between the Hancock Collection of the Los Angeles County Museum of Natural History (LACM) and the collections of the University of California Museum of Paleontology (UCMP). The extinct dire wolf, *Canis dirus*, is one of the best represented animals from La Brea. However, the paleobiology of the dire wolf at La Brea has been described based only on specimens from the LACM's Hancock Collection and more recently excavated Rancho La Brea Project Collection, while the material held in the UCMP has remained largely unexamined for the last century. Here, we present the first quantitative study of morphological variation in dire wolves from this neglected collection of material from La Brea. Linear measurements of size were taken from fifty-eight left femora and the postcanine dentition of fifty unassociated left dentaries. Shape variation was also quantified for thirty-eight adult crania using a three-dimensional geometric morphometric approach. Principal component (PC) analysis of cranial shape variation indicates that the greatest dimension of variation contrasts wide crania with dorsally angled rostra and narrow crania with ventrally angled rostra (PC1=16%). Cranial shape also varies in the posterior extension of the premaxilla and anterior extension of the frontals along the nasals with decreasing zygomatic width (PC2=13%), as well as in the relationship between facial width and height (PC3=10%). Interestingly, the shape variation represented by the first three PCs (and the amount of variation accounted for by each PC) is nearly identical to that found in a sample of 120 recent gray wolf crania (*Canis lupus*). Despite body size differences between the two species, the similarities in cranial shape variation suggest that the gray wolf could potentially be used as a proxy for the dire wolf. Distributions of cranial centroid size, femoral size dimensions, and individual tooth size dimensions do not indicate sexual dimorphism in this sample, with the possible exception of the width of the greater trochanter. Average body mass, estimated from femoral shaft circumferences, was found to be 61.24 kg with a range of 43.05-85.31 kg -- a slightly higher average value and wider range than that previously reported for western dire wolf populations. These data show that more extreme forms existed than were previously described. These differences could be due to greater geographic or temporal variation within the sample, but are not due to greater sampling effort.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST DESCRIPTION OF THE TALAR MORPHOLOGY OF *PSEUDOLORIS PYRENAICUS* (OMOMYIDAE, PRIMATES) AND IMPLICATIONS FOR ITS LOCOMOTOR BEHAVIOUR

ROIG, Imma, Institut Català de Paleontologia, Cerdanyola del vallès, Spain; MOYÀ-SOLÀ, Salvador, Institut Català de Paleontologia, Cerdanyola del vallès, Spain

The omomyid *Pseudoloris pyrenaicus* from the Robiacian (middle Eocene) locality of Sant Jaume de Frontanyà 3C (MP14-15; Eastern Pyrenees, NE Spain) has been recently described on the basis of the most abundant dental sample of this genus found until now in the Iberian Peninsula. Additionally, this level has also yielded some postcranial elements of *P. pyrenaicus*. Here, we describe for the first time the morphology of the talus of this genus and compare it with other fossil and living primates. We emphasize those talar features that have proven useful in reconstructing higher-level primate phylogeny and discuss the osteological features that reflect functional attributes related to locomotor behaviour. We estimated the body mass of *P. pyrenaicus* in 80 g using the multivariate regression equation ("the prosimian model") based on the crown areas of the cheek teeth. The talus of *P. pyrenaicus* exhibits a suite of features that are primarily found in extinct and extant haplorhines (e. g., a vertically oriented articular lateral facet for the fibula, a plantar groove on the posterior trochlear shelf for the *hallucis longus* muscle and a shallow medial talo-tibial facet) and in omomyids (e. g., a moderate talar neck angle, a moderately high talar body, a small posterior trochlear shelf and a relatively narrow talar body). These characteristics are consistent with the haplorhine-like dentition characterizing *Pseudoloris*. From a functional point of view, the combination of a high talar body with some degree of development of the posterior trochlear shelf, the elongation of the talar trochlea and the trochlear rims with a similar degree of height, are features supporting the hypothesis that leaping was an important component of the locomotor behaviour of *P. pyrenaicus*. According to this, the locomotion of *P. pyrenaicus* may have been similar to that inferred for other omomyids.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

ONTOGENY OF THE BRAIN ENDOCASTS OF OSTRICHES (AVES: *STRUTHIO CAMELUS*), WITH IMPLICATIONS FOR INTERPRETING EXTINCT DINOSAUR ENDOCASTS

ROMICK, Cheyenne A., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

The study of brain evolution in the fossil record typically uses the cranial endocast (the internal surface of the bony braincase) as a proxy for the brain itself. Computed tomographic (CT) analysis has revolutionized the field, and digital endocasts are now available for many extinct and extant species. A component missing from these recent studies, however, relates to ontogenetic changes in the endocast, compromising the interpretation of endocasts from presumably juvenile dinosaurs. Our lab has previously studied endocast ontogeny in alligators, and this project presents a comparable ontogenetic study in ostriches (*Struthio camelus*), which are basal members of the avian limb of the extant phylogenetic bracket of nonavian dinosaurs. This study provides the densest ontogenetic sampling for any palaeognath bird to date: nine ostriches, including two embryos, neonatal chicks, juveniles 2–4 months old, as well as young and fully mature adults. All specimens were subjected to microCT scanning (45 and/or 90 micron voxels). Digital endocasts of the brain cavity, inner ear, and neurovasculature were generated for all specimens using the 3D visualization software Avizo 7. Additionally, some of the specimens were soaked in an iodine/potassium-iodide solution to stain the neural and other cephalic soft tissues. These heads were subsequently rescanned and the iodine-stained brain tissues were segmented to compare the osteologically-based endocasts with the actual brain tissue. One two-month-old specimen also was subjected to radio-opaque vascular injection to assess how blood vessels impact the endocast. The results of the comparison of the iodinated brains with bony endocasts confirmed that the endocast is a fair approximation of the surface structure of the brain at all ages, which differs from the finding in alligators in which the endocast becomes progressively less brain-like during ontogeny. Ontogenetic changes in brain growth include relative expansion of the cerebral hemispheres, greater prominence of the Wulst (hyperstriatum, associated with visual processing), and relative contraction of the cerebellum, among others. Some structures, such as the optic tectum, change relatively little in general proportions. In general, the cranial endocast becomes much more detailed during ontogeny, such that neural and vascular structures become increasingly apparent and discrete. The ontogenetic findings broadly correlate with phylogenetic trends in the cranial endocasts of Theropoda as a whole, and shed light on the interpretation of the endocasts of presumed juveniles in certain dinosaur clades (e.g., tyrannosaurids), some of which appear to follow ontogenetic trends more characteristic of alligators than ostrich.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE IMPORTANCE OF SEDIMENT IN THE GRAZER/GRASSLAND STORY OF NORTH AMERICA

ROOK, Deborah L., University of Wisconsin-Madison, Madison, WI, United States

A debate has long been waged between proponents of two competing hypotheses regarding the evolution of grazing ungulates and expansive grasslands of North America: did grazers cause the sweeping grasslands we see today or did the expansion of grasslands force the evolution of hypsodont grazers? The plants and animals involved are generally the focus of studies involving these questions, from phytoliths to megaflora to tooth wear and isotopes. The presence of volcanic sediment has the potential to greatly influence these dynamics, as volcanic dust would both introduce excess grit to mammal diets and teeth (provoking hypsodonty) as well as cause forest disturbances (leading to openings for grass to thrive). I use the Macrostrat Database to examine changes in lithology through the Cenozoic of North America. Volcanic sediments show a large spike in the Eocene, right around the advent of hypsodonty in multiple groups, including the grazing ungulates. The marked increase in volcanic sediments presents an interesting direction for future research regarding the evolution of both hypsodont grazers and grasslands in North America.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

WHOLEY SMOKE: BRACKETING AND EMPIRICAL RECOGNITION OF DISEASE IN THE FOSSIL RECORD, AS APPLIED TO THE TYRANNOSAURUS REX, SUE

ROTHSCHILD, Bruce M., University of Kansas, Lawrence, KS, United States

Confidence in identification of the etiology of bone alterations is enhanced when the same pathology is identified in individual(s) documented to have that disease. That assumes the pathology is not simply coincidental. Recognition of a phenomenon in multiple individuals with a given diagnosis enhances confidence. That approach works when diseases are relatively uncommon. Common pathogens, such as trichomonas, will be occur in the presence of other diseases. Indeed, such parasitic diseases often occur as a triple threat, in association with two other parasites. Trichomonas does not cause those diseases; they are simply common co-occurences. Trichomonas has been suggested to be the cause of mandibular holes because of its presence in a hole-afflicted animal, despite failure to identify any evidence that trichomonas can actually alter bone. Once it is recognized that there is no evidence that bone is affected by that pathogen, the smoke clears and actual etiology can be surmised. This contrasts with healing of trephanation, clearly demonstrated to produce the same holes as observed in the *Tyrannosaurus* Sue. Healing of human-derived bone defects is analogous to healing of bites, supporting the assessment that the mandibular defects in Sue represent normal healing bites. Perspective that bone pathology is phylogeny-independent in character has been tested and found valid for both recent and fossil reptiles.

Technical Session XVIII (Saturday, October 20, 2:45 pm)

INNER EAR ANATOMY OF *LEPTICTIDIUM AUDERIENSE* (LEPTICTIDA, MAMMALIA) REVEALS HIGHLY AGILE LOCOMOTION

RUF, Irina, Steinmann Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Bonn, Germany; VOLPATO, Virginie, Abteilung Paläoanthropologie und Messelforschung, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main, Germany; BILLET, Guillaume, Steinmann Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Bonn, Germany; DE MUIZON, Christian, Département Histoire de la Terre, Muséum National d'Histoire Naturelle, Paris, France; LEHMANN, Thomas, Abteilung Paläoanthropologie und Messelforschung, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main, Germany

Leptictida are basal insectivorous placentals comprising species with highly specialized postcranial features. Among these *Leptictidium* from the middle Eocene of Messel (Germany) is considered to be very agile with a bipedal saltatory locomotion as indicated by its very short forelimbs and extremely elongated hind limbs and tail. Agility and locomotor behavior can also be investigated from the shape of the semicircular canals of the inner ear bony labyrinth, which are involved in detecting angular acceleration of the head. As clearly demonstrated by former studies the size of the semicircular canals in mammals correlates with body mass and agility. Here we provide the first insight into the inner ear anatomy and morphometry of *Leptictidium* represented by *Leptictidium auderiense*, the smallest of the three species known from Messel. High resolution computed tomography scans were used for preparing reconstructions of virtual 3D models of the bony labyrinth. The morphology and morphometry of the bony labyrinth in *Leptictidium auderiense* were compared with those of a specimen of *Leptictis* from the Oligocene of North Dakota referred to *Leptictis dakotensis*. Though *Leptictidium* resembles *Leptictis* in much of the skeleton except limb proportion, the locomotion of the latter is supposed to be mainly quadrupedal. The general morphology of the bony labyrinth reveals that both species have a prominent secondary crus commune which is a primitive mammalian character. The cochlea of *Leptictidium* shows almost 2 turns and a secondary bony lamina is not present. *Leptictis* has 2.25 cochlear turns and a short but distinct secondary bony lamina. Both species have thin and prominently arcuated semicircular canals, but those of *Leptictidium* are relative larger than in *Leptictis*. The mean size of the radii of the semicircular canals was plotted against the geometric mean of the body mass in a regression analysis taken from literature and comprising 210 therian species. *Leptictidium* clusters with other highly agile mammals and has much larger semicircular canals than most similar sized species. In contrast *Leptictis* plots below the regression line closer to slow moving species. Complementarily, we also estimated the agility scores of the semicircular canals. The agility scores of *Leptictidium* range from 4.5 to 5.5, which indicate a medium to medium-fast moving animal. Its highest scores fall into the range of extant saltatory mammals supporting the hypothesized very agile and saltatory locomotion. Conversely, *Leptictis* has much lower agility scores (3.5-3.7), which refer to a medium-slow to medium speed of locomotion and correspond to the scores of most extant mammals comprising more general types of locomotion (terrestrial, cursorial, scansorial, arboreal, semiaquatic).

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE VERTEBRAL COLUMN OF THE PACHYOSTEOMORPH ARTHRODIRE *DUNKLEOSTEUS TERRELLI*

RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; CUMBAA, Stephen L., Canadian Museum of Nature, Ottawa, ON, Canada

The Late Devonian (Famennian) Cleveland Shale of north central Ohio has historically produced an abundance of placoderm and shark specimens. The placoderms are known primarily from head and thoracic shields, with only rare evidence of vertebrae due to their composition and presumed preservational properties. Recently, the most complete segment of vertebral column known for the pachyosteomorph arthrodire *Dunkleosteus terrelli* was recovered, along with a partially articulated skull which preserves at least 12 plates and both lower jaws. The specimen, CMNH 50322, is a subadult *Dunkleosteus* less than 3 m in length. At least 20 articulated vertebrae, each measuring approximately 2.5 cm high and 0.7cm long, are preserved in lateral view in a 14.6 cm section. The vertebrae are on a block of shale which includes the left anterior dorsolateral plate, apparently in anatomical position. The vertebrae nearest the skull are not fused, either to each other or completely around the notochord, leaving a small open space on each side. Each vertebra is composed primarily of a fused neural arch and spine, and a fused haemal arch and spine. The curved edges of the bases of the neural and haemal arches of the anterior 13 vertebrae are ornamented with a single line of small, rounded tubercles; some show a double line, with the inner line composed of much smaller tubercles. The five complete posterior vertebrae of the remaining seven exhibit marked structural differences from the anterior portion; the notochordal area appears to be covered with a thin layer of bone, which is considerably fractured. These vertebrae are laterally somewhat expanded, with cup-like structures forming the lateral portion of the bases of the neural and haemal arches; they show no ornamentation. The interpretation of these latter few vertebrae is perplexing. Chondrichthyans and some placoderms have a cervicothoracic synarcual posterior to the occipital region which fuse vertebrae to each other and enclose the notochord. However, a synarcual is unknown in *Dunkleosteus*, although it may have been present on a 10 cm portion of the block directly behind the skull that was lost during collection. The preserved vertebrae are located posterior

to the position that a synarcual would have occupied, and they would have to have been flipped 180° and moved 10 cm forward to allow for this interpretation. Alternatively, if the vertebrae are approximately in anatomical position, it is possible that these vertebrae either represent a thoracocolumbar synarcual (a second, more posterior fused unit common in myliobatoid chondrichthyans), or that this structural change indicates the beginning of the abdominal region above the pelvic girdle and fin, with the increased bony structure providing protection for the gut.

Preparators' Session (Thursday, October 18, 10:30 am)

COMPARING IMPRESSION MATERIALS FOR DENTAL MICROWEAR ANALYSIS IN A SMALL FOSSIL MAMMAL

SADOWSKA, Victoria A., University of Toronto, Toronto, ON, Canada; MORRISON, Ian, Royal Ontario Museum, Toronto, ON, Canada; SILCOX, Mary T., University of Toronto, Scarborough, Toronto, ON, Canada

Casting is a common procedure for making high-quality replicas in order to conduct microwear analysis. The goal of this project was to determine the best impression material to create high resolution casts that preserve the pits and scratches present on the original specimen. A range of molding materials was chosen that differed in viscosity and age to determine the effect of these variables in producing a faithful mold. The molding materials used in this study include Coltene Putty, President-jet MicroSystem Light Body, and President-jet MicroSystem Regular Body (a batch from 1999 and another from 2011) polyvinylsiloxanes; Rhodia's RTV 4410 Platinum and RTV 4420 QC food grade silicones; Bluestars V-SIL 1062 silicone; and Reflection Patterson Super Hydrophilic Vinyl Polysiloxane Putty. All eight molding materials were used to mold a partial dentary with p4-m3 (USGS 7788) of the primitive primate *Microsyops latidens* from the early Eocene of the Bighorn Basin, a small (but not tiny) mammal (m2 length = 3.8 mm). A shearing facet on the m2 was imaged in the original specimen, and in epoxy casts made using the various molds. Images were taken using JEOL-5000 scanning electron microscope (SEM) and microscopic features were manually counted in Microware 4.0 software. The quality of dental surface replication was assessed by comparing the percent features visible in the cast relative to the original enamel surface. The values range from 73.17% for V-SIL1062 to 34.15% for Coltene Regular body from 1999. Age of the material was found to have an effect, with Coltene Regular Body from 2011 producing a better quality replica (46.34% visibility of microwear features). Viscosity also had a significant effect. The least viscous molding compound used (V-SIL1062) provided the best resolution, and the Light Body President jet material more faithfully represented microscopic features than the more viscous Regular Body, although the molds made from the Light Body material were quite fragile, so that they were unsuitable for repeated casting. The most commonly used molding material for microwear studies, Coltene Regular Body, performed comparatively poorly, although major pits and scratches were preserved, suggesting that it may nonetheless be possible to use casts produced with this impression compound to make general statements about diet.

Preparators' Session (Thursday, October 18, 8:45 am)

IMPROVING CURATION AND CONSERVATION STANDARDS AT THE VERTEBRATE PALEONTOLOGY LABORATORY THROUGH INTERDISCIPLINARY COLLABORATIONS

SAGEBIEL, James C., The University of Texas at Austin, Austin, TX, United States; BROWN, Matthew A., The University of Texas at Austin, Austin, TX, United States

The history of the collections at the Vertebrate Paleontology Laboratory (VPL) of the Texas Memorial Museum spans more than one hundred years. This history is tied to both famous names in vertebrate paleontology and the histories of many other institutions. Preventing and mitigating the loss of archival data, historic documents and photographs, as well as the specimens themselves are the focus of recent conservation efforts by the VPL collections staff. Although interest in preserving documents, photographs, and digital data related to the fossil collections is high, the small permanent staff of VPL faces a number of constraints familiar to most natural history curators and conservators – limited time, staff and training. Our approach over the past year has been to exploit the resources from our larger campus and museum community. We have targeted resources on our own university campus by first defining our collections care priorities. The photographs and documents at VPL are a hidden archive resource. However, this archive has only recently been organized. Documentation within the VPL collection itself is another source of hidden archival riches. However, these documentary materials (as well as the specimens) have suffered from gross variations at all levels in storage conditions and treatments. Field notes and photos are critical to interpretation of fossil materials; likewise, documentation of the provenance of specimens is crucial to collections management. By stressing to our students, faculty, and staff that the documentation of specimen treatments are essentially part of the specimen, we are improving this situation. VPL curatorial staff found willing partners in our conservation efforts through the University of Texas at Austin's Harry Ransom Center and School of Information. By working with these campus units, we have found not only a wealth of opportunity for expanding our own expertise, but also potential funding and qualified personnel. Our retrospective effort to conserve archives is informing our present curatorial practices and procedures. Documentation of the collections is expanded to include conservation methods and materials. Materials and practices for storage are more consciously considered. These efforts are also receiving greater emphasis among the students who are the most frequent users of the VPL.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

QUATERNARY BATS FROM SERRA DA MESA (BRAZIL): HUMERAL REMAINS AND TAXONOMIC ASSESSMENTS

SALLES, Leandro O., Museu Nacional, Rio de Janeiro, Brazil; CARLOS, Moraes Neto R., Museu Nacional, Rio de Janeiro, Brazil; LANZELOTTI, Wagner, Museu Nacional, Rio de Janeiro, Brazil; PERINI, Fernando A., American Museum of Natural History, New York, NY, United States; SIMMONS, Nancy B., American Museum of Natural History, New York, NY, United States

The fossil record of bats from the Quaternary of Serra da Mesa (Brazil) is here documented with 231 humeral fragments collected in three limestone caves, displaying stratigraphic profiles covering a timeframe of approximately 25.000 BP (unpublished C14 data). Serra da Mesa is a karstic region in the middle of Brazilian savannas (Cerrado Domain), located in the State of Goias. This material is being studied as part of a research program focused on the patterns of variation in the morphology of the humerus in the order Chiroptera. The identification of the material so far reveals an especially rich paleofauna of bats. It includes 22 genera, with potentially another 4, which are identified up to this point as *incertae sedis*; and 37 species (22 determinate, 15 under investigation), belonging to 5 families (the parentheses denote number of fragments followed by an indication of the status of the taxon as fossil (F) or recent (R) record for the bat fauna of Serra da Mesa): Phyllostomidae, Desmodontinae – *Desmodus rotundus* (5); Glossophaginae, Glossophagini – *Anoura* cf. *geoffryi* (2), *Glossophaga soricina* (3) (F), *Glossophaga* sp. (10), cf. Glossophaginae (1), Lonchophyllini – *Lonchophylla* sp. (5); Phyllostominae – *Lonchorhina* sp. (22), cf. *Lophostoma* (1), *Macrophyllym macrophyllum* (1) (F), *Micronycteris* sp. (1), cf. *Micronycteris* (1), *Mimon bennettii* (6), *Mimon* cf. *crenulatum* (1), *Phyllostomus discolor* (2), *Phyllostomus hastatus* (16), *Phyllostomus* sp. (1), *Trachops cirrhosus* (1), Phyllostomini *inc. sedis 1* (5), Phyllostomini *inc. sedis 2* (2); Carollinae - *Carollia castanea* (1) (F&R), *Carollia perspicillata* (2) (F); Stenodermatinae, Sturnirini – *Sturnira* sp. (5); Stenodermatini – *Artibeus* cf. *fimbriatus* (1) (F&R), *Artibeus jamaicensis* (2) (F), *Artibeus* sp. (1), cf. *Artibeus* (1), *Platyrrhinus* cf. *helleri* (1) (F), *Vampyrodes caraccioli* (1) (F&R), cf. *Stenodermatinae* (1); Mormoopidae – *Pteronotus gymnonotus* (28) (F&R), *Pteronotus parnelli* (75); Furipteridae – *Furipterus horrens* (1) (F); Natalidae – *Natalus stramineus* (20); Molossidae, Molossinae – *Nyctinomops* cf. *laticaudatus* (1) (F&R); Vespertilionidae, Vespertilionini - *Histiotus* sp. (1) (F&R); Myotinae – *Myotis albescens* (1) (F), *Myotis riparius* (1) (F). Six taxa were not recorded previously for the extant fauna of the region. Some material, such as a *Macrotus*-like humerus, may represent new taxa, while others represent the first fossil records for the region, the Brazilian territory and the South American continent. We conclude highlighting the potential of bat humerii as a source of character information for taxonomic and phylogenetic studies.

Technical Session III (Wednesday, October 17, 4:00 pm)

SKULL SHAPE REFLECTS LOCOMOTOR ECOLOGY IN RODENTS AND CARNIVORANS

SAMUELS, Joshua X., John Day Fossil Beds National Monument, Kimberly, OR, United States

The postcranial morphology of mammals has been shown to reflect cursorial, aquatic, arboreal, and fossorial locomotor habits. In the fossil record relatively complete postcrania are uncommon, while well-preserved skulls exist for many taxa. Features of the cranium, particularly the orientation of the orbits, have also been demonstrated to be linked to locomotor ecology. This study examines how skull shape, particularly the size and orientation of sensory structures, reflects locomotor habits in two ecologically diverse orders of mammals. Digital photographs of over 800 skulls, from 153 rodent and 54 musteloid and arctoid carnivoran species, were analyzed using geometric morphometric methods. Results of relative warps analyses reveal some convergence in skull shape associated with locomotor ecology, as well as some distinct differences in herbivorous and faunivorous taxa. Semi-aquatic carnivorans and rodents both display a broad and deep rostrum with elevated nasals and enlarged external nares. This position would allow the animal to breath while most of the body is submerged and accommodates enlarged maxilloturbinates associated with thermoregulation. Semi-aquatic herbivores display elevated orbits and external acoustic meatuses, which allow them to see and hear predators out of the water while submerged. Arboreal species display enlarged and more convergent orbits, allowing larger binocular visual fields. This is more pronounced in arboreal faunivores than herbivores, possibly due to pressure for a wider field of view in prey species. Saltatory rodents show enlarged orbits and auditory bullae; this reflects their nocturnal habits, their dependence on binocular vision for locomotion, and enhanced hearing for detection of predators. Fossorial species show reduced orbit size and enlarged auditory bullae, likely reflecting increased reliance on hearing to detect predators and prey. Canonical analysis classification of species ecology by skull shape was very accurate, greater than 90% correct for both carnivorans and rodents. Mapping of canonical variate scores onto phylogeny reveals convergence in skull shape within multiple lineages. Application to 51 extinct rodents and 22 extinct carnivores helps confirm previous researcher's hypotheses and reveal aspects of paleoecology that were previously unknown.

Technical Session VII (Thursday, October 18, 4:00 pm)

THE MARSUPIAL-PLACENTAL DICHOTOMY REVISITED: THE RELEVANCE OF GEOGRAPHY AND PHYSIOLOGY ON EVOLUTIONARY PATTERNS OF DIVERSITY AND DISPARITY

SÁNCHEZ-VILLAGRA, Marcelo R., University of Zurich, Zurich, Switzerland

Placental mammals occupy a larger morphospace and are taxonomically more diverse than marsupials, as shown by quantitative and phylogenetic studies of several character complexes and clades. This pattern holds when considering the rich ecomorphological diversity of fossils. The contrasting evolutionary path of therian clades has been coupled with a bias introduced by marsupials' developmental features, including lack of feto-maternal intimacy, general altriciality and functional requirements around birth. But the relevance of life history features in imposing constraints on the evolution of morphological features, such as those in the appendicular skeleton, is at best speculative. There are numerous cases of circumvention of developmental biases in morphological evolution, such as the autopodial specializations of moles. This and other examples as well as the common decoupling of morphogenetic events from adult anatomy in several groups of organisms and character complexes suggest that other factors produced the pattern of restricted morphospace in marsupials. A review in the literature on phylogenetic and geographic data for fossil and living species and the physiology in living forms offer new insights on this issue.

At many time and places in geological history, metatherians have been more diverse than eutherians or at least as diverse as the latter, as documented in Cretaceous and Paleogene faunas. Furthermore, there are no positive tests of competitive displacement of metatharians by eutherians. The diversification of Marsupialia and that of the major clades within it occured about 20 myr. more recently respectively than that of Placentalia and its 'orders'. The geographic pattern of taxonomic and morphological diversity within Placentalia mirrors that of placentals as a whole versus marsupials: northern clades are more diverse (ca. 4,800 spp.) than southern ones (200 spp.) and include those that are outliers in taxonomic (rodents; bats) and ecomorphological (whales; bats) richness. This pattern suggests that the largely restricted distribution of marsupials in southern continents after the Cretaceous must have played a decisive role in their diversification.

Physiological features are a likely source of biases in the evolution of marsupials, as shown by past macroevolutionary patterns that followed conditions imposed by global temperatures at the Eocene/Oligocene boundary. The apparent lack of brown adipose tissue and the close tie of metabolism with food consumption make marsupials more vulnerable to climate change. In general, the differential diversity and disparity among therians is more a reflection of 'opportunity' than one of biases in the production of morphological variants during development in marsupials.

Technical Session VI (Thursday, October 18, 3:30 pm)

CERVICAL RIB HISTOLOGY OF SAUROPOD DINOSAURS SUGGESTS FUNCTION IN THE MUSCULAR CONTROL OF THE NECK

SANDER, P. Martin, University of Bonn, Bonn, Germany; KLEIN, Nicole, University of Bonn, Bonn, Germany

Cervical ribs were an integral part of the anatomy of the neck of sauropodomorph dinosaurs. Prosauropods such as *Plateosaurus* show extremely elongated, posteriorly directed ribs that span more than one intervertebral joint, depending on position in the vertebral column. This condition is retained in most Sauropoda except for Diplodocoidea which have autapomorphically shorter cervical ribs overlapping only one intervertebral joint at most. Two competing hypotheses adress the function of the elongate cervical ribs of sauropods, one viewing them as ventral bracing elements taking up compressive force, and the other interpreting them as tensile elements integrated into the muscle-tendon system of the neck. We used bone histology to test these hypotheses, sampling the cervical ribs of *Diplodocus* and *Brachiosaurus* in serial sections along their entire length as well as fragmentary cervical ribs of some other sauropods. In addition, we studied the histology of ostrich cervical ribs. Except for the region of the capitulum and tuberculum, the primary bone of the entire ribs is metaplastically ossified tendon, including the anterior process of the *Diplodocus* rib. This is the situation in the ostrich as well. Only the region of the rib heads shows the normal periosteal bone seen in the dorsal ribs of sauropod dinosaurs. The primary metaplastic bone is made up of tightly packed fiber bundles that are surrounded by a fibrous sheath. Bundle orientation is strongly longitudinal. This histology indicates that the posterior shafts and anterior processes of sauropod cervical ribs are ossified tendons that may have been part of the ventral m. longicollis system. The lack of radially oriented fibers argues against the long overlapping cervical ribs having been bound into a tightly intergrated rod but is consistent with these ribs having slid past each other during neck movement. The hypothesis of a ventral bracing function for the cervical ribs of both long-ribbed and short-ribbed sauropod dinosaurs thus can be confidently rejected. Instead, the extremely long ribs may have allowed a caudal shift of the heavy musculature operating the neck, as seen in some birds. This would have decreased the mass of the anterior and middle parts of the neck, contributing to lightening of the neck in addition to its extensive pneumatization.

Technical Session III (Wednesday, October 17, 2:15 pm)

ONTOGENETIC, BEHAVIORAL AND EVOLUTIONARY CONSIDERATIONS OF CRANIAL POLYMORPHISM IN EARLY OLIGOCENE *AEGYPTOPITHECUS ZEUXIS* (CATARRHINI, PRIMATES)

SANDERS, William J., University of Michigan Museum of Paleontology, Ann Arbor, MI, United States; GUNNELL, Gregg F., Division of Fossil Primates, Duke Lemur Center, Duke University, Durham, NC, United States

Abundant remains of the early Oligocene stem catarrhine primate *Aegyptopithecus zeuxis* demonstrate that it is a sister taxon to cercopithecoids and hominoids. Extreme sexual dimorphism in *Aegyptopithecus* is marked by non-overlapping ranges of postcanine tooth size, exceeding that in extant hominoids, and strong contrasts in canine dimensions, consistent with polygyny. Among anthropoids, diverse forms of polygyny have different morphological correlates and varied ecological and genetic consequences. A diminutive female *Aegyptopithecus* cranium lacks ectocranial cresting typical of male specimens and is only 53-70% as large as an age-grade series of adult male crania. External and CT-scan measurements show substantial age-related differences between male crania in facial dimensions and extent of maxillary sinuses, revealing that growth continued throughout adulthood, consistent with contrasts in timing of skeletal maturity in males versus females. Bimaturism in *Aegyptopithecus* exaggerated differences between males and females, but even young males have larger crania than females, indicating that dimorphism resulted from sex-based variance in both rate and duration of growth. This suggests single-male polygyny, in which older, high-ranking males competed intensely for access to multiple females and younger males were marginalized. Extreme single-male polygyny and bimaturism generally are believed to be highly derived among catarrhines, exemplified in orang-utans and mandrills, in which adult features are hormonally suppressed in young males in the presence of larger, ornamented males. Cranial ontogeny in *Aegyptopithecus* resembles bimaturism in the early hominid *Paranthropus robustus*, whose males underwent progressive facial growth throughout adulthood to attain hyper-male morphology. As cranial size increases in *Aegyptopithecus*, upper facial growth is negatively allometric, mid-facial changes are isometric, and lower facial growth is positively allometric; maxillary sinuses and the posterior maxilla expand substantially. These trends characterize the inferred morphological transformation between increasingly larger *Aegyptopithecus*-mid Oligocene *Saadanius*-early Miocene *Afropithecus*, associated in the latter with canine hypertrophy. This transformation was not due solely to extended or accelerated growth, as facial angulation increased with size in *Aegyptopithecus,* but conversely became more acute in the later taxa. The results indicate that the common ancestor of crown catarrhines was highly sexually dimorphic and polygynous, and that the use of non-dimorphic extant taxa in the reconstruction of the ancestral morphotype for crown catarrhines is therefore inappropriate.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

SOMETHING'S FISHY: WAS ONE OF THE MOST ABUNDANT LATEST CRETACEOUS THEROPODS A FISH-EATER?

SANKEY, Julia T., California State University Stanislaus, Turlock, CA, United States

Latest Cretaceous (Maastrichtian) theropod and bird diversity in North America is partly known from thousands of isolated teeth from microvertebrate sites, especially from the rich Hell Creek and Lance Formations in Montana, Wyoming, and North and South Dakota. Based on 500+ theropod and bird teeth from Hell Creek and Lance Formation microsites in Montana, relative abundances of small theropods are: dromaeosaurids (23%), troodontids (14%), cf. *Richardoestesia isosceles* (35%), cf. *Paronychodon* (20%), and bird (8%). What is strikingly different compared to earlier sites (late Campanian) is that the Maastrichtian sites contain a high abundance (55%) of two unusual and enigmatic small theropods, *Richardoestesia isosceles* and *Paronychodon*. However, almost nothing is known about these taxa – what they looked like, what they ate, and why they were so abundant during the Maastrichtian. However, one interesting insight relates to these questions. Because of its straight teeth, *R. isosceles* may have been a fish-eater. This interpretation fits with the fact that *R. isosceles* is much more abundant in more coastal deposits such as the Hell Creek Formation compared to more inland deposits. If this is correct, then *R. isosceles* is the first recognized piscivorous theropod in North America (although this has been inferred for spinosaurs from South America and Africa). This has interesting implications for K/P mass extinctions as it supports the hypothesis that there was disruption in all habitats, both terrestrial and aquatic, during the K/P mass extinction.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

LIFE AMONG THE DUNES, A LOWER JURASSIC "MEGATRACK BLOCK" FROM THE NAVAJO SANDSTONE, GLEN CANYON NATIONAL RECREATION AREA, UTAH

SANTUCCI, Vincent L., National Park Service, Washington, DC, United States; MILNER, Andrew R., St. George Dinosaur Site at Johnson Farm, St. George, UT, United States; BIRTHISEL, Tylor A., Grand Staircase Escalante National Monument, Kanab, UT, United States; CLITES, Erica C., National Park Service, Page, AZ, United States; KIRKLAND, James I., Utah Geological Survey, Salt Lake City, UT, United States

A rich and diverse Mesozoic vertebrate ichnofossil record is documented at Glen Canyon National Recreation Area, Utah. Paleontological resource inventories along the shoreline of Lake Powell have yielded thousands of dinosaur and other vertebrate tracks. In 2009, a large block of Navajo Sandstone, containing a well preserved dinosaur trackway, was reported by a family visiting the recreation area. Evaluation of the large block revealed

the preservation of at least 83 fossil footprints in two distinct track-bearing horizons from interdunal deposits in the lower part of the Navajo Sandstone Formation. The Early Jurassic ichnofauna preserved in the block referred to as the "Megatrack Block" includes: 10 large ornithopod-like tracks which were likely produced by a theropod; 47 tracks tentatively identified as *Grallator*, produced by small coelophysoid theropod dinosaurs; three large theropod tracks showing two morphotypes; 14 medium-sized theropod tracks that appear *Kayentapus*-like in morphology; five smaller unidentified quadruped footprints possibly made by a crocodylomorph; and, 10 unidentified tracks. The ichnoassemblage preserved on the "Megatrack Block" sheds new light on the life of the Jurassic Navajo desert.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

INTRASPECIFIC VARIATION IN THE STYLAR CUSPS OF DIDELPHIS VIRGINIANA

SARTIN, Catherine E., Johns Hopkins School of Medicine, Baltimore, MD, United States; ROSE, Kenneth D., Johns Hopkins School of Medicine, Baltimore, MD, United States

In the fossil record, mammalian taxa are routinely identified on the basis of molar morphology. The presence, absense, size or unique shape of just one cusp or conule can lead to the naming of a new species, even a new genus. The underlying assumption is that these surface features do not vary within species; that these features only vary between species. This study challenges that assumption.

We examined the upper molars of extant *Didelphis virginiana* from the collections of the Smithsonian Institution, National Musuem of Natural History, Division of Mammals. Only molars that showed little to no evidence of wear, whose crown details could be seen relatively clearly and unambiguously, were used in order to avoid conflating wear patterns with morphology. Only specimens that possess a right and left M1 and M2 were used, so that variation within an individual, as well as between individuals, could be assessed for each molar. Specimens were photographed under a light microscope using a standardized procedure. At this time, any variation in the morphology of the stylar cusps was noted. The width of the molar and height of each stylar cusp was measured from the photograph using ImageJ.

Intraspecific variation was found with respect to cusp height (especially Cusps B and C) and cusp morphology (especially Cusp C). Using ANOVA analyses, we were able to determine that the variation between individuals is statistically significant. These variations occurred across the collection localities, as well as across the four subspecies. Interestingly, some of the variations found are reminiscent of characters used to discriminate between taxa in the fossil record. This study forces us to re-evaluate the characters we use to distinguish taxa.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

TRANSITIONAL *TRICERATOPS*: DETAILS OF AN ONTOGENETIC SEQUENCE FROM THE UPPER MIDDLE UNIT OF THE HELL CREEK FORMATION, MONTANA

SCANNELLA, John B., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; FOWLER, Denver W., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; GOODWIN, Mark B., University of California Museum of Paleontology, Berkeley, CA, United States; HORNER, John R., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States

Currently, two species of the latest Cretaceous ceratopsid *Triceratops, T. horridus* and *T. prorsus*, are distinguished, in part, by the following cranial morphological features: postorbital horn core length, morphology of the rostrum, closure of the frontoparietal fontanelle, and the length of the epinasal. Recent work in the approximately 90 meter thick Hell Creek Formation (HCF) of Montana confirms that these species are stratigraphically separated. *T. prorsus* is found in the upper third of the HCF and *T. horridus* occurs in the lower and middle thirds. A collection of disarticulated skulls represents a range of ontogenetic stages and reveals new cranial characters of the epinasal, nasals, and premaxillae that further distinguish these species. *Triceratops* recovered from the upper part of the middle third of the HCF (~ 5 meters below the base of the upper third) are morphologically intermediate between *T. horridus* and *T. prorsus*, and exhibit a combination of cranial features that characterize each taxon. Targeted collecting of the upper middle HCF has produced an ontogenetic sequence of *Triceratops* from this stratigraphic zone. These skulls exhibit: (1) elongate postorbital horn cores and a pronounced anterior nasal process, features that are characteristic of *Triceratops* from the lower half of the HCF; and (2) an elongate epinasal, expanded ascending process of the premaxilla, and deep rostrum that are characteristic of *Triceratops* from the upper third of the HCF. The absence of autapomorphies in these specimens from the upper middle HCF supports the hypothesis that the evolution of *Triceratops* was characterized by anagenesis, the morphological transformation of a lineage over time. Interestingly, juvenile skulls and cranial elements from the upper third of the HCF exhibit character states found in more mature individuals collected from lower in the formation. This HCF dataset suggests that morphological variation in *Triceratops* may be largely a result of heterochrony, indicating that stratigraphic and ontogenetic details are necessary for a comprehensive taxonomic evaluation of non-avian dinosaurs.

Technical Session IX (Friday, October 19, 11:30 am)

UNIDIRECTIONAL AIRFLOW AND PULMONARY ARCHITECTURE IN *ALLIGATOR MISSISSIPPIENSIS* AND THE IMPLICATIONS FOR THE EVOLUTION OF THE AVIAN RESPIRATORY SYSTEM

SCHACHNER, Emma R., University of Utah, Salt Lake City, UT, United States; SARRAZIN, John C., University of Utah, Salt Lake City, UT, United States; FARMER, C. G., University of Utah, Salt Lake City, UT, United States

The unidirectional airflow pattern in the lungs of birds has long been considered both derived and unique; however, the discovery of this trait in the lungs of the American alligator (*Alligator mississippiensis*) suggests that it is not an avian autapomorphy but plesiomorphic for Archosauria. In birds, unidirectional airflow is maintained by a series of inspiratory and expiratory aerodynamic valves. These valves arise from the geometry and branching angles of the primary and secondary bronchi. This anatomy is what maintains unidirectional airflow during both the inspiratory and expiratory phases of ventilation. Experimental and CT data indicate that this is also the case in the alligator. Detailed airflow measurements from all of the major secondary bronchi in five specimens of *A. mississippiensis* show that airflow follows an avian-like pattern. Air flows cranially to caudally in the cervicoventrobronchus (CVB or D1), and caudally to cranially in the following four dorsobronchi (D2-D5) and medial bronchi (M1-3). These airflow patterns support previous hypotheses of homology between the CVB and the avian ventrobronchi, and the crocodilian and avian dorsobronchi. Dissections, CT, and experimental data demonstrate that flow patterns are maintained by aerodynamic valves, suggesting that this trait, like the airflow patterns, is plesiomorphic for Archosauria. A computation fluid dynamic model was created using this CT data, which supported the experimental data and confirmed the hypothesis that bronchial geometry and airflow conditions are the key factors that generate unidirectional flow in alligators.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

QUANTITATIVE INTERPRETATION OF DINOSAUR TRACKS REVISITED

SCHANZ, Tom, Ruhr-Universität Bochum, Bochum, Germany; LINS, Yvonne, Ruhr-Universität Bochum, Bochum, Germany; VIEFHAUS, Hanna, Ruhr-Universität Bochum, Bochum, Germany; SANDER, P. Martin, Universität Bonn, Bonn, Germany

All over of the world, dinosaurs left their tracks in sediment, the original subsoil, which are observed as fossil footprints today. In this study, we present two theoretical approaches to the prediction of dinosaur weights based on the geometry (i.e. the 3D deformation field) of fossil footprints. The deformation field is the result of the stress state applied to the subsoil by the weight of the dinosaur via its foot, and we use the deformation field to back-calculate this weight by inverse analysis. Since the mechanical behavior of any soil varies with soil type and bedding conditions, the stiffness parameters of the original subsoil have to be back-calculated from the properties of the rock in which the footprint is preserved. Using Micro-CT as well as experimental soil mechanics, we derive subsoil grading properties and original stiffness.

The first theoretical approach estimates the error introduced by sediment compaction, i.e., the difference between today's track geometry (the fossil footprint) and original track geometry (the footprint left by the dinosaurs when uplifting the foot). Any subsoil stiffness parameter is sensitive to loading path direction and stress level. Therefore, the stress history contributed by the geological surcharge (i.e., the overburden) is taken into account by introducing an equivalent stiffness parameter. The main outcome of this approach is that the weight calculated using only the fossil footprint geometry and neglecting the deformation of the track by compaction of the sediment underestimates the true weight by less than 7%.

The second theoretical approach addresses the problem of undertracks. Fossil footprints as preserved in the field may not represent the original surface on which the dinosaur walked, i.e., they are preserved as undertrack footprints, and therefore may be difficult to use for weight estimates based on deformation fields. For the interpretation of such footprints, it must be kept in mind that stresses and vertical displacements induced by surface loads decline with increasing depth while spreading laterally. Our second theoretical approach allows calculation of the deformation field with increasing depth, and thus the dinosaur's weight, even by analyzing an undertrack footprint only. We verify our approach by the analysis of two in-situ undertracks well documented in the literature and by additional model tests in the soil mechanics lab.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A SHARK-BITTEN HADROSAURID FEMUR FROM THE BASAL HORNERSTOWN FORMATION, NEW JERSEY, U.S.A.: ONE OF THE YOUNGEST NON-AVIAN DINOSAUR REMAINS KNOWN

SCHEIN, Jason P., New Jersey State Museum, Trenton, NJ, United States; POOLE, Jason C., Academy of Natural Sciences of Drexel University, Philadelphia, PA, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

We report the discovery of an isolated left femur (New Jersey State Museum 22688) of a hadrosaurid dinosaur from Gloucester County, New Jersey, U.S.A. The femur is approximately 34.8 cm in length, with a midshaft circumference of 17.8 cm around the fourth trochanter and a minimum shaft circumference of 15.8 cm. The specimen can be referred only to an indeterminate member of Hadrosauridae. The ontogenetic stage of the individual is unclear.

The femur exhibits numerous straight to slightly arced grooves along its entire length, concentrated on the medial and lateral portions of the midshaft. The grooves are generally unpaired, unparallel, and sub-perpendicular to the long axis of the femur, and are consistent with tooth marks created by one or more scavenging sharks. This 'bloat and float' hadrosaurid carcass was deposited in nearshore marine deposits in which shark remains are common. None of the tooth marks exhibit serration grooves, and no tooth fragments remain in the femur.

The femur was excavated from the Main Fossiliferous Layer (MFL) of the basal Hornerstown Formation. Various ages have been assigned to the MFL, ranging from latest Maastrichtian, to earliest Danian, and most recently, terminal Cretaceous. Likewise, there are multiple interpretations of the depositional history of the MFL and the taphonomic characteristics of the fossiliferous layer. Whatever the depositional setting, it is clear that these fossils exist very near to, or even in, the K/Pg boundary, making this femur one of the youngest non-avian dinosaur remains known.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

RECONSTRUCTING HABITATS WITH CANNON BONES

SCHELLHORN, Rico, Steinmann-Institut, Paläontologie, Universität Bonn, Bonn, Germany

The fused metapodials of the third and the fourth ray in more progressive artiodactyls, like bovids and cervids, are called cannon bones. This term is used in both the fore and the hind leg, and also for the metapodials in extant equids, where the third ray is used for walking.

It is well known, that not only teeth, but also the postcranial skeleton, especially limb elements, are useful to determine habitat preferences. For the presented study the long bones of fore and hind limbs of extant cervids and bovids have been measured. The log transformed data of all long bones have been analyzed together within a principal component analysis (PCA). The results concerning distinguishing different habitats are striking for the various bovid species living in grassland, forest and mountainous habitats. The bovids preferring the three different ecological niches are distinguished in different clusters by plotting the data of the principal components (PC). For cervids this approach was proved as not useful, because no ecological signal occurred, probably due to very close habitat preferences in extant deers and relatives.

The method works well for all long bones of fore and hind limbs in one PCA, but in fossil sites ungulate remains are often disarticulated and the material is not well-preserved. Due to this fact the method was applied to the cannon bones only, which are mainly preserved as single remains in good conditions. With the modified method the distinction of different preferred ecological niches is still obvious in bovids by plotting the PCs for metacarpals and metatarsals, at least for grassland and forest habitats. The members of the mountainous habitat cluster are plotting either in the grassland cluster or the forest cluster.

To check if the method is just working for bovids the long bones of extant horses and relatives (all belonging to the genus *Equus*) have been measured. All equids are plotting close together within the cluster of grassland preferring bovids. This is the case for the PCA based on all long bones together and the PCAs made for the single cannon bones. The result for the cannon bones is surprising because the cannon bones of the perissodactyl horses are modified single bones, while the cannon bones of the artiodactyl bovids are a fusion of formerly two bones.

The method using just the cannon bone has been tested for different fossil taxa from the Miocene to the Pleistocene. For instance the fossil horse *Hipparion* shows similar adaptations to grasslands like extant horses, which is expressed by plotting close to grassland preferring bovids and equids in the PC plots for metacarpals and metatarsals. The modified approach using cannon bones could be an additional tool to determine the fossil habitat, when other data are not sufficient.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:00)

NEOGENE CROCODYLIAN MEGADIVERSITY PEAK AND FAUNAL SUCCESSION IN VENEZUELA

SCHEYER, Torsten M., Palaeontological Institute and Museum, University of Zurich, Zurich, Switzerland; AGUILERA, Orangel A., Museu Paraense Emilio Goeldi, Coordenação de Ciências da Terra e Ecologia, Departamento de Geociências, Belém, Brazil; FORTIER, Daniel C., Departamento de Paleontologia e Estratigrafia, IGeo, UFRGS, Porto Alegre, Brazil; SÁNCHEZ, Rodolfo, Municipio Urumaco, Edo. Falcón, Urumaco, Venezuela; SÁNCHEZ-VILLAGRA, Marcelo R., Palaeontological Institute and Museum, University of Zurich, Zurich, Switzerland

Crocodylian remains, together with turtle shells, make up the majority of vertebrate fossils recovered from the Neogene Urumaco Sequence in Venezuela. In the Late Miocene Urumaco Formation alone, a diversity peak with up to 14 crocodylian taxa, including one previously unknown alligatoroid with posterior crushing dentition similar to that of *Caiman brevirostris*, has been recovered. These findings thus constitute seven alligatoroids (*Caiman brevirostris*, *C. lutescens*, *Melanosuchus fisheri*, *Purussaurus mirandai*, *Mourasuchus arendsi*, *M.* cf. *nativus* and the possible new alligatoroid taxon), four gavialoids (*Gryposuchus croizati*, *G. jessei*, *Hesperogavialis cruxenti*, *Ikanogavialis gameroi*) and probably three crocodyloid taxa (*Charactosuchus mendesi* and possibly two separate species of the tomistomine *Thecachampsa*). Newly available stratigraphic control and refined global positioning data after a decade of collecting for crocodylian fossils indicate that regionally up to a minimum of six of the 14 known species lived sympatrically, with several of them constituting apex predators in the ecosystem (e.g. *Purussaurus* or *Gryposuchus*). Six taxa are thus known to occur in the Puente (Middle Member, Urumaco Fm.) and Corallito localities (Upper Member, Urumaco Fm.) respectively, followed by the El Hatillo (Middle Member, Urumaco Fm.) and Tío Gregorio localities (Upper Member, Urumaco Fm.), with five species each. Several other localities show also four taxa. This high diversity is outstanding as compared to any recent or extinct crocodylomorph assemblage (only Acre in Brazil and the Honda Group in Colombia show similar high levels of species diversity). On the other hand, the overlying Codore Formation (latest Miocene-early Pliocene) is devoid of crocodylians and only in the Vergel Member of the overlying San Gregorio Formation (early Pliocene), one representative of a more modern crocodylian fauna, a new crocodile species assignable to the genus *Crocodylus* appears. A phylogenetic analysis suggests that the new species is the sister taxon to extant *Crocodylus* species. This faunal succession from the diversity peak in the Miocene Urumaco Fm. to the depleted Pliocene fauna is indicative of severe environmental changes, including important changing hydrographic courses related to the Orinoco River.

Technical Session VI (Thursday, October 18, 2:00 pm)

SEMICIRCULAR CANAL DIMENSIONS IN SAUROPODOMORPHA: PALEOBIOLOGICAL IMPLICATIONS

SCHMITT, Armin, Steinmann Institut für Geologie, Mineralogie und Paläontologie, University of Bonn, Bonn, Germany; SANDER, P. Martin, Steinmann Institut für Geologie, Mineralogie und Paläontologie, University of Bonn, Bonn, Germany; RUF, Irina, Steinmann Institut für Geologie, Mineralogie und Paläontologie, University of Bonn, Bonn, Germany

The vestibular system is the sensory system in vertebrates that contributes information about movement and balance. The vestibular system, consisting of the semicircular canals (SCC) and the vestibule, is located within the bony labyrinth of the inner ear. The size of the SCC determines its sensitivity, and extant vertebrates of similar body size and lifestyle have similar-sized semicircular canals. This suggests that SCC dimensions may be paleobiologically informative in the largest terrestrial animals ever, the sauropod dinosaurs. Not only did sauropods surpass extant terrestrial animals by an order of magnitude in body mass, but the neck of some sauropods is more than three times longer than that of the giraffe. The small head on this long neck must have experienced very fast angular accelerations, even during slow movements of the neck, raising the question of how the vestibular system of sauropods could cope. Using µCT data and 3D reconstruction software, we visualized the vestibular system and the SCC and quantified SCC dimensions of representatives of most major sauropod clades (*Spinophorosaurus*, *Nigersaurus*, *Apatosaurus*, *Diplodocus*, *Europasaurus*, *Brachiosaurus*) and a basal sauropodomorph (*Plateosaurus*). SCC size in relation to estimated body mass indicates apomorphic vestibular proportions. Specifically and contrary to previous suggestions that semicircular canals in sauropods were rather small, this holds true only for basal Neosauropoda (*Spinophorosaurus*) and Diplodocoidea (*Nigersaurus*, *Apatosaurus*, *Diplodocus*), while basal macronarian sauropods (*Europasaurus* and *Brachiosaurus*) had average-sized semicircular canals like in *Plateosaurus*. Furthermore, all studied sauropods had disproportionately large anterior SCC but disproportionately small and thick lateral SCC. Because no direct parallels between Sauropoda and extant species exist in SCC dimensions and proportions, this size discrepancy between the three SCC likely reflects the great body mass and extremely long neck of sauropods. We hypothesize that it was particularly the high angular acceleration experienced by the head during neck movement that is responsible for the peculiarities of sauropod SCC dimensions. The differences between different sauropod taxa in absolute canal size and proportions also suggest different behavioral strategies such as low-browsing vs. high-browsing. These results will not only provide a better understanding of sauropod feeding strategies as well as head and neck movements but also have implications for the ongoing controversy about neck posture in sauropods.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 10:45 am)

GLOSSY FEATHERS AND NOCTURNAL ACTIVITY: INFERENCE OF *MICRORAPTOR* FEATHER COLORS USING A PHYLOGENETIC FRAMEWORK

SCHMITZ, Lars, Department of Evolution and Ecology, UC Davis, Davis, CA, United States; HINIC-FRLOG, Sanja, Departments of Biology and Earth Sciences, Carleton University, Ottawa, ON, Canada; MOTANI, Ryosuke, Department of Geology, UC Davis, Davis, CA, United States

Quantitative analyses of continuous morphological traits with explicit functional relevance provide testable models of trait inferences in fossil vertebrates, a rapidly growing area in paleobiology. In the midst of this trend a new technique has been developed to make retrodictions of feather colors in dinosaurs. This technique relies on exquisitely preserved melanosome structures in fossil feathers that record information about color. However, current interpretations do not account for phylogenetic bias and thus may potentially be misleading. In order to test whether the use of non-phylogenetic methods is justified, we developed a time-calibrated phylogenetic hypothesis for all 118 extant bird species for which data on melanosome structure are available. Next, we repeatedly subsampled the data to only include a single observation per species, creating a distribution of results. The resampling combined with the phylogenetic framework minimizes the risk of violating the assumption of independence among samples. Then, we quantified the correlation between melanosome structure and feather color (five categories) while varying the level of phylogenetic bias removal by adjusting Pagel's lambda. We found the highest correlation

when 7-13% of phylogenetic bias expected from Brownian motion was removed. This value was reduced to 0-5% when only two categories (iridescent vs. non-iridescent) were used, yet a small amount of phylogenetic bias remained even in this simplified case. Thus, we performed phylogenetic flexible discriminant analysis (pFDA) at the appropriate level of phylogenetic bias removal and prior probabilities obtained from training data. Results from pFDA suggest that the full color model with five categories suffers from high misclassification rates (25-37%). In contrast, the simple model with two color categories (iridescent vs. non-iridescent) is robust, with misclassified proportions ranging between 8-14%. Posterior probabilities of pFDA support the inference of iridescent feathers in *Microraptor* as suggested previously. However, the inferred presence of glossy feathers does not contradict the reconstruction of nocturnality in *Microraptor* on the basis of scleral ring and orbit morphology. Nocturnal species with iridescent feathers are found in at least two phylogenetically distinct clades of extant birds (Anseriformes, Psittaciformes). It is probable that *Microraptor* was a nocturnal animal with glossy feathers. However, the reconstruction of feather color in other dinosaurs and basal avians needs further scrutiny, because even a small amount of phylogenetic bias may result in different classifications.

Technical Session XIV (Saturday, October 20, 9:45 am)

A DISTINCTIVE NEW ARCHOSAURIFORM REPTILE FROM THE MIDDLE TRIASSIC (LADINIAN) OF GERMANY AND ITS PHYLOGENETIC RELATIONSHIPS

SCHOCH, Rainer R., Staatliches Museum fuer Naturkunde Stuttgart, Stuttgart, Germany; SUES, Hans-Dieter, Smithsonian Institution, Washington, DC, United States

In recent years fieldwork in late Ladinian (Middle Triassic) strata of the Lower Keuper (Erfurt Formation) of Baden-Württemberg (Germany) has yielded many well-preserved skeletal remains of a considerable variety of tetrapods and fishes, many of them new to science. These discoveries include partial skeletons as well as numerous isolated elements of a distinctive new armored archosauriform reptile. The dorsal dermal armor of the new taxon comprises transverse rows of four rectangular osteoderms in the cervical, trunk, and caudal regions, with the individual plates closely resembling those of *Doswellia kaltenbachi* from Carnian-age formations in Virginia and Texas. Ventral armor is absent but small osteoderms covered at least portions of the limbs. The long and low maxilla of the new taxon held at least 15 teeth. The labial and lingual surfaces of the tall, only slightly recurved crowns of the maxillary teeth bear distinct vertical ridges. The cervical portion of the vertebral column is long. The anterior dorsal ribs have sharply bent shafts. Phylogenetic analysis places the new taxon as the sister taxon to *Doswellia kaltenbachi* in Doswelliidae. Doswelliidae is diagnosed by the coarsely reticulate, deeply incised ornamentation of osteoderms composed of central regular pits of subequal size and contour and a mostly smooth anterior articular lamina on each osteoderm. At present the phylogenetic position of this clade cannot be confidently determined more precisely than non-archosaurian archosauriforms more derived than Proterosuchidae, Erythrosuchidae, and *Euparkeria capensis*. Along with recent finds from South America, the new taxon establishes that Doswelliidae was widely distributed across Pangaea during the late Middle and early Late Triassic.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

HISTOLOGY OF NORMAL AND DEFORMED ARGENTINEAN TITANOSAUR FEMORA

SCHROETER, Elena R., Drexel University, Philadelphia, PA, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

Previous histological examination of the humerus of a new titanosaur species from Argentina indicated that it was still actively growing at the time of its death, though the individual was very large (humeral length = 1.6 m) compared to other known titanosaurs. To support the hypothesis of active growth, we conducted a histological examination of the anterior side of the femur (length = 1.95 m) associated with this individual. Transverse sections of the femur showed well-vascularized, laminar fibrolamellar bone in the outer cortex that extends to the periosteal surface. Lines of arrested growth (LAGS) and annuli, if present, are not well defined. Secondary remodeling is less extensive than observed in the humerus, with isolated secondary osteons appearing deep to the periosteal surface. Though Haversian tissue becomes increasingly dense towards the medullary cavity, large areas of primary bone are retained between the secondary osteons throughout the middle cortex. The absence of an external fundamental system (EFS) or avascular, lamellar-zonal, or parallel-fibered bone at the periosteal margin is consistent with the assessment of this individual as a young adult.

In addition, a second, shorter titanosaur femur (length = 1.29 m) was recovered from the same locality. The smaller femur has an elongated femoral head that is pathologically and/or taphonomically deformed. To test the hypothesis that this bone is from a younger individual that has been diagenetically altered, a transverse section of this specimen was examined and compared with the larger femur. It exhibits a pattern of tissue development not observed in its larger counterpart, including the following characteristics: (1) a higher level of secondary remodeling, with more abundant and closer-spaced secondary osteons developing nearer the periosteal surface; (2) the presence of a few well-defined annuli. The presence of apparently more mature tissues in a smaller femur may be an osteological response to compensate for an injury sustained during the individual's life, or may indicate it is a member of a distinct species. While additional investigation is necessary to determine unequivocally the origin of the histological differences, the hypothesis that the smaller femur represents a conspecific juvenile appears less likely in light of these data.

Technical Session X (Friday, October 19, 10:30 am)

MAJOR TRANSFORMATION IN MASTICATORY AND DENTAL FUNCTIONS IN EARLY MAMMALS

SCHULTZ, Julia A., Steinmann-Institut, Universität Bonn, Bonn, Germany

Precise dental occlusion is a key evolutionary adaptation of mammals. In combination with various modifications of the dentition, modern placentals and marsupials developed a versatile masticatory function from pre-tribosphenic Mesozoic ancestors.

This important functional evolution can now be studied quantitatively for pre-tribosphenic dryolestid mammals and other mammaliaforms. For the first time masticatory movements and the original wear pattern of fossil teeth can be integrated in a quantitative 3D-surface analysis for analyzing chewing biomechanics.

The mastication of dryolestids is characterized by embrasure shearing. The trigonids of the lower molars slide into the interdental spaces between the upper molars. Food is sectioned and sheared along the main shearing area, the hypoflexid groove. This groove is of great importance for the food reduction, while the hypoflexid is less involved into occlusal contacts in tribosphenids. Two directions of striations on dryolestid molars indicate that the chewing cycle consisted of two phases: an initial piercing-cutting phase followed by a shearing phase, ending with centric occlusion. In tribosphenids, centric occlusion is followed by a grinding phase in the talonid basin.

Compared to the transversal chewing movement of dryolestids, the chewing pattern of tritylodonts and multituberculates is fundamentally different. The postcanine morphology of the herbivorous tritylodonts and multituberculates is triggered by the palinal (mesial to distal) chewing movement. Two cusp rows on the lower molars interlock with three cusp rows on the upper molars. Despite the similarity of the occlusal surface, tritylodonts and multituberculates have different strategies of mastication. The cusps of tritylodonts are narrow and high with significant shearing edges, while the cusps of multituberculates are rounded without sharp edges. Food particles are cut along the series of blades in tritylodonts, while in multituberculates food is mainly sheared between large shearing areas. A similar chewing pattern occurs in muroid rodents, but shape of the cusps indicates a proal movement (distal to mesial) of the lower jaw.

Quantification of shearing planes and collision areas are the basis for the estimation of the efficiency of various molar types. The interpretation of physical properties of food items resulting from the function of single elements of the occlusal surface allows ecomorphological comparisons. It shows that the ability of precise occlusion is mandatory to evolve highly efficient dentitions before the tribosphenic molar appeared in the mammalian history.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

IDENTIFYING THE ORIGINS AND IMPLICATIONS OF BONE PATHOLOGY IN FOSSIL REPTILES

SCHULTZE, Hans-Peter, University of Kansas, Lawrence, KS, United States; ROTHSCHILD, Bruce M., University of Kansas, Lawrence, KS, United States; PELLEGRINI, Rodrigo, New Jersey State Museum, Trenton, NJ, United States

A famous 19th century physician observed that diagnosis without knowing the literature is like going to sea without charts, and suggested that lack of knowledge of history only leads to its repetition, not progress. As science develops, concepts are transformed, such that there is value in re-examining the literature in view of our current understanding of disease and its impact on the skeleton. The perspective that bone pathology was phylogeny-independent in character was tested and found valid for both recent and fossil reptiles. That is the first step in understanding pathology in the fossil record. This allowed identification of what has been clearly documented and areas for future investigation. Congenital anomalies and neoplasia (tumors) are rare and injuries and infections are predominantly reported as isolated phenomena. Decompression syndrome is found within a relatively narrow phylogenetic window, but at high frequency. Past notations of fusion of vertebrae are re-examined and compared. Whereas some are attributable to infected bites, more have vertebral bridging more characteristic of spondyloarthropathy, similar to that noted in contemporary varanids. This unique form of arthritis was recognized in *Dimetrodon*, *Diadectes*, *Ctenorhachis* and crocodylians, as well as in mosasaurs and dinosaurs. Study of fossil reptiles provides evidence extending the ability to recognize bone pathology from a trans-mammalian phenomenon to a more general trans-phylogenetic phenomenon.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW PLIOSAUR (PLESIOSAURIA, PLIOSAURIDAE) FROM THE CARLILE SHALE (CRETACEOUS: MIDDLE TURONIAN) OF RUSSELL COUNTY, KANSAS

SCHUMACHER, Bruce A., Denver Museum of Nature and Science, Denver, CO, United States; CARPENTER, Kenneth, Prehistoric Museum, Utah State University – Eastern, Price, UT, United States; EVERHART, Michael J., Sternberg Museum of Natural History, Hays, KS, United States

The Eulert pliosaur remains (FHSM VP-321) housed at the Sternberg Museum of Natural History (Kansas, USA) include one of the world's best examples of a Cretaceous pliosaurid plesiosaur skull. The specimen's original assignment to *Brachauchenius lucasi* was based solely upon the skull in dorsal view and the left lower jaw in lateral view because the specimen was embedded in a plaster mount. The history of *B. lucasi* is similarly problematic because the type (USNM 4989) and a referred skull (USNM 2361) were formerly visible

only in ventral and dorsal views, respectively. Further preparation and comparison of these specimens reveals new data about the arrangement of cranial elements. The Eulert pliosaur bears several distinct autapomorphies as compared *B. lucasi*, including cranial proportions (pre-temporal length of palate longer, shorter temporal fenestrae), configuration of skull roof elements (frontals participate in premaxillae-parietal suture, suture occurs further to the anterior), and configuration of the palate (posterior vomers not masked by medial alar extensions of the palatines, caudal vomerian fenestrae positioned further posterior, long slit-like anterior ptergyoid vacuity present). Furthermore, FHSM VP-321 possesses double-headed cervical ribs, a feature which until recently was unknown in Cretaceous pliosaurs. This combination of characters merits separation of the Eulert pliosaur and a referred specimen (UNSM 50136) to a new taxon. The skull of the Eulert pliosaur and the referred specimen are 1.5 m and 1.75 m in length, and thus fifty and seventy-five percent larger than known *B. lucasi*, respectively. Reliable body proportions of pliosaurs are difficult to ascertain given the paucity of skeletons, however skull length equates to between twenty and twenty-five percent of total body length. The 1 m long skulls of *B. lucasi* thus equate to individuals between 4 and 5 meters in total length, animals that are certainly adult in size. Yet the Eulert pliosaur and the referred skull suggest animals ranging from minimally 6 to maximally 9 meters in total length. The marked disparity in size may have taxonomic significance, although this is difficult to assess given the small number of known pliosaur specimens. We acknowledge the seemingly problematic issue of two closely related sympatric top predators in the Cretaceous Seaway. However, we note the modern example of the killer whale *Orcinus orca*, a modern marine apex predator once thought to constitute only a single species, but now widely recognized to contain two or distinct subgroups which have overlapping ranges but avoid each other and do not interbreed. Thus, although unusual, sympatry of two pliosaurs in the Turonian sea should not be considered unique.

Technical Session IV (Wednesday, October 17, 3:30 pm)

MOLECULAR EVIDENCE FOR ENDOGENEITY OF DINOSAUR OSTEOCYTES

SCHWEITZER, Mary H., North Carolina State University, Raleigh, NC, United States; CLELAND, Timothy P., North Carolina State University, Raleigh, NC, United States; ZHENG, Wenxia, North Carolina State University, Raleigh, NC, United States; BERN, Marshall, Palo Alto Research Center, Palo Alto, CA, United States

The discovery of soft, transparent structures in dinosaur bone consistent in morphology with osteocytes was controversial. We hypothesize that, if original, these microstructures will have molecular features in common with extant osteocytes. We present immunological and mass spectrometry evidence for preservation of proteins comprising extant osteocytes (Actin, Tubulin, PHEX, Histone H4) in osteocytes recovered from two non-avian dinosaurs. Furthermore, antibodies to DNA show localized binding to these microstructures, which also react positively with DNA intercalating stains propidium iodide (PI) and 4′,6′-diamidino-2-phenylindole dihydrochloride (DAPI). Each antibody binds dinosaur cells in patterns similar to extant cells. These data are the first to support preservation of multiple proteins and to present multiple lines of evidence for material consistent with DNA in dinosaur cells, supporting the hypothesis that these structures were part of the once living animals. We propose mechanisms for preservation of cells and component molecules, and discuss implications for dinosaurian cellular biology.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW INFORMATION OF THE EVOLUTION OF THE SHOULDER GIRDLE AND FORELIMBS OF FOSSORIAL MOLES

SCHWERMANN, Achim H., Steinmann Institut, Bonn, Germany

The forelimbs of moles are highly adapted to a fossorial mode of life. Except for humeri, postcranial remains are rarely preserved. Postcranial elements of four individuals of Desmanini, Scalopini, and Talpini were investigated by µ-CT and shoulder girdle and forelimbs were reconstructed.

Specimen BSP 2008 LI 280 from Viehhausen (Germany; MN 5/6) was reassigned as *Mygalea jaegeri* to the Desmanini by humeral characters. CT-scans revealed the so far unrecognized manubrium, left clavicle and both scapulae. These bones bear desman-like characters as the suprascapular foramen, wide lateral wings at the manubrium and a relatively narrow and elongated clavicle. The reconstruction shows basal, “desman-like” skeletal elements of shoulder and forelimbs. The former assignment of *Mygalea* to the Desmanini is confirmed.

The second Viehhausen-specimen BSP 2008 LI 282 was assigned to *Proscapanus sansaniensis* within Scalopini by dental characteristics. The re-examination revealed a suprascapular foramen, which is known of *Mygalea* and extant Desmanini and Scalopini. Reconstruction of the shoulder girdle and forelimb demonstrates that it was a highly fossorial mole with stout clavicle, broad humerus and a wide digging-hand.

The holotype of *Geotrypus montisasini* SMNS 44523 from Ulm (Germany; MN 2a) comprises fragments of toothrows, left humerus, both radii and right ulna and was assinged to Talpini. A number of unidentified bones could now be determined: A proximal fragment of the right humerus, an anterior fragment of the manubrium, a vertebra and a rib. Additionally 17 elements of the manus were found and their positions in the hand were reconstructed.

SMNS 43499 from Haslach (Germany; MN 2) was assigned to *Geotrypus montisasini* based on the humerus. Additionally, a scapula, a radius, and a forth bone, now identified as a clavicle, are articulated to the humerus. The skeletal elements found in both fossil specimens of *Geotrypus montisasini* were used for a reconstruction of the shoulder girdle and forelimb with parts of the hand.

The length/width-ratio of the clavicles of *Proscapanus sansaniensis* and *Geotrypus montisasini* is ≤1 and the metacromion of the scapula is reduced in both species. Similar features are found in extant Scalopini and Talpini. The more basal Talpini *Geotrypus antiquus* from the Upper Oligocene does not show any of these characters, which indicates a convergent evolution of highly specialised forelimb skeletons within Scalopini and Talpini.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

DENTAL MORPHOLOGY AND FUNCTION OF *DIACODEXIS* IN COMPARISON WITH PRIMITIVE ARTIODACTYLA

SCHWERMANN, Leonie, Steinmann-Institut für Palaeontologie, Universitaet Bonn, Bonn, Germany; VON KOENIGSWALD, Wighart, Steinmann-Institut für Palaeontologie, Universitaet Bonn, Bonn, Germany

The masticatory cycle of the modern selenodont artiodactyls is relatively uniform and derived with a one-phased power stroke and no centric occlusion. Their teeth, equipped with many sharp cutting edges, are ideal tools for cutting, shearing and grinding of fibrous, plant food. The dentition of *Diacodexis*, the first known artiodactyl, is distinctly different in morphology and function compared to the selenodont dentition of modern artiodactyls. Therefore the masticatory cycle of *Diacodexis* was investigated, in order to understand the evolution of the tooth pattern and the linked functional differences in mastication among the artiodactyls.

Diacodexis occurs in the lowest Eocene and has a primitive bunodont dentition with triangular upper molars and six cusped lower molars. In contrast to most other artiodactyls it has only three main cusps and no hypocone. The masticatory cycle was reconstructed by the orientation of enamel facets and the direction of striations on their surface. The results show a two-phase cycle, with Phase I and Phase II separated by centric occlusion. It combines a cutting function in Phase I and a crushing function during centric occlusion and Phase II. While the sharp, w-shaped ridges of the buccal cusps of the upper molars are suitable for breaking up leaves, the rather blunt lingual protocone is useful for crushing brittle food items like fruits, nuts or seeds. Investigations based on digital 3D models of dentitions of *Diacodexis* show that the facets, that are developed during the cutting function occupy a higher percentage of the occlusal surface than the facets of the crushing function. Thus, it can be concluded that the proportion of leaves in the diet was relatively higher than the proportion of fruits, seeds or nuts.

During the Eocene the artiodactyls diversified into several lineages, which show more derived bunoselenodont or selenodont dentitions with differences in crown morphology and cusp pattern. Primitive members of the Oreodontoidea, the Agriochoeridae, have a bunoselenodont dentition with quadritubercular molars. Their more derived relatives, the Oreodontidae, have a completely selenodont dentition. The Anthracotheriidae show five cusped bunoselenodont upper molars with three cusps in the anterior part of the teeth. In comparison the Cainotheriidae, a European endemic group, show selenodont molars, which are also five cusped but with three cusps in the posterior part of the teeth. In these groups the fundamental differences of the chewing cycle are unresolved. Based on the *Diacodexis* study further investigations will follow concentrating on the modification of the masticatory cycle during artiodactyl evolution.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 8:45 am)

LATE CRETACEOUS (MID-CAMPANIAN) VERTEBRATES OF THE HANNAHATCHEE CREEK SITE, WESTERN GEORGIA, A NEARSHORE MARINE BONE BED AT THE ATLANTIC/GULF TRANSITION

SCHWIMMER, David R., Columbus State University, Columbus, GA, United States

During the Late Cretaceous, absent the Florida Peninsula, the Atlantic and Gulf of Mexico coastlines met in western Georgia. Campanian fossiliferous marine strata is exposed in westernmost Georgia along 2.0 km of Hannahatchee Creek, Stewart County. A 1.0 m bone-and-shell lag deposit yields fossils of at least 40 vertebrate taxa, including 29 different fish: sharks, chimaeras and osteichthyes, mosasaurs, plesiosaurs, freshwater and sea turtles, fluviatile and estuarine crocodylians, five dinosaur taxa, and fragments of pterosaur wing. This deposit comprises the stratigraphic boundary between the Blufftown and Cusseta Formations and is dated to the mid-Campanian (Zone of *Exogyra erraticostata*), also bracketed by nanno- and microfossils to 77.5 +/- .05 Myr. The concentrated vertebrate material is commonly ablated, implying that it is reworked from the underlying unit and transported to the starved marine shelf from offshore concentrates: however, some vertebrate remains are relatively complete and appear to be deposited in situ.

The admixture of fossils at Hannahatchee Creek indicates accumulation in a perimarine, distal estuarine environment. The presence of mostly marine taxa and relatively rare terrestrial fauna indicates deposition in near-normal marine salinity. However, the presence of significant non-marine taxa indicates proximity to shorelines or significant fluvial input. Non-marine fauna include an abundance of the gigantic estuarine crocodylian *Deinosuchus rugosus*, as well as other crocodylians, freshwater turtles, riverine/estuarine fish (including gar and sturgeon), and the obviously terrestrial dinosaurs. Additional indicators of proximity to the paleo-shoreline include *Teredo*-bored, coalified wood, and storm-runoff beds below

the lag deposit. Nevertheless, the common clams, snails, ammonites, sharks, and marine osteichthyes (e.g. *Xiphactinus vetus*, *Anomoeodus phaseolus, Protosphyraena* sp., *Enchodus petrosus*) in the assemblage indicate normal marine environments. In contrast to most Atlantic Coastal Plain Cretaceous deposits, the dinosaur assemblage is relatively sparse and no mammal teeth have been found to date, which may reflect a relatively deeper water environment than more northerly sites, or a lack of time and depth of study. However, the site has provided some correlations between Gulf/Western Interior and Atlantic biota, and is the type area for the sclerorhynchid sawfish *Borodinopristis*. It has also provided the fossils indicating *Xiphactinus vetus* as a distinct species, and the North American occurrence of the African fishes *Squalicorax yangaensis* and *Phacodus punctatus*.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

LATE PLEISTOCENE *EQUUS* AND *BISON* FROM THE TULE SPRINGS LOCAL FAUNA, UPPER LAS VEGAS WASH, CLARK COUNTY, NEVADA

SCOTT, Eric, San Bernardino County Museum, Redlands, CA, United States; SPRINGER, Kathleen, San Bernardino County Museum, Redlands, CA, United States; MANKER, Craig R., San Bernardino County Museum, Redlands, CA, United States

Late Pleistocene ground water discharge deposits in the Upper Las Vegas Wash outside of Las Vegas, Nevada have yielded an abundant and diverse vertebrate fossil assemblage, named the Tule Springs local fauna. The San Bernardino County Museum has documented over 500 discrete localities from the Las Vegas Formation in this region. Stratigraphically ascending units A-E from this formation span as much as the last 225 Ka; most of these units have yielded fossils. The recovered fauna includes relatively common remains of extinct *Equus* and *Bison*.

Fossils of *Equus* are well represented in the megafaunal sample; however, the material is not sufficiently complete to enable confident species assignments. Nevertheless, based upon body size as inferred from measurements of postcranial elements, three species of horse can be discerned in the fauna. Large and small stout-limbed forms are clearly present, while some fossils suggest the additional presence of a small stilt-legged species. This latter assessment is buttressed by the occurrence of late Pleistocene small stilt-legged horses from the geographically proximate Gypsum Cave locality just outside of Las Vegas. The presence of three species of horse in the Las Vegas region at the end of the Pleistocene differs markedly from the present-day global distribution of equid species, where generally only one equid species occurs in a geographic region at any one time. Further, the presence of three equid species in the Tule Springs local fauna contrasts with recent molecular studies suggesting that only two horse lineages may have been present in late Pleistocene North America. The discrepancy may be traced to the limited sample size of the available genetic data.

The Tule Springs local fauna also contains the oldest and youngest reliably dated occurrences of *Bison* in the Mojave Desert and the southern Great Basin. Fossils of a long-horned form similar to *Bison latifrons*, as well as a smaller form in the size range of *B. antiquus*, are interpreted to derive from unit B_2 of the formation, which dates to ~47 Ka. Fossils assigned to *B. antiquus* are also known from unit E of the Las Vegas Formation, directly associated with a radiocarbon date of 14.78 Ka. These records effectively delimit the Rancholabrean North American Land Mammal Age in this critical region of the American southwest.

Previous studies proposed that remains of small horses were only present in the latest Pleistocene unit E_1 of the Las Vegas Formation, while fossils of bison were confined to the older unit B_2. Our findings confirm neither of these interpretations, as newly-discovered fossils reveal that both small horses and bison occur throughout most of the exposed sequence. In fact, the presence and relative abundance of *Bison* in the youngest sediments is consistent with the record of this genus throughout the Mojave Desert and the American southwest, although this distribution differs markedly from conclusions reached by molecular studies suggesting a sharp decline in the abundance of North American bison after 25 Ka. Here, too, the disagreement may result from the somewhat limited genetic material available from late Pleistocene *Bison* in the American southwest.

Technical Session XVIII (Saturday, October 20, 1:45 pm)

STABLE ISOTOPE ECOLOGY OF EARLY PALEOCENE (PUERCAN AND TORREJONIAN) MAMMALS FROM THE SAN JUAN BASIN, NEW MEXICO

SECORD, Ross, University of Nebraska, Lincoln, NE, United States; WILLIAMSON, Thomas E., New Mexico Museum of Natural History & Science, Albuquerque, NM, United States; WEIL, Anne, Oklahoma State University Center for Health Sciences, Tulsa, OK, United States

Stable isotopes in mammalian tooth enamel can be used to infer ancient ecologies and environments. In habitats dominated by C_3 vegetation, carbon isotopes in enamel can be used to recognize habitat partitioning among mammals, while oxygen isotopes can be used to recognize semiaquatic species. Here we analyze the stable isotope ecology of Puercan (Pu2 and Pu3 biozones) and late Torrejonian (To6 biozone) faunas from the San Juan Basin. These are the oldest mammalian faunas ever studied isotopically.

We sampled teeth of three Puercan mammals: *Taeniolabis* (Taeniolabidoidea, Multituberculata), and *Carsioptychus* and *Ectoconus* (Periptychidae, "Condylarthra"), and four Torrejonian mammals: *Pantolambda* (Pantodonta), *Psittacotherium* (Taeniodonta), *Tetraclaenodon* (Phenacodontidae, "Condylarthra"), and *Periptychus* (Periptychidae, "Condylarthra"). These are the largest common mammals in these faunas; all were medium-sized except *Pantolambda* (~160 kg). The periptychids appear to have been hard-object feeders (nuts, fruits, seeds), while *Tetraclaenodon* was omnivorous, and *Taeniolabis* and *Pantolambda* may have been folivorous. In the Puercan, *Carsioptychus* and *Ectoconus* have high mean carbon values (~-12‰), relative to very low values in *Taeniolabis* (-15.1‰). When the post-industrial decrease of ~1.5‰ in atmospheric carbon values is considered, values this low in most therian mammals today would be indicative of feeding in a densely vegetated, wet microhabitat. However, *Taeniolabis* belonged to an extinct group of non-therian, mostly Mesozoic mammals and its low carbon isotope values could be indicative of a lower diet-to-enamel enrichment factor, reflecting a different physiology. Semi-aquatic mammals are also expected to have low carbon values, but median oxygen values in *Taeniolabis* are not consistent with it being semiaquatic. In the Torrejonian, *Periptychus* has the highest mean carbon values (-11.3‰) followed by *Tetraclaenodon* (-12.0‰), *Psittacotherium* (-13.6‰), and *Pantolambda* (-14.6‰). *Pantolambda* is isotopically well separated from the first two taxa and one individual is an outlier with an extremely negative value (-16.8‰). This outlier does not appear to be the result of diagenesis, based on comparison of five dentin-enamel samples that show increased carbon values with diagenesis. The low carbon values in *Pantolambda* suggest that it inhabited a dense, possibly canopied, part of the forest where water was readily available to plants, such as in or near rivers. However, oxygen values in *Pantolambda* are not consistent with it being semi-aquatic. *Psittacotherium* has the lowest mean oxygen values in the fauna, which is consistent with a diet of tubers or stems, as suggested by anatomical studies.

Technical Session XVI (Saturday, October 20, 8:30 am)

ELUCIDATING PALEODIETARY TRENDS IN NORTH AMERICAN HORSES FROM *HYRACOTHERIUM* TO *EQUUS* USING TOOTH WEAR ANALYSES

SEMPREBON, Gina M., Bay Path College, Longmeadow, MA, United States; SOLOUNIAS, Nikos, New York College of Osteopathic Medicine, Old Westbury, NY, United States; RIVALS, Florent, Institut Català de Paleoecologia Humana i Evolució Social (IPHES), Tarragona, Spain; HULBERT Jr., Richard C., Florida Museum of Natural History, Gainesville, FL, United States

Paleodietary trends for North American horses, starting with *Hyracotherium*, (early Eocene) and ending with *Equus* (late Pleistocene) were examined using tooth wear analyses. Over 1500 fossil specimens were analyzed for enamel stereomicrowear (single observer) and results compared to published mesowear results for fossil horses and to microwear and mesowear trends in extant zebra and other extant ungulates studied here. This study tests the hypothesis that Eocene horses browsed on low abrasion foods whereas Oligocene and later horses switched to more abrasive diets concomitant with the spread of more open habitats. Microwear results indicate that Hyracotherinae engaged mostly in fruit browsing during the Eocene concordant with their rounded cusp apices and slightly abrasive mesowear scores. Oligocene Anchitherinae have microwear scratch numbers typical of grazing and mixed feeding ungulates but very fine scratch textures which are unusual in modern C4 grazers. Mesowear of these Oligocene taxa indicates low abrasion, which gives credence to the fact that the type of grazing revealed through microwear may reflect a different type of grass consumption than typical in grasslands today. In the early Miocene, there is an increase in dietary abrasion among brachydont Anchitherinae that are primarily engaged in browsing and mixed feeding. The Equinae apparently consumed moderately abrasive diets when they first appeared in the early Miocene and throughout the middle Miocene. Microwear results are concordant with published mesowear trends through time regarding relative abrasion but also show that in the middle Miocene, Equinae engaged in a wide variety of dietary behaviors, including some forms showing microwear consistent with browsing with a hypsodont tooth. This trend toward a wider variety in dietary behavior in hypsodont Equinae continued throughout the late Miocene and into the Pliocene but overall abrasion increased through time. Even so, many hypsodont Pleistocene horses studied have results atypical of pure grazers - a pattern also observed in many Pleistocene European taxa.

Technical Session VII (Thursday, October 18, 1:45 pm)

PHENOSCAPE: A NEW ANATOMICAL ONTOLOGY OF VERTEBRATES

SERENO, Paul C., University of Chicago, Chicago, IL, United States; IBRAHIM, Nizar, University of Chicago, Chicago, IL, United States; MABEE, Paula M., University of South Dakota, Vermillion, SD, United States; VISION, Todd J., University of North Carolina, Chapel Hill, NC, United States; LAPP, Hilmar, National Evolutionary Synthesis Center, Durham, NC, United States

A recent explosion of anatomical, genetic and taxonomic information on vertebrates has led to major efforts to organize this data in ontologies and to make observable descriptions of phenotypes machine readable using semantic similarity tools. This has culminated in a large scale, multimillion-dollar project, with the aim of creating an online, definition enabled, image linked and reference hyperlinked database – called Phenoscape. This multidisciplinary National Science Foundation project involves workers from the fields of bioinformatics, comparative anatomy and model organism research and pushes the boundaries of Anatomical Ontologies in three major areas. Firstly, it will allow users to search and compare phylogenetic and anatomical data, thus making divergent and inconsistent morphological data from character matrices testable and comparable. This is achieved by turning free text data and descriptions into machine-readable statements that can be queried and compared. Secondly, using data from model organisms (zebrafish, frog, mouse), Phenoscape connects genomic and morphological data, opening avenues for research on the underlying causes of major anatomical transitions in the fossil record. At its current stage, the Phenoscape project focuses on the fin-limb transition and the Anatomy Ontology mostly contains fish, amphibian

and archosaur data. The genetic, developmental and anatomical data underlying the fin-limb transition are being assembled to test homology statements and candidate gene predictions. Finally, because all terms and definitions are expert vetted and continuously refined, the Phenoscape Vertebrate Anatomy Ontology (VAO) and Vertebrate Taxonomy Ontology (VTO) will also provide a detailed and accessible atlas of morphological and taxonomic terms for students and scholars alike, through a website interface.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW FOSSIL BIRD FROM THE UPPER EOCENE GREEN RIVER FORMATION OF WYOMING

SEYMOUR, Kevin L., Royal Ontario Museum, Toronto, ON, Canada; HINIC-FRLOG, Sanja, Carleton University, Ottawa, ON, Canada; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

The late Eocene (55-48 Ma) fossil deposits of the Green River Formation have produced tens of thousands of complete fossil fishes but very few other vertebrates. We report here on the phylogenetic affinities of a virtually complete skeleton of a new and as yet unnamed fossil bird (Royal Ontario Museum [ROM] 52665) from these deposits. We scored anatomical character states for ROM 52665 based on recently published phylogenetic matrices of stem parrots. Parsimony ratchet analysis based on 29 taxa and 105 characters recovered five most parsimonious trees with 243 steps in support of currently established clades of stem and crown parrots. Based on a strict consensus tree, ROM 52665 clusters within the stem parrot family Halcyornithidae. The placement of this new avian specimen from Wyoming within Halcyornithidae is supported by at least two shared characteristics: relatively elongate and curved humerus shaft and absence of the completely enclosed canalis interosseus distalis of the tarsometatarsus. The position of the new specimen remains unresolved within the family, however, thus it is equally closely related to *Pulchrapollia*, *Pseudasturides*, *Serudaptus*, and *Cyrillavis*. ROM 52665 and *Pseudasturides* are both characterized by a rostrum of approximately one-third of the skull length, while the new ROM specimen shares a cup-shaped cotyla scapularis of the coracoid with *Cyrillavis*. In addition to similarities in relative wing and leg proportions with *Pseudasturides* and *Pulchrapollia*, ROM 52665 also shows the presence of both medial and lateral foramina vascularia proximalia on the tarsometatarsus. *Cyrilavis, Serudaptus* and ROM 52665 have relatively long pedal unguals in common. In addition to shared features with members of the Halcyornithidae, ROM 52665 exhibits the following unique characteristics within the clade: lack of projection of processus supraorbitalis above the orbit and wide separation of temporal fossa on the dorsal surface of the skull. These characters are currently unknown in some members of the Halcyornithidae. Only when more material is found for the previously known genera, especially *Pulchrapollia,* will the relationships within the family be potentially resolvable. Although the relationships within Halcyornithidae remain poorly resolved, this new bird from the Green River Formation provides more resolution for previously unknown characters within the family, such as the number of cervical vertebrae.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PECCARIES (MAMMALIA, ARTIODACTYLA, TAYAUSSIDAE) FROM THE MIOCENE-PLIOCENE PIPE CREEK SINKHOLE LOCAL FAUNA, INDIANA

SHEETS, Hope A., Trine University, Angola, IN, United States; PROTHERO, Donald R., Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County, Los Angeles, CA, United States

The Pipe Creek Sinkhole local fauna from near Swayzee, Grant County, Indiana, yields an interesting mixture of both plant and animal fossils, including previously unidentified peccaries. The fossil mammals suggest either a latest Hemphillian (latest Miocene-Pliocene) or earliest Blancan (earliest Pliocene) age for the assemblage. The peccaries can be assigned to two taxa: *Catagonus brachydontus*, a large species with brachydont, bunodont cheek teeth, found in the latest Miocene of Mexico, Florida, and Oklahoma, which is related to the living Chacoan peccary *C. wagneri*. The second peccary is *Platygonus polleni*, a newly described latest Miocene taxon. It is the smallest and most primitive species known from the lineage of flat-headed peccaries (*Platygonus compressus*) common in the Pleistocene. Both of these species are unknown from the early Blancan, and support (along with the rhinos and other taxa) a latest Hemphillian age for the fauna.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DENTITION OF LATE CRETACEOUS SHARK, *PTYCHODUS MORTONI* (ELASMOBRANCHII: PTYCHODONTIDAE)

SHIMADA, Kenshu, DePaul University, Chicago, IL, United States

Ptychodus (Elasmobranchii: Ptychodontidae) is an enigmatic durophagous shark that lived in Cretaceous seas. Based on multiple articulated tooth plates of *Ptychodus mortoni* Agassiz from the Smoky Hill Chalk Member of the Niobrara Chalk in western Kansas, USA, the dental pattern of *P. mortoni* and its paleobiological implications were examined. Each tooth plate consists of one medial tooth row and about nine lateral tooth rows on each side. One individual shark possesses a total of slightly over 550 teeth with approximately 220 functional upper teeth and 260 functional lower teeth. The largest tooth plate of the species possibly measured about 55 cm in length and 45 cm in width. Although this study does not resolve the ordinal placement of Ptychodontidae, it demonstrates that there are two different patterns of tooth plate organization in *Ptychodus*: a plesiomorphic condition characterized by juxtaposed, non-overlapping tooth rows (e.g., *P. decurrens*, *P. marginalis*, and *P. occidentalis*) and an apomorphic condition characterized by imbricated tooth rows (e.g., *P. mortoni*). It is hypothesized that the imbrications of tooth rows in *P. mortoni* likely helped distributing the bite-induced load on its dentition more widely where its sharp-tipped crowns were effective in shattering animals with comparably thin, brittle shells (e.g., bivalves and crustaceans). The recognized difference in tooth plate organization adds another level of complexity to the dental evolution of *Ptychodus* as well as to the already complex evolutionary history of predatory behaviors in cartilaginous fishes.

Technical Session XIX (Saturday, October 20, 1:45 pm)

THE EVOLUTION OF BODY MASS DISTRIBUTION AND DIVERSIFICATION WITHIN EQUIDAE

SHOEMAKER, Lauren G., Univeristy of Colorado, Boulder, Boulder, CO, United States; CLAUSET, Aaron, University of Colorado, Boulder, Boulder, CO, United States

Within large taxonomic groups, extant species often exhibit a broad and right-skewed body mass distribution. This pattern can be explained as the result of macroevolutionary "diffusion" between a minimum physiological size and extinction risks that increase with size. This explanation has previously been shown to accurately predict the extant distribution of mammal sizes as well as their size diversification over the past 80 million years. However, it remains unknown if this explanation can also explain species size dynamics within subclades. We investigate this question using a novel database of fossil species body sizes over the past 56 million years within well-studied Equidae. Importantly, Equidae exhibits a dramatic increase in both maximum size and taxonomic diversity during the Miocene, and we test whether these patterns can be explained by the constrained diffusion hypothesis. Using a time-dependent solution of the constrained convection-diffusion-reaction model, we show that the Equidae exhibits a minimum size of 20kg and a consistent expansion away from this boundary in the form predicted by the model. This strong agreement between theory and data supports the hypothesis of universal macroevolutionary dynamics for terrestrial mammal sizes. However, unlike the stable lower limit of 2g observed for terrestrial mammals in general, the lower limit for Equidae appears to have increased over the past 20 million years, perhaps due to certain ecological or climatic effects. Furthermore, we estimate that only 60% of the 10-fold increase in the sizes of the largest horses during the early Miocene can be attributed to the simultaneous 5-fold increase in taxonomic diversity, while variations in taxonomic diversity track global temperatures. This difference suggests that morphological disparity and species diversity were only partly coupled during this period, and that weak but pervasive ecological effects may explain the remaining increase. Finally, a decline of equid diversity in the late Miocene appears concentrated among the smallest species, in contrast to the typical extinction pattern where large species disappear first, again suggesting large-scale competitive effects or ecological turnover.

Technical Session X (Friday, October 19, 9:45 am)

A NETWORK APPROACH TO STUDYING FAUNAL PROVINCES ACROSS SOUTHERN PANGEA DURING THE PERMIAN AND TRIASSIC

SIDOR, Christian A., University of Washington, Seattle, WA, United States; VILHENA, Daril A., University of Washington, Seattle, WA, United States; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; NESBITT, Sterling J., University of Washington, Seattle, WA, United States; PEECOOK, Brandon R., University of Washington, Seattle, WA, United States

Mass extinctions have the potential to reshape the composition and ecological structure of communities on a scale unparalleled by background extinction. For decades, the effects of the Permo-Triassic extinction on terrestrial ecosystems have been studied in the Karoo Basin of South Africa. However, the Karoo's utility as a model system likely diminishes by the Middle Triassic, when distinct assemblages are evident in other Gondwanan basins. To examine this critical transition across a broad geographic region, we apply network methods to visualize pre- and post-extinction faunas. We collected presence/absence data for 65 Permian species and 68 Middle Triassic species in four basins: 1) Karoo Basin of South Africa, 2) Luangwa Basin of Zambia, 3) Ruhuhu Basin of Tanzania, and 4) Beacon Basin of Antarctica (although the latter lacks Permian tetrapods). Taxon identifications from the literature were extensively updated by over a decade of recent fieldwork and extensive studies of historic collections. From these basin-level faunal lists, we generated a network from the co-occurrences between species. In contrast to traditional measures of faunal similarity, a network representation of co-occurrences increases the signal extractable from assemblage data by incorporating the higher order connections between pairs of taxa. We used community detection algorithms from network science to find densely connected subcomponents in the network before and after the end-Permian mass extinction event. A densely connected subcomponent, or network module, is a collection of taxa that are more internally connected to one another than to the rest of the network. We found a transition from a spatially homogeneous co-occurrence network in the Permian to a network with modular spatial organization in the Middle Triassic. To visualize these differences, we used a force-directed layout algorithm to embed the taxa in Euclidean space. These visualizations provide an intuitive way to identify the emergence of provincial spatial organization. These results suggest that pre- and post-extinction faunas differ significantly and that a single, broadly distributed faunal structure characteristic of the Late Permian (~255 Ma) was replaced by multiple faunal provinces by Anisian times (early Middle Triassic; ~242 Ma). The establishment of divergent assemblages within the same basins that had previously hosted a broadly similar pre-extinction community highlights the role of mass extinctions in checking the effects of evolutionary incumbency.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

CRANIAL ANATOMY OF PALEOGENE MICROSYOPIDAE (MAMMALIA, EUARCHONTA) AND ITS RELEVANCE TO UNDERSTANDING EUARCHONTAN RELATIONSHIPS

SILCOX, Mary T., University of Toronto, Scarborough, Toronto, ON, Canada; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; GUNNELL, Gregg F., Duke Lemur Center, Durham, NC, United States

The Microsyopidae are extinct mammals from the late Paleocene-middle Eocene of North America and the late Paleocene of Europe usually included in the "Plesiadapiformes." While results from several recent phylogenetic analyses suggest affinities among stem primates, specific relationships relative to the most primitive members of primates are unresolved. Two undescribed specimens clarify previous interpretations of the cranial anatomy and allow for a re-consideration of the relationships of the family. The specimens are from the middle Eocene and include a nearly complete cranium of *Microsyops annectens* (UW 12362; previously mentioned but never described; the best preserved for the family, and for any "plesiadapiform") from Wyoming and a more fragmentary specimen of *Microsyops kratos* (SDMNH 47729) from California that preserves part of the roof of the middle ear cavity which is damaged in all other microsyopid crania, clarifying the pathway of the facial nerve. The basicranial anatomy of microsyopids is generally very primitive featuring: 1) a transpromontorial groove for an unreduced internal carotid artery (ICA) entering the middle ear posteromedially; 2) grooves for both stapedial and promontorial arteries; 3) a foramen faciale that opens into the middle ear cavity, with the facial nerve exiting the ear through a stylomastoid foramen primitivum; and 4) unexpanded caudal and rostral tympanic processes of the petrosal. There is no evidence for any development of an osseous bulla. The boundaries of the petrosal can be traced in UW 12362 and it clearly did not contribute significantly to the floor of the middle ear cavity, unlike that of euprimates and scandentians. The absence of any preserved bullar elements contrasts with other "plesiadapiforms" suggesting that if microsyopids are on the primate stem they might be more primitive than other taxa for which basicrania are known. Microsyopids also lack specialized features seen in scandentians (e.g., expanded entotympanic contributing to the bullar roof and floor; bony canals for the ICA and facial nerve) and dermopterans (e.g., absent ICA; inflation to the caudolateral portion of the cranium; tubular external auditory meatus; absent postglenoid foramen) although they share similarities with dermopterans in the presence of a blunt postorbital process and a large, rugose mastoid process. In sum, the basicranial anatomy of microsyopids fails to clearly link the group with any euarchontan order, and suggests that the primitive morphology of this region in Euarchonta was little differentiated from that observed in the most primitive placental mammals. The lack of clear euarchontan synapomorphies in the cranium complicates attempts to decipher relationships within Euarchontoglires and Boreoeutheria.

Technical Sesssion XII (Friday, October 19, 3:15 pm)

THE PHYLOGENETIC POSITION OF THE MESOZOIC LIZARDS OF BRAZIL AND THE DESCRIPTION OF A NEW SPECIES

SIMOES, Tiago R., Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander W., Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The phylogenetic relationship and biogeography of the Mesozoic Gondwanan lizards are some of the widest gaps in our knowledge of early squamate radiation. There are less than ten species described for Gondwana, of which four are from Brazil. Here we describe a new species (MN 7234-V) from the Early Cretaceous (Aptian/Albian) from the Crato Formation of northeast Brazil and present a phylogenetic analysis which includes this and two other taxa from the same strata: *Tijubina pontei* and *Olindalacerta brasiliensis.* MN 7234-V is a small short limbed lizard which differs from *T. pontei* and *O. brasiliensis* by short anterior and posterior limbs which are subequal in length, extremely robust and straight pterygoids, a posterodistally highly angulated (sickle shaped) clavicle and a parietal with concave lateral and straight posterior margins. Scoring those taxa in the largest published squamate data set indicate MN 7234-V as a scincomorph, falling out as a basal member of the clade Lacertoidea+Cordyliformes, in a sister group relationship to *Sakurasaurus* and *Ornatocephalus. O. brasiliensis* was recovered as a stem scincogekkonomorph, in a similar position as previously proposed. However it is not clear if *Olindalacerta* falls within the Scleroglossa. The phylogenetic position of *T. pontei* is more problematic since this taxon generated the colapse of most of the squamate clades, and a clear systematic positioning could not be inferred by the cladistic analysis. Despite the limitation offered by ontogenetic and preservation biases, these are among the best preserved lizard taxa known for Gondwana and demonstrate to be crucial for any phylogenetic and biogeographic analysis Gondwanan squamates. The position of MN 7234-V is only the second confident record of a scincomorph from South America and the first one for the Early Cretaceous of that continent, making this the oldest record of a Gondwanan scincomorph from outside Africa. This is evidence that scincomorphs had an older and wider geographic distribution in Gondwanan continents than previously known.

Technical Session XI (Friday, October 19, 3:30 pm)

GIANT THEROPOD EGGS FROM THE ALBIAN-CENOMANIAN WAYAN FORMATION OF IDAHO: TAXONOMIC, PALEOGEOGRAPHIC AND REPRODUCTIVE IMPLICATIONS

SIMON, D., Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; JACKSON, Frankie D., Montana State University, Bozeman, MT, United States; ROBISON, Steve, Caribou-Targhee National Forest, Idaho Falls, ID, United States

Elongatoolithid eggs, previously known only from Asia, are often associated with embryonic or adult skeletal remains of oviraptorids. These eggs are typically small, elongate, and occur in ring-shaped clutches of up to three layers. Moderate gas conductance values suggest parital burial during incubation, and associated adults are interpreted as having died while protecting or brooding the clutch. Eggs of the oogenus *Macroelongatoolithus* are unique within Elongatoolithidae due to their extreme size and elongation, and are the largest non-avian dinosaur eggs known. Eggs as long as 52 cm occur in large, single-layered circular clutches with a diameter of up to 2.1 m. Preliminary gas conductance rates and exceptional size of the eggs, circular egg arrangement, and potential egg-layer raise questions about incubation of *Macroelongatololithus* eggs.

Here we describe a pair of large eggs from the mid-Cretaceous Wayan Formation of Idaho. The eggs were excavated from mudstone and claystone with bands of small nodular development and rare thin beds of fine sandstone. Eggshell fragments were collected in additon to a pair of eggs measuring 38 cm long, 9 cm wide at the equator, with an average shell thickness of 1.8-2 mm. Ornamentation varies from dispersituberculate at the poles to lineartuberculate at the equator, with ramotuberculate in between. The mammillary layer to continuous layer ratio is 1:5, and prisms of the continuous layer show a woven appearance under cross polars. These features place the specimen firmly within *Macroelongatoolithus,* within the oofamily Elongatoolithidae. Significantly, this specimen represents the first intact elongatoolithid material known from North America and the first egg material of any kind known from the Lower Cretaceous of the continent. Gas conductance was estimated from tangential thin sections using Image J software to measure total pore area and pore length, assuming a temperature of 25°C. Preliminary gas conductance values, estimated for surface collected eggshell from Wayan locality, are lower than those previous calculated for other *Macroelongatoolithus* specimens. The Wayan eggs are paired, similar to within-clutch egg pairing seen in Chinese macroelongatololithid specimens and in smaller oviraptorid clutches. Given the strong link between elongatoolithid eggs and oviraptorids, the presence of *Macroelongatoolithus* in North America provides the first evidence for the occurrence of an extremely large oviraptorid outside of Asia and support for the Asia-North America faunal influx at an earlier date than initially presumed. Sedimentology of the Wayan material suggests the egg-layer was nesting on a floodplain, however, incubation strategies for *Macroelongatololithus* remain unclear.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

REPRESENTATION OF EXTANT MONOTREME DIVERSITY EFFECTS PHYLOGENETIC RESULTS OF EXTINCT AND CROWN-GROUP MAMMALS

SIMON, Rachel V., The University of Texas at Austin, Austin, TX, United States

Relationships among extinct mammals from the Southern Hemisphere, and the relationships of those taxa to extant monotremes, are highly contentious. One hypothesis groups all fossil mammals from the Southern Hemisphere into a monophyletic taxon, Australosphenida, of which crown monotremes are the surviving members. Another hypothesis is that fossil mammals from the Southern Hemisphere are more closely related to placental mammals, and monotremes are a distinct clade with only a few extinct relatives. This conflict is due in part to a poor fossil record where many extinct species are known only from jaw fragments and isolated molars. Another source of complication is a lack of data from extant monotremes. Phylogenetic analyses only included *Ornithorhynchus anatinus* and/or *Tachyglossus aculeatus* to represent Monotremata, excluding the most speciose living monotreme, *Zaglossus*. To test the effects of monotreme diversity in a phylogenetic analysis, a published matrix of mammalian taxa was modified so that the two monotreme genera (*O. anatinus* and *T. aculeautus*) used in the analysis were collapsed into a supraspecific taxon. Variation between the two genera was scored as polymorphism. The result split Australosphenida as polyphyletic with several australosphenidans positioned closer to therians. Additionally, resolution within Monotremata decreased when supraspecific terminals were used. Specifically, *Steropodon* and *Obdurodon* alternated positions as sister taxon to Crown Monotremata, whereas *Obdurodon* consistently is the sister taxon to *O. anatinus* in analyses using species exemplars. This test demonstrates that representation of extant monotreme diversity with species exemplars increases resolution between extinct and extant monotremes. Furthermore, these results show that clades from the published phylogeny are not supported strongly and that the amount of monotreme diversity represented in an analysis affects the topology of trees that incorporate fossil mammals.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:15 am)

MEASURING SPECIES SELECTION IN THE MOLECULAR PHYLOGENETIC RECORD

SIMPSON, Carl, Museum für Naturkunde, Berlin, Germany

Understanding historical patterns of diversity dynamics is of paramount importance for many evolutionary questions. The fossil record has long been the only source of information on patterns of diversification, but the molecular record, derived from time- calibrated phylogenies, is becoming an important additional resource. Both fossil and molecular approaches have shortcomings and biases. These have been well studied for fossil data but much less so for molecular data and empirical comparisons between approaches are lacking. I present a comparison of the patterns of diversification derived from fossil and molecular data in scleractinian reef coral species. Despite imprecise estimates of the magnitude of the molecularly derived diversification rates, the temporal patterns observed in the fossil and molecular records are highly correlated. This result permits the use of temporal patterns in molecular phylogenetic data to study macroevolutionary processes. For example, the magnitude and direction of species selection--differential diversification of species with varying characteristics--can be directly measured from the temporal patterns of diversification rates. In corals, species selection acts in opposite directions for coloniality and against photosymbiosis and overpowers cladogenetic and anagenetic changes in both traits.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

LOCOMOTOR FORCES AND STRESS IN THE METAPODIA OF ADULT OSTRICH *STRUTHIO CAMELUS* AND JUVENILE *ALBERTOSAURUS SARCOPHAGUS* (TYRANNOSAURIDAE): CORRELATING ANATOMY, DYNAMICS AND FINITE ELEMENT ANALYSIS

SISSONS, Robin, Grand Prairie Regional College, Grand Prairie, AB, Canada; GILBERT, Meagan, University of Saskatchewan, Saskatoon, SK, Canada; SNIVELY, Eric, Ohio University, Athens, OH, United States

Three-dimensional finite element analysis (FEA) is potentially informative about locomotor stresses and performance limits in extinct vertebrates. Juvenile and adult tyrannosaurid dinosaurs are intriguing candidates for such analyses, with proportionally long lower limbs indicating higher cursoriality compared to other large theropods. Context from extant relatives is critical for understanding methodological limits and applying biological interpretations of FEA to extinct forms. Fortunately, a wealth of anatomical, kinematic, and force data for extant ostriches (*Struthio camelus*) enables grounding and refinement of FEA for studies of extinct theropods. CT, FEA, and dynamics methods were integrated to compare data from *Struthio* with those for a tyrannosaurid of similar body mass, a juvenile *Albertosaurus sarcophagus* from Dry Island Provincial Park, Alberta.

Limb elements of *Struthio* and *Albertosaurus* were CT scanned, to examine densities and construct biomechanical models. The program OsiriX facilitated interpretation of internal structure and density. Mimics and Avizo enabled the construction of finite element models for analyses in Strand7. Quasi-static models, in 3D and simplified to the sagittal plane, estimated ankle extensor force necessary to counteract ground reaction force for a slow run (*Struthio*: 2453 N; *Albertosaurus*: 1515 N) at a mid-stance posture. These forces were used for FEA, with the metatarsus constrained at the ankle joint. Custom MATLAB programs independently calculated joint and ground reaction forces, and extensor tensions, through similar stance phase kinematics in both taxa.

Results reveal utility and limitations of FEA for studies of extinct taxa. Force magnitudes at the constraints were similar to the MATLAB-simulated joint reaction forces, suggesting the promise of FEA for estimating joint forces (similar to its use for bite/food reaction forces in feeding studies). Stress magnitudes varied little between sagitally-restricted and 3D force models for the metapodia. However, errors in patterns of stress distribution are likely to be greater for more proximal elements, which deviate mediolaterally from a vertical orientation more than the metatarsus. An internal remnant of fusion between metatarsals III and IV likely resists compression in the ostrich. Finally, relative to body mass, the juvenile *Albertosaurus* specimen required lower extensor tension to maintain a given ankle posture than in the ostrich, suggesting the ability to impart greater angular acceleration to its metatarsus with less energy expenditure.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:30 am)

FOSSILS, PHYLOGENIES AND MODELS OF QUANTITATIVE TRAIT EVOLUTION

SLATER, Graham J., University of California, Los Angeles, Los Angeles, CA, United States

Evolutionary biologists are increasingly interested in assessing the fit of explicit macroevolutionary models to phenotypic data. By identifying the best-fitting model of trait evolution, such as an early burst of evolution or a biased random walk, evolutionary biologists can test explicit hypotheses regarding the tempo and mode of evolution in their clade of interest. A significant barrier to implementing these methods in paleontological studies is the requirement of a resolved, time-calibrated phylogeny; as we often only have very broad ideas regarding the phylogenetic placement of fossil taxa, application of these methods is typically restricted to time-calibrated molecular phylogenies of extant taxa or phylogenies of extinct taxa with exceptional fossil records. Here, I introduce a Bayesian model fitting approach that allows for integration of information from fossil taxa that have not been placed in an explicit phylogenetic context by using their traits to define informative prior distributions on nodes in a phylogeny. Using simulated datasets, I show that incorporating informative priors on even a small number of nodes with associated fossil information can dramatically alter and improve model selection performance. I provide an empirical example by applying this approach to the case of body size evolution in caniform carnivores. Incorporating informative fossil priors on less than 10% of nodes in this dataset dramatically alters ancestral size estimates and results in identification of a trend towards increased body size through caniform phylogeny. Using fossils in this way increases statistical power to distinguish among evolutionary models while making more complete use of the historical record of the evolutionary process documented in the fossil record.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

MEASURING MICROVERTEBRATES: A CASE STUDY USING A RARE RECORD OF A HYBODONT SHARK FROM THE UPPER TRIASSIC OF NORTH CAROLINA

SLOAD, Eric J., Appalachian State University, Boone, NC, United States; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States; SCHNEIDER, Vincent P., North Carolina Museum of Natural Sciences, Raleigh, NC, United States

Imaging and measuring fossils has long been one of the most cost- and time-consuming tasks in microvertebrate study. Through the use of a digital three-dimensional microscope, we have successfully imaged and measured a set of 34 minute hybodont shark teeth recovered from Triassic age deposits of the Newark Supergroup of North Carolina. The locality is in the Durham sub-basin of the Deep River Basin, and the fossiliferous strata are identified as “Lithofacies association II.” These teeth range in size from approximately 450 to 1000 microns along the crest, and therefore pose a challenge to measure and image accurately. Each tooth was captured in occlusal and labial view at 200 x magnification, and four measurements using on-board software were taken from each; crown length, crown height, width, and the length of the labial peg, with an average time to capture of 13 minutes per tooth. Shape values were calculated with these data, with a mean crown length to width ratio of 2.25, and mean crown length to height ratio of 2.23. With this model of a three dimensional digital microscope, measurements are taken with on-board software, with no need for manual calibration or exporting images to third party measurement programs. This study was undertaken to exemplify the usefulness of digital microscopy, as well as to give needed quantitative data to the study of small hybodont shark teeth. Values gathered from this study were compared to values measured from literature figures in an attempt to resolve the currently debated classification scheme of Lonchidiidae. Teeth analyzed here, as a whole, match most closely with teeth from the mesial portion of the jaw (based on published reconstructions of *Lissodus nodosus*), with crown length to width ratios of 2.25-2.59. These teeth are characterized by their somewhat gracile shape, lack of ornamentation, strongly developed labial pegs, and often angled principal crests. Although the shape data match closely with known specimens from *Lissodus*, many teeth analyzed here are much too diminutive to fit into the accepted size range of *Lissodus*. Therefore, it seems that many of these teeth belong to *Lonchidion*, which some recognize as a genus distinct from *Lissodus*. Regardless of assignment to *Lissodus* or *Lonchidion*, they most closely resemble *L humblei*, a hybodont known from Upper Triassic strata in Texas and New Mexico.

Technical Session XVI (Saturday, October 20, 12:00 pm)

STABLE OXYGEN AND CARBON ISOTOPES RECORD SEASONAL VARIATION IN DRINKING WATER AND DIET OF MODERN LARGE HERBIVORES IN AMBOSELI NATIONAL PARK, KENYA

SMILEY, Tara M., University of Michigan, Ann Arbor, MI, United States; BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States; BEHRENSMEYER, Anna K., National Museum of Natural History, Washington, D.C., DC, United States

Mammals living in seasonal habitats experience changes in environmental variables such as temperature, rainfall, and primary productivity; these changes influence mammalian feeding ecology, social behavior and timing of reproduction. Over evolutionary time, seasonal environmental variation can influence natural selection on mammalian life histories. Incremental deposition of tooth enamel records the seasonal variation in isotopic composition of water and diet ingested by mammals over time; hypsodont teeth of herbivores can record an entire year. Intra-tooth sampling along the growth axis of teeth thus tracks seasonal changes in the isotopic composition of drinking water as well as seasonal variation in diet due to vegetation availability or water stress.

From a large sample of adult molars collected between 1975 and 2010, we evaluated the seasonal isotopic record of enamel in zebra and wildebeest from Amboseli National Park in Kenya, a semi-arid, seasonal savanna ecosystem. During the time of year inferred as the rainy season, the enamel record reflects the seasonal precipitation signal, becoming gradually depleted in ^{18}O as the season progresses due to the amount effect. Conversely, the dry season is represented in enamel by increasing $\delta^{18}O$ values through time. Seasonal variation in $\delta^{18}O$ is on average 2.1 per mil (n=10 individual teeth), which is characteristic of equatorial regions dominated by seasonality of rainfall rather than temperature. However, $\delta^{18}O$ values of enamel are higher than in meteoric waters from eastern Africa in general, indicating that zebra and wildebeest in Amboseli are drinking from water sources influenced by evaporation. The average bulk oxygen isotopic composition of wildebeest enamel (32.42 per mil) is significantly higher than zebra enamel (30.64 per mil). There is no significant difference between the $\delta^{13}C$ values of wildebeest and zebra, 1.28 per mil and -0.04 per mil, respectively. Carbon isotopic composition of enamel in both zebra and wildebeest signify

a nearly exclusive C_4 diet, with low seasonal variation (1 per mil). $\delta^{13}C$ values change inversely with $\delta^{18}O$ values over the annual cycle for all individuals sampled. Decreasing carbon isotopic composition of tooth enamel could indicate a shift in dietary content from the wet to the dry season or a seasonal shift in $\delta^{13}C$ values of the C_4 vegetation itself. Stable isotope studies on modern species provide fundamental insights for reconstructing the ecology of extinct mammals and discovering the influence of seasonal changes on Cenozoic mammalian lineages and faunas.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW RHOMALEOSAURID PLIOSAUR FROM THE SINEMURIAN (LOWER JURASSIC) OF LYME REGIS, ENGLAND

SMITH, Adam S., British Geological Survey, Nottingham, United Kingdom; ARAÚJO, Ricardo, Southern Methodist University, Dallas, TX, United States

An excellently preserved partial skeleton of a rhomaleosaurid pliosaur (Sauropterygia: Plesiosauria) from the Sinemurian (Lower Jurassic) of Lyme Regis, England, consists of a complete cranium, mandible, and articulated cervical vertebral column. The material is taxonomically distinct and its occurrence is noteworthy because pliosauroids are rare from this stratigraphic horizon. The new taxon is diagnosed by a single autapomorphy: a pronounced pit on the posterior margin of the dorsal ramus of the squamosal. It also possesses the following unique combination of characters: premaxillary rostrum short (length and width subequal), five teeth in the premaxilla, premaxilla-maxilla sutures parallel anterior to the external nares, frontals contact on the midline, prefrontal-frontal suture convex and gently curved medially, mandibular symphyseal region spatulate and short (length and width subequal), robust rod-like axis neural spine with a circular transverse cross section, and cervical neural spines with a laterally expanded apex. The taxon shares some characters with older (Hettangian) rhomaleosaurids (e.g. *'Rhomaleosaurus' megacephalus*), and other characters with younger (Toarcian) rhomaleosaurids (e.g. *Rhomaleosaurus sensu stricto* and *Meyerasaurus*), and it is therefore morphologically and proportionally intermediate between these two groups.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A RECONSIDERATION OF THE STATUS OF THE UPPER JURASSIC PTERODACTYLOID PTEROSAUR *MESADACTYLUS ORNITHOSPHYOS* FROM THE MORRISON FORMATION OF COLORADO

SMITH, David K., Northland Pioneer College, Show Low, AZ, United States; HARRIS, Jerry D., Dixie State College, Saint George, UT, United States

Pterosaurian fossils from the Upper Jurassic Morrison Formation remain fragmentary and poorly known. In the 1980s, a small synsacrum from Dry Mesa Dinosaur Quarry, Mesa County, Colorado, was proposed as the holotype for the new pterodactyloid pterosaur species *Mesadactylus ornithosphyos*. A number of disarticulated cranial and postcranial elements subsequently have been referred to the same taxon.

Although the referred postcranial material is certainly pterodactyloid, the synsacrum would constitute an extremely unusual element for a pterosaur. It consists of a series of fused sacral vertebrae with prominent, distally fused neural spines that dramatically decrease in height posteriorly. The vertebrae also become minute posteriorly, indicating that this animal could not have had an extensive or large tail. Micro-CT scans failed to recover any evidence of internal structure or pneumaticity.

The holotype synsacrum has been extensively figured, a detailed description is lacking. It was initially identified as avian; it has also been informally suggested to be derived from a bird, a small dromaeosaurid theropod, or an anurognathid or dsungaripteroid pterosaur. We provide a detailed description of the synsacrum and discuss the various hypotheses concerning its affinity. Finally, phylogenetic analysis including *Mesadactylus* is undertaken, making use of the available material and assuming that it is all derived from the same taxon.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

DENTAL WEAR AND LAMELLAR FREQUENCY ANALYSIS TO CONSTRAIN THE IDENTITY OF THE NORTH AMERICAN MAMMOTH SPECIES

SMITH, Gregory J., Penn State University, University Park, PA, United States; GRAHAM, Russell, Penn State University, University Park, PA, United States

A mammoth skeleton found at the Newton Site, a kettle lake 15 km southeast of Towanda, Pennsylvania, has been referred to *M. columbi* on the basis of its high, narrow skull. However, the specimen's thin enamel (1.5 mm) and moderately high lamellar frequency (9 plates/decimeter) resemble some specimens of *M. primigenius*, as well. Maps from the Neotoma database show that a Columbian mammoth inhabiting the Towanda area would be a significant outlier from the general geographic range (western US and Gulf Coast area from Florida to Texas) for this species. This record would suggest that *M. columbi* inhabited a broader range of environments than previously presumed. However, if the specimen was in reality *M. primigenius*, its location, 50 km north of the Olean drift border, would align well with the Woolly mammoth's range.

To better ascertain the Newton mammoth's identification, we examine herein the effects of dental wear on the morphology of mammoth teeth, especially enamel thickness and lamellar frequency. Sagittal sections of mammoth teeth reveal the tendency for enamel lophs to become more broadly spaced and enamel ridges to thicken towards the base of the crown. Thus, an older *M. primigenius* with extensively worn molars might display thicker enamel and a lower lamellar frequency, and might therefore appear to be a Columbian mammoth on the basis of dental morphology alone. Here, we conduct an analysis of numerous *M. columbi* and *M. primigenius* molars at various stages of dental wear to determine if this phenomenon has played a role in determining the species identification of the Newton mammoth.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PROBLEMATIC IDENTIFICATION OF PROBOSCIDEANS AT THE MIDDLE PLEISTOCENE PALEONTOLOGICAL/ARCHAEOLOGICAL LOCALITY OF ELANDSFONTEIN (WESTERN CAPE PROVINCE, SOUTH AFRICA)

SMITH, Kathlyn M., Georgia Southern University, Statesboro, GA, United States; STYNDER, Deano D., University of Cape Town, Cape Town, South Africa

Three proboscidean species inhabited Africa in the middle Pleistocene: *Loxodonta atlantica*, *Loxodonta africana*, and *Elephas recki*. *L. africana* can easily be distinguished from *L. atlantica* and *E. recki* by the broad, lozenge-shaped wear surfaces of its molars. *L. atlantica* and *E. recki* are more difficult to distinguish on the basis of molar characteristics. These two species rarely co-occur in the African fossil record, with *L. atlantica* in northern and southern Africa and *E. recki* in eastern equatorial Africa. Consequently, taxonomic assignment of isolated molars from these species may have been based, in some cases, on geography rather than morphology. Elandsfontein (EFT), a middle Pleistocene locality on the west coast of South Africa, has produced hundreds of skeletal elements referred to *L. atlantica*. Among these are 15 complete or nearly complete permanent molars, one of which is newly recovered and has not yet been referred to a species. The last taxonomic revision of EFT proboscidean material was done in the 1970s, and additional material has been recovered since then, so an updated assessment could yield new insights into the biogeography and evolutionary history of middle Pleistocene African elephants. With this goal in mind, standard molar characteristics (crown height, width, length, enamel thickness, lamellar frequency, number of enamel plates, and hypsodonty index) were recorded for EFT molars, and characteristics of M3s (n=5) were evaluated against diagnostic characteristics for *L. atlantica* and *E. recki*. EFT molars were in general more similar to *L. atlantica* than to *E. recki*, but they exhibited features of both species and could not definitively be assigned to one. Principal components analysis (PCA) was conducted to compare EFT M3s to those of *E. recki* and *L. atlantica* described in the literature. Variables used in the PCA were those not substantially affected by tooth incompleteness: height, width, enamel thickness, and average lamellar thickness (a measurable reflection of lamellar frequency). The first principal component sorted individuals by species and showed that the newly recovered M3 was more similar to *L. atlantica* than to *E. recki*, but species assessment based on PCA was unreliable because the distinction between species was unclear on the first or any axis. Qualitative criteria may be more useful for identifying species based on molars; for example, *E. recki* exhibits irregular enamel folding, usually not present on *L. atlantica* and not present on EFT molars. Overall, there is little reason to revise taxonomic assignment of EFT specimens or to refer the new molar to *E. recki*. However, if not for geographic differences and based on molar criteria, *E. recki* and *L. atlantica* might be described as members of the same genus.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

REGIONAL PATTERNS OF MODERN SYMPATRY IN NORTH AMERICAN QUATERNARY MAMMAL FAUNAS

SMITH, Michael R., Indiana University, Bloomington, IN, United States; POLLY, David, Indiana University, Bloomington, IN, United States

The temporal and regional responses of past faunas to Quaternary climate cycles provide important insights for how biotas respond to changing climates and environments. We used cluster analyses, digital range data for modern mammals, and digital climate data to determine whether faunal similarity from 27 Quaternary sites in North America was affected by site age, past climate, or biogeographic region.

Cluster analysis using the Raup-Crick index was used to categorize sites based on the similarity of their mammalian faunas. Areas of maximum modern sympatry for the extant species at each site were quantitatively identified using the modern geographic. Areas of sympatry were found by counting the number of modern species shared at each 50 km grid point in North America. The climate associated with the areas of maximum sympatry were located using the digital climate data for North America (1960-1990 average). Rectilinear climate envelopes were constructed for the points with maximum sympatry using the minimum and maximum values for MAT and total annual precipitation from those points.

Faunas clustered into four groups, which separate first on regional basis and secondarily on a climatic basis. The first cluster contained sites whose extant species were largely sympatric in the area of the site, the second cluster contained sites whose extant species are today sympatric in the northeast Appalachians or north of the Great Lakes, the third cluster with a mixture of species that are today sympatric in the great plains or greater midwest, and the fourth with species that are today sympatric in the inter-montane west. The extant component of the faunas were highly predictive of this pattern despite the wide variety of ages, paleoclimates, and proportions of extinct fauna at the sites. Local climate and/or other geographical range controllers were mixed in these continental scale patterns indicating a need for understanding faunal dynamics on a regional scale.

Technical Session XVII (Saturday, October 20, 3:30 pm)

VARIATION IN THE ENDOCRANIAL ANATOMY OF THE CHARADRIIFORMES (AVES): SENSORY SYSTEM EVOLUTION ASSOCIATED WITH THE TRANSITION TO WING-PROPELLED DIVING

SMITH, N. A., National Evolutionary Synthesis Center, Durham, NC, United States; CLARKE, Julia A., The University of Texas at Austin, Austin, TX, United States

Just as osseous features can provide clues regarding the behavior of extinct vertebrates, evaluation of soft endocranial tissues provides a means of making comparisons between extinct taxa and extant taxa with known ethological characteristics. Through construction of digital endocasts using high-resolution computed tomography, fine-scale morphological details of both extant and extinct species can be evaluated to infer new information about the evolution of sensory systems. Previous research has established that the morphology of brains and endosseous labyrinths vary across Aves; however, endocranial variation among closely related species remains largely unexplored. The Charadriiformes (shorebirds and allies) are an ecologically diverse clade with a rich fossil record, and therefore, are ideal for investigating intraclade endocranial variation, and potential links between endocranial morphology, phylogeny, ethology, and ecology. Furthermore, although osteological correlates of the transition to wing-propelled diving and flightlessness in charadriiforms have been previously documented, corresponding morphological changes in the sensory systems of these birds have not been studied.

Digital endocasts were rendered for 17 charadriiforms (15 extant and 2 flightless, extinct species). Mapping of character state changes onto a well resolved phylogeny for Charadriiformes resulted in the recognition of differences between the endocranial anatomy of wing-propelled diving Pan-Alcidae and other charadriiforms, distinctions between flightless and volant pan-alcids, and identification of characters that differentiate terrestrial and aquatic charadriiforms. In comparison with other charadriiforms, pan-alcids displayed compressed semicircular canals, indistinct occipital sinuses, and indistinct cerebellar fissures. Flightless pan-alcids have relatively smaller optic lobes and more laterally expanded anterior wulsts than those of volant pan-alcids. Aquatic charadriiforms are differentiated from terrestrial species by the possession of more vertically oriented brains, wulsts that are more anteroposteriorly expanded, posteriorly positioned endosseous labyrinths, and tapered cochlear ducts. Additionally, the brain of *Rynchops niger* is unlike that of any other sampled charadriiform, and may be related to the unusual foraging behavior of that species. Furthermore, charadriiform affinity of the enigmatic fossil taxon *Halcyornis* was supported through comparisons with charadriiform and outgroup taxa. Finally, based on these new morphological data and comparisons of relative brain volume, evaluation of hypotheses regarding charadriiform genome size and its relation to flightlessness, gregariousness, flight capability, and developmental strategy were facilitated.

Technical Session VI (Thursday, October 18, 2:45 pm)

NEW DINOSAURS FROM THE EARLY JURASSIC HANSON FORMATION OF ANTARCTICA, AND PATTERNS OF PHYLOGENETIC DIVERSITY IN EARLY JURASSIC SAUROPODOMORPHS

SMITH, Nathan D., Field Museum of Natural History, Chicago, IL, United States; HELLERT, Spencer M., Augustana College, Rock Island, IL, United States; MATHEWS, Joshua, Augustana College, Rock Island, IL, United States; HAMMER, William R., Augustana College, Rock Island, IL, United States; MAKOVICKY, Peter J., Field Museum of Natural History, Chicago, IL, United States

The Early Jurassic Hanson Formation of Antarctica has yielded unprecedented insight into the evolution of high-latitude vertebrate faunas during the early Mesozoic. Our 2010/11 expedition collected additional material of the theropod *Cryolophosaurus ellioti*, and the sauropodomorph *Glacialisaurus hammeri*, the two previously known dinosaurs from the Hanson Formation. Remains of two new species of sauropodomorph were also recovered. Sauropodomorph A is represented by a nearly complete juvenile specimen, and includes portions of the skull, axial, and appendicular skeleton. Sauropodomorph B is represented by three articulated vertebrae (2 dorsals, 1 dorsosacral), a left ilium, both pubes, and a partial ischium. New U-Pb zircon dates of 194.0 +/– 1.6 Ma from 20 meters below the Mt. Kirkpatrick sites help constrain the age of this fauna.

A phylogenetic analysis of 57 taxa and 353 characters recovers the three Antarctic sauropodomorphs as distantly related to each other, and both new species as more closely related to Sauropoda than to Massospondylidae. Sauropodomorph A is recovered as the sister taxon to *Ignavusaurus* from the Early Jurassic of South Africa, with *Sarahsaurus* from the Early Jurassic of North America forming the sister taxon to this diad. Sauropodomorph B is recovered as the sister taxon to the Early Jurassic *Leonerasaurus* from Argentina. *Glacialisaurus* is recovered as a member of Massospondylidae in a polytomy with *Coloradisaurus* and *Lufengosaurus*.

Previous studies posited that some Early Jurassic sauropodomorph regional faunas were phylogenetically overdispersed (i.e., taxa from any given fauna are more distantly related to each other than expected by chance), but such patterns have not been tested quantitatively. We analyzed aspects of Early Jurassic sauropodomorph faunal structure using phylogenetic comparative methods and a time-sliced dataset with several branch length estimations. The phylogenetic diversity (standardized for unequal species richness) represented in the Antarctic sauropodomorph fauna is as high or higher than that of the other five Early Jurassic regional faunas analyzed. We found no significant support for phylogenetic overdispersion of sauropodomorphs in Early Jurassic regional faunas, though analyses generally recovered Antarctica as having the most evenly dispersed fauna. These results provide additional support for biogeographic links and prevalent dispersal across Pangaea during the Early Jurassic. The presence of three distantly related sauropodomorphs in Antarctica also implies that although endemism in Antarctic vertebrates increased from the Early Triassic to Early Jurassic, climatic and/or physiographic barriers did not prevent dispersal into Antarctica during the Early Jurassic.

Technical Session X (Friday, October 19, 11:00 am)

A TRANSYLVANIAN CRETACEOUS MAMMAL WITH RED IRON PIGMENTS IN TOOTH ENAMEL

SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; CODREA, Vlad, Universitatea Babès-Bolyai, Cluj-Napoca, Romania

Red pigments in tooth enamel of living mammals are known in soricomorph insectivores and murid and castorid rodents. They are of iron composition and thought to increase the resistance of the enamel to the abrasion in some “grinding” mammals. Here we report the presence of red pigments in the tooth enamel of a primitive Cretaceous mammal, a multituberculate from the Maastrichtian of the Hateg Basin in the southern Carpathian Mountains of south western Transylvania, Romania. The red coloration is present on the anterior side of the incisors and on the tips of the cusps of most of the teeth. The pigments are also of iron composition identified on surface enamel with a low environmental scanning electronic microscope in conjunction with energy-dispersive X-ray analysis. This composition is like that presents in living placentals. The mammal described belongs to the Kogaionidae, one of the rare mammal families that survived the K-T crisis in Europe. Moreover, the specimen that has preserved a partial skull associated with the lower jaws allows to identify for the first time the complete dentition in kogaionids and to solve the systematics of the enigmatic species *Barbatodon transylvanicus*. Based on our new specimen, *B. transylvanicus* differs from *Kogaionon ungureanui* by the more rectangular M1 with only two cusps on the lingual row in state of three, the more square M2 in state of triangular, the P4 that has about the same width on all the length of the tooth whereas the P4 of *K. ungureanui* is much wider on the posterior border than it is on anterior border, the P2 that has no long posterior expansion. The new specimen presents a pattern of red pigment distribution more like in soricomorph insectivores than in rodents and importantly shows that *B. transylvanicus* had no ever-growing incisors.

Technical Session I (Wednesday, October 17, 8:15 am)

FEEDING MOTIONS IN *ALLOSAURUS* (DINOSAURIA: THEROPODA): MULTIBODY DYNAMICS OF THE CERVICOCEPHALIC APPARATUS SUGGESTS RAPID LATERAL STRIKES BUT SAGITTAL PREY DISMEMBERMENT

SNIVELY, Eric, Ohio University, Athens, OH, United States; COTTON, John R., Ohio University, Athens, OH, United States; RIDGELY, Ryan C., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Allosaurus was the most common and widespread large predatory theropod dinosaur from the Morrison Formation (154-148 Ma). Tooth marks and pathologies suggest that *Allosaurus* was a generalist carnivore, feeding on diverse prey. Finite element studies have revealed much about its skull biomechanics, but little work has quantified feeding motions of the head and neck.

We tested hypotheses of predation and feeding motions in *Allosaurus* with multibody dynamics simulations of a well-preserved specimen’s head and neck, using the software MSC ADAMS. CT scanning and soft-tissue reconstruction (e.g., neck muscles, air spaces), using Avizo and Solid Edge software, established dimensions for volumetric models of the feeding apparatus. We applied full-model inertial properties, joints, and muscle forces to a CT-based model of the skull and cervical vertebrae. The skeletal model enabled us to assess range of motion, and to enable forward dynamics (calculating motion from applied forces) through muscle activation. Manipulation of the model constrained possibilities for muscle lines of action.

Parameters such as geometric dimensions, material densities, and interpretation of muscle scars had varying effects on dynamics results. An anatomically complex reconstruction, incorporating sinuses, airways, and bone density, had minor effects on mass moments of inertia (MMI) and acceleration compared to a solid model assigned an average soft tissue density. Estimates of trachea diameter had little effect on MMI and centers of mass of neck segments, and therefore on dynamic capabilities. In contrast, acceleration results varied substantially between muscle reconstructions. M. complexus inserting onto the parietals would enable more rapid dorsiflexion than a squamosal attachment, yet still facilitate lateroflexion.

Regardless of these parameter effects, the following dynamics results reveal comparative and intrinsic aspects of *Allosaurus* feeding. Tentatively contradicting earlier hypotheses, lateral angular acceleration of the head for this *Allosaurus* specimen was twice as rapid as previously calculated for an adult *Tyrannosaurus rex*, although dorsiflexive accelerations were similar. Results strongly support hypotheses that *Allosaurus* could co-opt lateroflexive muscles (including m. longissimus capitis superficialis) for powerful ventroflexion. Despite low MMI and high accelerations for turning the head alone, low lateroflexive torque, a narrow skull, and high sagittal mobility of the neck suggest that *Allosaurus* pulled its head straight back when dismembering large prey. *Allosaurus* therefore most likely dismembered prey by sagittal motions similarly to raptorial birds, and relied less on shake-feeding than do extant crocodilians and probably large tyrannosaurids.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A DEVONIAN 'IN-GROWING' FINSPINE: PATHOLOGICAL DEFORMITY IN A GYRACANTH FISH

SNYDER, Daniel, Middle Georgia College, Cochran, GA, United States; TURNER, Susan, Queensland Museum Geosciences, Brisbane, Australia

Dental pathologies are not unusual, with fossil examples known even in microfossils. Most are the result of injury, some result from heterochrony, but occasionally there is a developmental cause. Because they are modified placoid odontodes, dermal spines can be compared to teeth and they are formed primarily of a type of dentine called osteodentine. Dermal spines are found in sharks, acanthodians ('spiny sharks') and their relatives from the late Silurian onward. Fin spines sometimes show pathological damage, usually resulting from injury. Developmental or late-stage changes in keratinous structures are well known in mammals but few if any pathological changes in early vertebrate fin spines have been recorded. A unique deformed pelvic(?) fin spine from a gyracanthid acanthodian, probably *Gyracanthides sherwoodi* Newberry, has been found in the Upper Devonian (Famennian) Duncannon Member, Catskill Formation, at Red Hill, Clinton Co., PA, USA. The deformity has been determined by its position on the body; rather than growing anteroposteriorly, the fin spine grew mediolaterally, and did not lengthen much further than its own area of insertion. Gyracanthids have no known descendents, so we review modern analogues. We conclude that injury in life is a sufficient explanation, that there is evidence of extreme trauma without breakage. Such injury supports the view of gyracanthids as fish that regularly rested, bumped and scratched against the bed of the waters where they lived, and may offer an explanation for variation seen in other, more poorly-known spine taxa (e.g., *Oracanthus*).

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

X-RAY MICRO-COMPUTED TOMOGRAPHY REANALYSIS OF THE UPPER TRIASSIC DIAPSID *ELACHISTOSUCHUS HUENEI*

SOBRAL, Gabriela, Museum für Naturkunde Berlin, Berlin, Germany; MÜLLER, Johannes, Museum für Naturkunde Berlin, Berlin, Germany

The Upper Triassic reptile *Elachistosuchus huenei* from Germany has been considered as both a pseudosuchian archosaur and as a sphenodontid lepidosaur in early studies based on characters such as presence of an antorbital fenestra and tooth implantation. Part of the reason for this ambiguous taxonomic assignment is that it shows many plesiomorphic characters, much of the material is encased in matrix, and it has been largely ignored in recent literature. In an attempt to shed new light on its morphology and phylogenetic relationships, parts of the holotype and assigned materials were scanned using high-resolution micro-computed tomography. Results revealed internal structures of the skull and new elements within the matrix. One of the most striking features recovered is the presence of well-developed processes in the frontals forming a tube-like structure medially. A similar, but more subtle character is reported for basal lepidosauromorphs and archosauriforms, but is lost in derived members of the latter clade. Due to lack of information, presence and distribution of this character among basal taxa is difficult to assess. Presence of a lacrimal, although reduced, and sub-thecodont tooth implantation are incompatible for sphenodontids. The condition of the posterior ramus of the jugal indicates a partially open lower temporal fenestra. Palatines, pterygoids and vomers bear a shagreen of denticles. The splenial might be absent. These are characters more commonly found in derived neodiapsids. Presence of a suborbital fenestra discards it as a basal synapsid. Scans also revealed a T-shaped interclavicle with a broad plate, a character not usually found in eosuchians. Clavicles are also present and partially articulated. Among assigned materials, a strongly dorsoventrally flattened juvenile skull was found. The parietals are not entirely ossified, showing a large dorsal fontanelle and the morphology of jugals also indicates the presence of an incomplete lower temporal bar. This new work suggests that *Elachistosuchus* may well be a late surviving neodiapsid or basal eosuchian taxon and that it has a great potential to provide new information on the phylogeny and evolution of these clades.

Technical Session XVIII (Saturday, October 20, 3:45 pm)

REFERRAL OF *MIACIS LATOURI* TO NEW GENUS, AND A PHYLOGENETIC ANALYSIS OF THE EARLIEST "MIACIDS" (CARNIVORAMORPHA)

SOLÉ, Floréal, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Richard, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; COILLOT, Tiphaine, SFA – Institut International de Paléoprimatologie, Paléontologie Humain: Evolution et Paléoenvironnements (IPHEP) – UMR 6046, Université de Poitiers, Poitiers, France; DE BAST, Eric, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Thierry, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Based on new collections from the earliest Eocene locality of Dormaal, Belgium, we almost entirely reconstructed the deciduous and permanent dentition of one of the earliest "miacids," *Miacis latouri*, previously known by only two teeth (M^1 and M^2). The 250 new specimens found in Dormaal illustrate almost all the *locii* and therefore give information on the dentition of the "miacid" species and its variability. Based on the dental features, we refer the species to a new genus. Indeed, this population shows a mixture of features that are typical of either *Miacis* or *Vulpavus*, which implies that the two genera were already almost separated from the very beginning of early Eocene. We also present evidence that *"Miacis" latouri* was sexually dimorphic and describe its tarsal bones (calcaneum and astragalus), associated with dental remains by indirect methods. They represent the oldest specimens known for the "Miacidae" and their morphology supports an arboreal capability for this species. In order to ascertain the position among "miacids," we performed a phylogenetic analysis of the earliest "miacids." The resulting cladogram defined three important groups: the *Uintacyon*-group, the *Miacis*-group – including *"Miacis" latouri* – and the *Oodectes*-group. Our results also suggest a dispersal of two lineages of "miacids" (*Miacis*-group and *Oodectes*-group) from Europe to North America around the Paleocene-Eocene boundary. Moreover, the topology of the phylogenetic tree supports a Paleocene radiation of the "miacids," which is presently poorly known. Finally, the morphological comparisons and the phylogenetic analysis allowed us to refer *Miacis rundlei* from Abbey Wood, England (MP8+9) to the genus *Gracilocyon*, and *Miacis exiguus* from the Bighorn Basin, Wyoming (Wa2-3) to the genus *Vulpavus*.

Technical Session XIV (Saturday, October 20, 11:00 am)

MACROEVOLUTIONARY TRENDS IN BODY SIZE DURING THE THERAPSID-ARCHOSAUROMORPH TRANSITION

SOOKIAS, Roland B., GeoBio-Center, Ludwig Maximilian University of Munich, Munich, Germany; BENSON, Roger B., Department of Earth Sciences, University of Cambridge and Department of Earth Sciences, University College London, Cambridge and London, United Kingdom; BUTLER, Richard J., GeoBio-Center, Ludwig Maximilian University of Munich, Munich, Germany

Many explanations for apparent trends in body size in the fossil record have been proposed. Two key questions concerning terrestrial tetrapod body size evolution are whether selection for larger body size has driven what appears to be an increase in the size of many clades over time ("Cope's rule"), and whether environmental changes are responsible for large-scale patterns seen in body size, including the exceptional size of dinosaurs. We investigated both of these questions, focusing on the replacement of basal therapsids (stem-group mammals) by archosauromorphs, including dinosaurs, as the dominant large-bodied terrestrial fauna during the Triassic. We compiled and analysed a dataset of body-size proxies for more than 400 therapsid and archosauromorph species spanning the Late Permian–Middle Jurassic. Maximum-likelihood analyses indicate that Cope's rule (i.e. an active within-lineage trend of body-size increase) is extremely rare, despite a clear long-term pattern of increasing maximum body size in archosauromorphs. Instead, non-directional processes of evolution predominate in taxonomically and ecomorphologically more inclusive clades, with stasis more common in less inclusive clades. In addition, we compared changes in three abiotic factors – oxygen, CO2 (as a proxy for temperature), and land area – with changes in the maximum size of Permian–Jurassic archosauromorphs and therapsids (with data from Cenozoic mammals for comparison) using time series generalised least squares regression models. When serial correlation is removed we find no robust correlations, suggesting that these environmental factors did not consistently control tetrapod maximum size. We also examined the shape of maximum size growth curves for Permian–Jurassic data by comparing fits of Gompertz and logistic models. Gompertz models – i.e. exponentially decreasing size increase with larger sizes – fit maximum size curves far better than logistic models. Together this suggests biological limits such as reduced fecundity and niche space availability, not environmental limits, become increasingly limiting as larger sizes are reached. Limits to body size appear to be highly clade-dependent, based on the lack of environmental correlations with body size, the exceptional size of dinosaurs, and the fact that maximum size of Middle–early Late Triassic archosauromorph predators exceeded that of contemporary herbivores, breaking a widely accepted 'rule' that herbivore maximum size greatly exceeds carnivore maximum size. Previously identified unique adaptations (e.g. skeletal pneumaticity, high growth rate) probably facilitated the exceptional size of archosaurs, but of these adaptations only rapid reproductive rate was likely important in facilitating opportunistic replacement of therapsids.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

AERIAL ABILITY IN BASAL DEINONYCHOSAURIA

SORKIN, Boris, Queensborough Community College, Bayside, NY, United States

The previously proposed hypothesis that non-volant derived members of the coelurosaur clade Deinonychosauria (Dinosauria: Theropoda) evolved from volant ancestors is evaluated by reviewing relevant publications subsequent to that of the hypothesis. Comparative anatomy and computer and physical modeling indicate that basal members of Dromaeosauridae, microraptorine *Microraptor* and unenlagiine *Rahonavis,* possessed substantial scansorial and aerial ability, the former being capable of both gliding and active flight that utilized long pennaceous feathers on both fore- and hindlimbs. This supports the hypothesis that the more derived non-volant Eudromaeosauria and the non-volant Unenlagiinae more derived than *Rahonavis,* evolved from volant ancestors. The phylogenetic positions of *Tianyuraptor* and *Mahakala* within Dromaeosauridae indicate that the short forelimbs and the inferred lack of scansorial and aerial ability of these two basal dromaeosaurids are autapomorphies and do not contradict the above conclusion. Comparative anatomy indicates that microraptorine *Sinornithosaurus* possessed substantial scansorial but no aerial ability, despite possessing a number of adaptations for active flight. It therefore appears to represent a transitional form between the volant basal dromaeosaurids and the more derived secondarily non-volant Eudromaeosauria.

Comparative anatomy indicates that basalmost known troodontid *Anchiornis* possessed substantial scansorial ability and was capable of gliding flight that utilized long pennaceous feathers on both fore- and hindlimbs. This supports the hypothesis that the more derived non-volant Troodontidae evolved from volant ancestors. The presence of substantial

scansorial ability and capacity for gliding flight that utilized long pennaceous feathers on fore and hind limbs in basal members of both Dromaeosauridae and Troodontidae suggests that the most recent common ancestor of Deinonychosauria is also a scansorial four-winged glider. Known morphology of basal avialans *Pedopenna* and *Archaeopteryx* suggest that the same is true of the most recent common ancestor of Paraves.

It has been previously proposed that adaptations for aerial locomotion present in the known non-volant members of the coelurosaur clade Oviraptorosauria were indicative of evolution from a volant ancestor, just as similar adaptations proved to be indicative of volant ancestry in derived non-volant Deinonychosauria. The morphology and phylogenetic position of yet unknown oviraptorosaurs whose future discovery would support or falsify this hypothesis are speculated on.

Technical Session XVIII (Saturday, October 20, 3:30 pm)

A VIRTUAL ENDOCAST AND ENDOCRANIAL FEATURES OF *OODECTES* (MAMMALIA: CARNIVORAMORPHA)

SPAULDING, Michelle, Carnegie Museum of Natural History, Pittsburgh, PA, United States; FLYNN, John J., American Museum of Natural History, New York, NY, United States

A virtual endocast of the basal carnivoramorphan *Oodectes herpestoides* was constructed from a high-resolution computerized tomography scan (CT scan) of an exceptionally well-preserved specimen from the Bridger Formation of Wyoming, USA. This specimen is essentially undeformed, and thus has generated the first undistorted full endocast known from a middle Eocene carnivoramorphan. Natural endocasts are known from the contemporary *Vulpavus* and the late Eocene *Procynodictis*. *Vulpavus* has been found to be the sister taxon to *Oodectes* in our recent phylogenetic analyses, and comparing these two endocasts shows them to be more similar to one another than either is to that of *Procynodictis*, but there are some key differences. Most notably *Oodectes* has a relatively more expanded frontal pole with some contact with the olfactory bulbs, and a longer dorsal neocortical sulcus. Both Bridgerian taxon endocasts possess straighter neocortical sulci on the cerebrum, with less cerebellum contact than in *Procynodictis.*

The endocranial morphology of *Oodectes* is also described, providing the first endocranial morphology description for a basal carnivoramorphan. Endocranial features, such as an ossified tentorium and the morphology of the dorsal surface of the petrosal, have long been incorporated in higher-level phylogenetic studies including carnivorans, but the status of these characters in stem carnivoramorphan taxa has been unknown. *Oodectes* possesses an ossified tentorium, but this structure is not as extensively developed as it is in crown carnivorans. The dorsal surface of the petrosal of *Oodectes* has an extremely large subarcuate fossa and a sharp anterior projection – the *apex parties petrosal*. This latter feature is typical of crown carnivorans, but the size of the subarcuate fossa is not.

Recent advances in CT scanning, and steadily increasing computing power for analyzing these scans permit much faster generation and processing of high resolution CT scans than previously available. A database of more than ten scans of basal carnivoramorphans is currently being assembled and this capability for 'virtual preparation' is greatly expanding the potential for incorporating the morphology of the endocranial space into phylogenetic analyses focused on these Paleocene and Eocene stem carnivoramorphan taxa. This will enable enhanced understanding of basal conditions and evolutionary transformations within Carnivoramorpha and across related groups (Ferae, Ostentoria).

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

POSTCRANIAL OSTEOLOGY OF EARLY ORNITHISCHIAN DINOSAURS AND THE ANCESTRAL BODY PLAN OF ORNITHISCHIA

SPENCER, Marc R., University of Iowa, Iowa City, IA, United States

Ornithischians first appear in the Late Triassic, but their early fossil record is sparse. The earliest known forms are relatively small, bipedal, and possess morphological features that are associated with herbivory. Furthermore, the phylogenetic position of many of these early ornithischians remains unresolved. Previous work has focused primarily on cranial anatomy because ornithischians demonstrate elaborate solutions for herbivory (e.g., tooth batteries) and possess extensive cranial ornamentation (e.g., crests). Little has been done, however, to evaluate the general postcranial body plan of ornithischians. Several of the earliest known ornithischians (e.g., *Lesothosaurus*, *Stormbergia*, *Heterodontosaurus*) were examined and evaluated with respect to more derived forms (e.g., thyreophorans, ornithopods, marginocephalians). To obtain a generalized postcranial body plan for the ancestral ornithischian, though, these taxa must be placed in a phylogenetic context to polarize the characters at the base of the tree. Therefore, I performed a maximum parsimony analysis to reconstruct ornithischian phylogeny. Taxon sampling focused on basal members, though members of derived clades were represented where applicable. The resultant phylogeny is poorly resolved but several important patterns related to the base of Ornithischia are evident. Heterodontosaurids are recovered in a polytomy with *Pisanosaurus* at the base of Ornithischia, corroborating recent studies suggesting that heterodontosaurids are basal ornithischians. *Lesothosaurus* is recovered within Genasauria as sister to Thyreophora and *Stormbergia* is the basalmost neornithischian. These results suggest that the postcranial morphology of these taxa likely reflects the ancestral ornithischian body plan. The ancestral ornithischian was bipedal with ossified tendons along the sacral vertebrae, likely extending anteriorly to the posteriormost dorsals. The forelimb was long relative to the hindlimb (~50% of the hindlimb length), had a pronounced olecranon process, and possessed a large manus with extensor pits for a grasping hand, more similar to that of early saurischians. Other, more derived bipedal ornithischians possess a relatively short forelimb, typically far less than half the length of the hindlimb. Basal saurischians (e.g., *Herrerasaurus*, *Eoraptor*) from the Late Triassic approximate this condition and these results suggest that early dinosaur postcrania were more similar than previously thought. The analysis presented here provides a glimpse into the evolution of dinosaurs in the Late Triassic and Early Jurassic.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW ARMORED ARCHOSAUROMORPH FROM THE LATE TRIASSIC (OTISCHALKIAN) COLORADO CITY FORMATION OF THE CHINLE GROUP, WEST TEXAS

SPIELMANN, Justin A., New Mexico Museum of Natural History and Science, Albuquerque, NM, United States; LUCAS, Spencer G., New Mexico Museum of Natural History and Science, Albuquerque, NM, United States; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States

Armored archosauromorphs are abundant components of Late Triassic faunas across Pangea, and in the Upper Triassic Chinle Group of the American West they are common vertebrate fossils. Phytosaurs and aetosaurs are among the most common Chinle Group fossils, and less common armored archosauromorphs include sphenosuchians and doswelliids. Here, we report a new, heavily-armored archosauromorph taxon from New Mexico Museum of Natural History and Science (NMMNH) locality 3101, which is in the Colorado City Formation of the Chinle Group in Howard County, West Texas. The incomplete skeleton, catalogued as NMMNH P-16723, consists of cranial elements, vertebral centra, a partial limb shaft and numerous osteoderms. The skull elements reveal a thick, heavily armored braincase, skull roof with parasagittal crest and sockets for large maxillary teeth. The relatively short sacral vertebrae suggest an animal less than 1 meter in total body length, not including the tail. The morphology of the osteoderms does not match any currently known armored archosauromorph, but is most similar to doswelliids among known taxa. Although most of the osteoderms possess large, closely packed pits that form no obvious pattern, some osteoderms have raised, linear ridges running across them and others have anterior laminae with faint patterning on the articular surface. Other osteoderm fragments have patterning on both sides of the element, indicating a more complex structure than the ornamented external/unornamented internal arrangement of most archosauromorph osteoderms. Some of the osteoderms are tightly sutured to each other via digitate sutures, and all are relatively thick. These osteoderms are thus readily distinguished from those of *Doswellia*, the only doswelliid previously reported from the Chinle Group. The patterning of the osteoderms well matches that of doswelliids in being coarse, deeply incised and mostly composed of equal-sized pits and in the possession of anterior laminae. It thus seems likely that NMMNH P-16723 is a new doswelliid taxon, and thus an addition to the relatively sparse doswelliid record from the Chinle Group. This taxon is derived from the oldest strata of the Texas Chinle Group, the Otischalkian, whereas the genus *Doswellia* is known from the Chinle Group in Texas, New Mexico and Utah, in strata of Otischalkian-Adamanian (late Carnian) age. Doswelliids are still rare, but visible components, of global Triassic faunas, with *Tarjadia* from the Anisian-Ladinian of Argentina, *Archeopelta* from the late Ladinian-early Carnian of Brazil, *Doswellia* from the Otischalkian-Adamanian of the American Southwest and this new taxon from the Otischalkian of West Texas.

Technical Session II (Wednesday, October 17, 9:00 am)

A LIVING ANALOGUE TO THE FIN-LIMB TRANSITION: LOCOMOTION AND FIN USE OF AN AIR BREATHING FISH ON LAND

STANDEN, Emily M., Redpath Museum McGill University, Montreal, QB, Canada; LARSSON, Hans C., Redpath Museum McGill University, Montreal, QB, Canada

When aquatic vertebrates first moved onto land they had to overcome many new physiological and biomechanical challenges. One major hurdle would have been transitioning from an aquatic mode of locomotion to a terrestrial mode of locomotion. In this study, *Polypterus senegalus*, an extant air breathing fish, is used to test how fins in a basal, relatively conserved actinopterygian can be used to locomote overland. Fish were filmed swimming and walking at 250 frames per second and video was analyzed to compare basic three dimensional kinematic variables. Both body oscillation and fin movements differed between walking and swimming. Qualitatively, fish used the medial surface of their pectoral fins as the primary power surface during swimming and switched to use the lateral pectoral fin surface for power and support during walking. Quantitatively, during walking, animals had significantly larger head and tail oscillations compared with swimming. *Polypterus senegalus* effectively locomote overland and do so with significantly different fin and body motions. This contrast in fin and body motion between walking and swimming suggests the pectoral fin 'functional landscape' is diverse. We hypothesize that it is this functional plasticity that allowed early aquatic vertebrates to co-opt their fins effectively for terrestrial locomotion.

Preparators' Session (Thursday, October 18, 8:15 am)

FROM DISCOVERY TO PUBLIC OUTREACH: A NEW VISITOR ORIENTATED FOSSIL QUARRY AND FOSSIL PREPARATION LAB OPENS AT THE BEN REIFEL VISITOR CENTER AT BADLANDS NATIONAL PARK

STARCK, Ellen, Badlands National Park, Interior, SD, United States; BENTON, Rachel, Badlands National Park, Interior, SD, United States; HOUSEHOLDER, Mindy, Badlands National Park, Interior, SD, United States; BOYD, Clint A., South Dakota School of Mines

and Technology, Rapid City, SD, United States; PAGNAC, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, United States

In May of 2010, a specimen of *Hoplophoneus* was discovered by a visitor at Badlands National Park. The collected elements include a complete skull and five cervical vertebrae. This specimen is one of the most superbly-preserved examples of *Hoplophoneus* collected from the White River Group, owing in part to the calcareous cement of the Middle Scenic upper sandstone interval of the Brule Formation. However, the mandible was incomplete, and the medial section of the left side was totally absent. Realizing the significance of this find, the park partnered with the South Dakota School of Mines and Technology to assist in the digital reconstruction of the mandible, including recreating the missing segment and adjusting the model to counter the effects of deformation. The resulting data were used to generate: 1) a rapid prototype of the skull, allowing study of the specimen without incurring damage to the original; and 2) the mass production of scaled casts. The importance of this specimen was realized during preparation, when several puncture wounds in the skull were observed, consistent in size and depth with that of another nimravid. This new knowledge motivated a preliminary survey of the area, producing a fairly diverse faunal list, including a marsupial (*Herpetotherium*); a leporid (*Palaeolagus*); rodents (*Eumys*, *Ischyromys*); perissodactyls (*Mesohippus*, rhinoceratids); artiodactyls (*Merycoidodon*, *Leptomeryx*); reptiles; and trace fossils. The diversity and unique preservation of these fossils led the park to open both a visitor-oriented research quarry and an interactive, fossil preparation lab, inside the adjacent Ben Reifel Visitor Center in June of 2012. Inserting a fossil preparation lab into a historic structure, utilized daily for interpretive education and visitor outreach, presents unique challenges. Concerns related to noise levels, safety, and preservation of the historical structure all had to be carefully addressed while ensuring that specimens are handled, prepared, and secured according to the highest standards. Since construction of a traditional viewing lab was impermissible, a workstation was fabricated that allows specimens to be viewed by the public while also providing a sealed work space to contain fossil preparation byproducts. For the first time in park history, visitors will be able to observe and interact with scientists at a fossil quarry, a fossil preparation lab, and a visitor center, all in an easily accessible area. With continued excavation and research, via expanded paleontological facilities and partnerships with universities, Badlands National Park plans to continue alternative, non-destructive methods of preparation and cast reproduction, in hopes of further preserving fossils for future generations.

Technical Session II (Wednesday, October 17, 11:30 am)

A NEW FOSSIL CHAR (*SALVELINUS*) FROM MIOCENE LAKE SEDIMENTS IN STEWART VALLEY, NEVADA

STEARLEY, Ralph F., Calvin College, Dept. of Geology and Geography, Grand Rapids, MI, United States; CAVENDER, Ted, Ohio State University, Department of Evolution, Ecology and Organismal Biology, Columbus, OH, United States

During middle Miocene time, between 18 and 9 Ma, the Walker Lane region of western Nevada was a high-altitude plateau undergoing transtensional disassembly. Intermittent N-S drainage connections formed between adjacent downfaulted basins, possibly extending northward to southeastern Oregon. To the east, in eastern Nevada and western Utah, a rugged highland served as a drainage divide. Geologic data, including mapped ignimbrites extending across the present crest of the Sierra Nevada, indicate probable drainage connections between western Nevada and the Pacific Ocean. In Stewart Valley, Mineral County, Nevada, lacustrine sediments, the Savage Canyon Formation, reveal the presence of a lake which occupied the basin approximately 15 million years ago, as determined by potassium-argon dates, plant-, and mammalian biostratigraphy. During the 1970's through early 1990's, University of California crews recovered fossils of a large (30+ cm), well-toothed eusalmonine from these lacustrine sediments. Non-cranial features of this eusalmonine include a small adipose fin, 58-60 vertebrae, and numerous small scales, 150 scale rows anterior to the pelvic insertion. Relevant cranial features diagnosing this taxon as a primitive member of a subset of species related to the genus *Salvelinus* include: a broad, dish-shaped hyomandibula with a long ridge for the attachment of the adductor mandibulae; a quadrate in which the anterior and posterior borders form an acute angle; and a long, flat maxilla. The lower jaw is massive. The dermethmoid, exposed in sagittal section, is long and narrow and the correlated dorsal processes of the premaxillae are longer and more vertical than those of any extant salmonine. The neurocranium is not depressed; the parasphenoid is straight in sagittal profile and thin. This new taxon differs from a species of *Salvelinus* obtained from western Churchill County, and provides more evidence for a Miocene radiation of eusalmonines in intermontane drainages of the western United States.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DRIVERS OF JAW SHAPE IN *NEOTOMA*: MANDIBULAR GEOMETRIC MORPHOMETRICS AND IMPLICATIONS FOR MORPHOLOGICAL PARTITIONING

STEGNER, M. A., U.C. Berkeley, Berkeley, CA, United States; FERRER, Elizabeth, U.C. Berkeley, Berkeley, CA, United States

The modern biodiversity crisis has generated interest in the response of species to climate change in the past. *Neotoma* is one of the most common taxa in Neogene North American fossil deposits; these woodrats are paleoecologically important because they collect bone-laden carnivore scats and raptor pellets in their middens, providing a major source of Quaternary fossil material. However, it is notoriously difficult to identify *Neotoma* fossils to the species level. Body size ranges overlap across most species, and body size within species is strongly correlated with climatic variables. Although teeth are often diagnostic to species in mammals, in *Neotoma* interspecific tooth variability among species is low, whereas within species it is high. Nevertheless, because *Neotoma* species partition their environment, knowing which species are present in fossil deposits is important for understanding the environmental implications of turnover and abundance changes.

We analyzed extant *Neotoma* jaws using geometric morphometrics to determine (1) if we could identify toothless mandibles to species, and (2) if climate and/or phylogeny correlates with differences in mandible shape. We photographed lateral views of 445 right mandibles (all individuals were adults with similar degrees of tooth wear) from nine species of *Neotoma* found in the Western US, and conducted a Procrustes analysis on two landmarks and four curves (60 semilandmarks). We performed a Canonical Variates Analysis (CVA) to explore the morphological relationships among species, and made pairwise Hotelling's T^2 test comparisons (permutation test with 1000 resamplings, Holm p value adjustment) to determine which species could be differentiated based on mandible shape. Though most species were morphologically too similar to distinguish, we found that several, including *N. cinerea* and *N. lepida*, could be identified in some pairwise comparisons. We also tested for a correlation between mandible shape and both climate variables and body size (nasal length as a proxy for size) using multiple linear regression. There is no correlation between jaw shape and body size, so we were able to rule out allometric effects. Phylogenetic signals were assessed using generalized least squares (GLS). Shape was significantly correlated with local temperature across species, but within species, mandible shape depends more on intraspecific competition—this is strong morphological confirmation for the observation that, when several species of *Neotoma* are present in the same region, they partition dietary resources.

Technical Session VI (Thursday, October 18, 3:45 pm)

NO FIBROUS (WOVEN) BONE IN SAUROPOD FIBROLAMELLAR BONE?

STEIN, Koen, Steinmann Institut fuer Geologie, Mineralugie und Palaeontologie, Bonn, Germany; PRONDVAI, Edina, Hungarian Academy of Sciences – Eötvös Lorand University "Lendület" Dinosaur Research Group, Budapest, Hungary

Fibrolamellar bone is defined as a composite tissue consisting of a rapid growing woven fibred bone matrix in which primary vascular canals are embedded in a space with a growing infilling of lamellar bone. This tissue is widely recognized in mammals, non-avian dinosaurs and birds. Here we provide histological evidence that the bone matrix hitherto interpreted as isotropic woven fibred bone in transverse sections of sauropod limb bones actually has a lamellar to parallel-fibred anisotropic nature in longitudinal sections. Thin sections of longbones of well known sauropod taxa (e.g. *Alamosaurus*, *Apatosaurus* and *Camarasaurus*) presented as prime examples of extinct animals possessing woven bone matrix show a strong birefringence in longitudinal plane. This optical feature is identical with that of the circumferential lamellar bone generally observed in transversal sections of poikilothermic ectotherm long bones, the presence of which is thought to be a reliable indicator of a slow growing bone tissue. The anisotropic nature of primary cortical bone in longitudinal sections is consistent with recent texture analyses on sauropod bone illustrating a preferential longitudinal orientation of the long (c) axis of the fluorapatite crystallites. This suggests that highly organized fibre orientation in a bony matrix does not necessarily limit growth rates; an observation that has significant implications for the interpretation of histological indicators of growth rates (Amprino's rule) and evolution of growth strategies. The longitudinal arrangement of crystallites reflecting the original alignment of the collagen fibres is most likely an adaptation to biomechanical requirements on the long bones of sauropods. Based on these results, the very presence of woven bone in non-embryonic and non-pathologic long bones of sauropods is hereby contested. We hypothesize that the mistaken isotropy observed in most commonly used transversal sections is most likely the result of the random orientation of the a and b axes of the crystallites along their c axis. These results again call for awareness of the three dimensional character of bone when drawing far reaching conclusions based purely on two dimensional histological thin section images.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW TAXON OF DIAMANTOMYS FROM THE LATE OLIGOCENE NSUNGWE FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA

STEVENS, Nancy J., Ohio University, Athens, OH, United States; O'CONNOR, Patrick M., Ohio University, Athens, OH, United States; ROBERTS, Eric M., James Cook University, Townsville, Australia

Diamantomys leuderitzi (Mammalia: Rodentia: Hystricognathi) was first described from localities of mid-late Miocene age in what is now Namibia, based on a lower jaw preserving three molar teeth. In the original description, the extreme distinctiveness of this taxon was remarked upon, with an arrangement of crests and cusps resembling no other rodent taxon. Hundreds of additional specimens recovered from the Miocene of southwestern and eastern continental Africa have subsequently been ascribed to the taxon. Yet discoveries from late Oligocene and early Miocene sites throughout eastern Africa have begun to reveal substantial early diversity in the clade, with the emergence of a handful of novel species attributed to the genus in recent years. Here we describe a new species of *Diamantomys* representing the largest of the Nsungwe Formation rodents, with mesiodistally elongate and distinctly crestiform molars generally consistent with members of the genus *Diamantomys*, yet highly size distinctive and preserving more elaborate cresting on the lower molars together with a posterior cingulid. The morphology of late Oligocene micromammals

from the Rukwa Rift Basin of Tanzania suggests that the Nsungwe fauna may provide bridge between well-documented early and mid Cenozoic hystricognath rodents. Rodent fossils from the late Oligocene interval on continental Africa are critical for linking the richly diverse early Paleogene faunas of Saharan Africa and Oman with the better-sampled Miocene faunas of Afro-Arabia and beyond.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ALESTID FISHES FROM THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

STEVENS, William, Ohio University, Athens, OH, United States; CLAESON, Kerin M., Ohio University, Athens, OH, United States; STEVENS, Nancy J., Ohio University, Athens, OH, United States

The Order Characiformes represents a clade of approximately 1600 species of teleost fishes first recorded from the Albian of what is now Brazil. They are primarily found in fresh water settings throughout Africa and South/Central America today, but a handful of fossil taxa are reported from Europe and North America. Alestidae is a family of African characiforms including 19 genera and ~105 species. Early alestid fossils are known from Afro-Arabia, with records reported 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. Here we report the first record of alestid fishes from the late Oligocene Nsungwe Formation in the Rukwa Rift Basin of southwestern Tanzania. Radiometrically dated at ~24.95MY, Nsungwe Formation localities have revealed a diverse vertebrate fauna including mammals, birds, crocodylians, lepidosaurs, anurans and multiple clades of fishes, together with a number of novel invertebrate taxa. The specimens we describe were collected from localities sampling fluvial and shallow lacustrine paleoenvironments. Teeth were mechanically prepared and digitally imaged prior to conducting morphometric analysis. Alestid specimens recovered to date consist of isolated premaxillary and dentary teeth ranging in crown height size from 0.63 – 4.32 mm. Specimens vary in morphology, ranging from simple unicusped teeth to strikingly asymmetric teeth exhibiting up to 12 individual cusps on the largest specimen. Results indicate that based on size and overall morphology, at least two alestid taxa are represented in Nsungwe Formation localities.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW MIDDLE PALEOCENE (TIFFANIAN NALMA) BIRDS FROM NORTH DAKOTA

STIDHAM, Thomas A., Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; HOGANSON, John W., North Dakota Geological Survey, Bismarck, ND, United States; PERSON, Jeff J., North Dakota Geological Survey, Bismarck, ND, United States

The fossil record of birds prior to the last ~1 million years of the Paleocene in North America is more poorly known than that of the latest Cretaceous. Lithornithids and rare neognathous birds represent the only known avian records from North America in the middle to late Paleocene. However, late Tiffanian (~ 58 Ma) Bullion Creek and Sentinel Butte Formation localities in North Dakota recently have produced a diverse vertebrate fauna including fishes, amphibians, reptiles, mammals, and birds. The 10 bird bones recovered from these new excavations represent at least 3 different taxa of small-bodied birds (duck-sized and smaller). None of the new bones appear referable to any of the previously named avian taxa from the Tiffanian of North Dakota and add to the known diversity of birds from the Paleocene of North America.

One of the new species represented by four bones (two coracoids, a scapula, and a humerus) is a presbyornithid approximately the same size as the early Eocene *Presbyornis pervetus* and significantly smaller than the contemporaneous *Presbyornis isoni*. It has a much larger procoracoid foramen and a smaller acrocoracoid than the Eocene species. Another taxon represented by a single coracoid has a strong resemblance to the Late Cretaceous *Cimolopteryx* and is likely from a plesiomorphic basal avian. One other coracoid that has a procoracoid foramen, but a relatively shallow scapular cotyla that is subtriangular in outline represents a third distinct coracoid-based taxon. It also lacks a distinctly medially projecting or overhanging acrocoracoid/furcular facet (present in the coracoids of the other Tiffanian taxa), and seems to be allied to one of the higher landbird clades. It may be the oldest known record of the stem of a derived ordinal level clade. A tibiotarsus is from a small non-anseriform bird that appears related to gruiforms or ciconiiforms. That tibiotarsus has an elongate tuber for the attachment of part of the extensor retinaculum on the shaft that might indicate that it represents a fourth avian taxon.

The abundance of presbyornithid remains is not unexpected given the interpreted paludal/pond depositional environments and abundance of freshwater vertebrate taxa in these localities. Furthermore, one of the bird bones appears to have damage from ingestion by a carnivore (i.e. gastric etching and related damage). That ingestion also is consistent with the abundance of coprolites and broken bones previously reported from the Medora Site in North Dakota. If accurate, that bone would be the oldest known record of predation on birds in North America.

Technical Session I (Wednesday, October 17, 8:30 am)

A MULTI-ELEMENT HISTOLOGICAL ANALYSIS OF THE JURASSIC TYRANNOSAUROID *GUANLONG WUCAII*

STIEGLER, Josef B., The George Washington University, Washington, DC, United States; CHOINIERE, Jonah N., American Museum of Natural History, New York, NY, United States; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; CLARK, James M., The George Washington University, Washington, DC, United States

While knowledge of skeletal development in Cretaceous coelurosaurs continues to grow, relatively little is known about ontogeny in their Jurassic counterparts. The basal tyrannosauroid *Guanlong wucaii* from the Upper Jurassic Shishugou Formation of Xinjiang, P.R.C. is known from two penecontemporaneously fossilized individuals of differing size and ontogenetic maturity. We produced histological sections from core samples of the right humerus, femur, and tibia from the larger holotype specimen, as well as whole-element sections from the humerus, femur, tibia, and fibula of the smaller referred specimen. In addition, we examined fibular thin sections of both specimens that were produced for a previous study.

Both individuals exhibit a fibro-lamellar complex with sub-plexiform vascular organization in all examined elements, although localized fields of reticular vascularization are present, especially in the smaller individual. The frequency of longitudinally oriented primary osteons increases approaching the periosteal surfaces of hind limb elements in both specimens (consistent with a slowed rate of growth). Double and triple lines of arrested growth (LAGs) are visible in the interior cortex of the tibia in the holotype. Multiple closely spaced LAGs have been previously ascribed to stressful life-history events and this pattern may be attributable to the interpreted seasonal aridity of the Shishugou Formation. An external fundamental system (EFS) is present in hind limb elements of the large specimen with varying numbers of LAGs in each, but no EFS is visible in the humerus, perhaps indicating significant allometric change in limb proportions during ontogeny.

Several features indicate substantial lateral migration and remodeling of the fibula and relative stationarity of the tibial medullary cavity during ontogeny in the smaller specimen: (1) a marked lack of concentricity of growth lines in the fibula; (2) osteoblastic and osteoclastic activity on the lateral and medial periosteal surfaces of the fibula, respectively; (3) numerous secondary osteons and large erosion rooms in the medial region of fibular cortex; and (4), the presence of extensive endosteal lamellar bone in the tibia with little evidence of peri-medullary haversian systems, Howship's lacunae, or resorption lines. Similar patterns of fibular remodeling and migration, and/or tibial stationarity can be seen in published histological sections of Cretaceous tyrannosaurids (e.g., *Tyrannosaurus*, *Daspletosaurus* and *Raptorex*). These findings reveal potential biases associated with age estimates derived from fibulae, and emphasize the utility of multi-element histological studies for accurate ontogenetic assessment.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE EVOLUTION OF RHINO ARTHRITIS IN THE CENOZOIC

STILSON, Kelsey T., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States; DAVIS, Edward B., University of Oregon, Eugene, OR, United States

The family Rhinocerotidae provides a natural system for understanding the evolutionary underpinnings of arthritis, because osteological evidence of arthritis increases in frequency through their evolutionary history. The severity and prevalence of arthritis in Rhinocerotidae increases substantially from 50 million years (Ma) to the present: early rhinocerotids and their relatives have arthritis rates similar to those of other mammals, but individuals of all five extant species of rhinoceros develop extensive arthritis in all of their distal limb bones before they reach maturity. Through this interval, rhinos increased dramatically in size, evolving from animals like *Hyrachyus*, which was about the size of a large dog (150 kg), to the one-ton, stout-limbed megafauna of today. Despite this order of magnitude increase in mass, rhinos consistently displayed cursoriality (the habit of running) throughout their evolutionary history. These competing factors of increasing size and consistent cursoriality provide a possible driver for the prevalence of arthritis in living members of the clade. We have examined specimens of *Hyrachyus* and the extinct rhinos *Trigonias, Diceratherium, Menoceras, Aphelops, Teleoceras*, as well as all five species of extant rhinos on the population level. Using 2700 specimens from 12 species of rhinos, we have been able to trace the history of arthritic development in the rhino lineage, finding that arthritis changes immensely through the history of the rhinocerotid lineage, from 20% of the bones in *Hyrachyus* to 50% of the early Miocene *Menoceras* to almost 100% of skeletal elements in modern rhinos. As it increases, it goes from a phenomenon localized mostly in the feet to one found throughout the skeletal system, showing the impact of the forces experienced by the skeleton over an ever-increasing proportion of the animal's body. The severity of arthritis also seems to increase, as indicated by indicators of greater severity of arthritis in individual joints. The frequency of arthritic development is related to increasing body size, but that there are clearly other evolutionary effects controlling its prevalence, in particular ongoing evolutionary changes in locomotion. Our results suggest arthritis was a pathology that was 'allowed' to develop in lineages of rhinos in the face of more pressing adaptations. The persistence and rise of arthritis in rhinocerotids suggests that the resolution to this evolutionary tradeoff may include a surprising degree of accommodation.

Technical Session IX (Friday, October 19, 10:45 am)

SPATIAL AND TEMPORAL SHIFTS IN PALEOGENE CROCODYLIFORM DIVERSITY AND A NEW GLOBIDONT ALLIGATOROID FROM THE MIDDLE EOCENE OF WEST TEXAS

STOCKER, Michelle R., The University of Texas at Austin, Austin, TX, United States; BROCHU, Christopher A., University of Iowa, Iowa City, IA, United States; KIRK, E. C., The University of Texas at Austin, Austin, TX, United States

Most of our knowledge regarding the loss of diversity within Crocodyliformes in the Middle and Late Eocene comes from specimens from the central Western Interior. However, crocodylians from the Middle Eocene Devil's Graveyard Formation (DGF) of West Texas provide additional information from southern North America during that period of faunal reorganization. Here we describe a new taxon of alligatoroid from the middle member of the DGF based on the most complete alligatoroid material known from Tertiary deposits outside of the Western Interior. The precise age of the new taxon is unclear because of a lack of associated fauna or datable tuffs. However, the holotype was recovered from a stratigraphic horizon between the Late Uintan Purple Bench locality and the Duchesnean Skyline Channels localities. The new taxon is similar to alligatorine material from the Uinta Formation of Utah and shares the presence of nearly spherical tooth crowns with previously published mandibular fragments from lower in the DGF stratigraphic section. However, the new DGF taxon can be distinguished from the Uinta Formation material and all other alligatorines on the basis of several caiman-like features, including a prominent, notched, descending lamina of the pterygoid posterior to the choana and a long descending process of the exoccipital that makes contact with the basioccipital tubera. Additionally, autapomorphies of the new taxon include rounded anterior processes of the palatines and a prominent, anteriorly extending crest on the dorsal surface of the skull anterior to the orbit. Although the posterior maxillary teeth are bulbous (a feature shared with basal alligatorines), the posterior alveoli are smaller than the fourth and fifth maxillary alveoli, which is a feature shared with *Alligator* and another new species from the Uinta Formation. Our morphological phylogenetic analysis indicates that the new DGF taxon has potential affinities with Alligatorinae. This new taxon adds to the diversity of specialized globidontans in the Paleogene and represents the southernmost known occurrence of a blunt-toothed alligatoroid in the Paleogene of North America. Other crocodylians known from the DGF include a pristichampsine and *Borealosuchus*. Crocodyloids are not identified from this formation, suggesting slightly lower crocodyliform diversity in West Texas than in Uintan deposits further north.

Preparators' Session (Thursday, October 18, 9:00 am)

METHODOLOGY AND RESULTS OF A COMPREHENSIVE SPECIMEN CONSERVATION CONDITION SURVEY OF AN ACTIVE BONE BED AND STORAGE COLLECTION AT THE MAMMOTH SITE OF HOT SPRINGS, SD, INC.

STORCH, Paul, Museum Science Consultants, Saint Paul, MN, United States; WILKINS, William J., Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; POTAPOVA, Olga, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; AGENBROAD, Larry, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States

The Mammoth Site of Hot Springs, SD (MSHS) poses unique challenges for collections management, conservation, and preservation in that it is both an active, on-going paleontological excavation site and a research collection. Discovered in 1974, the development of the site and the museum has paralleled the growth and development in the field of museum conservation. Over the past two decades the MSHS has applied conservation methods and materials used in the stabilization and preservation of the specimens. The museum has also undergone various assessments of its operations, developed a long-range conservation plan, and acted on the recommendations of the assessors. The comprehensive specimen condition survey, an object by object survey, is the most detailed conservation assessment available. The assessment consists of visual and tactile observations of individual specimens and recording ordinal numerical rankings of specimen and matrix condition and treatment priority. The ranking system was developed by the conservator (Storch) in collaboration with the MSHS staff (Potapova and Wilkins). The amount of time in hours required for conservation treatments (e.g. stabilization, cleaning, reversing improper treatments, etc.) were also estimated. The bone bed and collections storage specimens were assessed in two on-site visits of ten days each. Eight hundred and thirty individual bones were assessed and results tallied for the three metrics mentioned above. Condition assessment reports were filled out for each specimen and will be added to the more detailed collections specimen records. Images of representative conditions for each ranking were taken and are included in the final project report. In the bone bed, 12% of the specimens are in the poor to fair condition categories, 68% in good, and 20% rated as excellent. The condition of the "poor/fair" specimens, and many of the elements in the "good" ranking, is due to the presence of darkened and aged cellulose nitrate and polyvinyl butyral polymer resins applied as preservatives and consolidants to the bone surfaces and matrix. Results are similar for the specimens in storage. The final project report summarizes the results within a conservation risk assessment framework of ten agents of deterioration including disassociation, or the separation of provenience information from the specimen. The project also applied the condition rankings to the specimen location information in ArcGIS for the site as an additional mapping layer so the in-situ exhibit specimens can be highlighted by condition ranking for identification and preservation work planning.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

MYRMECOPHAGOUS MAMMAL MICROWEAR

STRAIT, Suzanne G., Marshall University, Huntington, WV, United States

Faunivorous mammals eat an extensive array of food items that vary substantially in their physical properties and offer different foraging challenges. Therefore, it is not surprising there are equally diverse adaptations for feeding on these foods including two morphological extremes. Small-bodied primate, bat, insectivoran, and marsupial insectivores tend to hunt and feed primarily on individual coleopterans, lepidopterans, and orthopterans. Morphologically they have elongate shearing crests and high dental complexity values relative to frugivores. On the other extreme are the myrmecophagous mammals from many groups (anteaters, tamandua, armadillos, echidna, aardvark, pangolin, numbats, sloth bears, and aardwolves) that have evolved to prey upon on colonial insects (hymenopterans and isopterans). The true specialists of this group have convergently evolved reduced dentitions and dentaries. Additionally, many other modern mammals include large quantities of colonial insects in their diets but do not demonstrate the extreme masticatory system reduction of species such as anteaters and pangolins. The question explored in this study was whether there is a dental microwear signal correlated to ant and termite feeding that could be used to identify fossil taxa that regularly eat colonial insects regardless of whether or not they demonstrate masticatory reduction.

Scanning electron micrographs at 500x magnification of lower molars were analyzed for microwear feature size and density on the only myrmecophagous mammals that have retained enamel-covered teeth: *Proteles cristatus* (aardwolf), *Melursus ursinus* (sloth bear), and *Myrmecobius fasciatus* (numbat). These data were compared to earlier work on other faunivorous mammals and data from the literature for frugivores and folivores. Results indicate that feature density is probably the microwear signal most suggestive of some sort of faunivory, with faunivores have much higher feature densities than either frugivores or folivores. Additionally, although termite/ant feeders tend to have same high feature density range as previously reported for other types of faunivorous diets, they can be distinguished from these by lower pit frequencies. These data suggest that the microwear signal of myrmecophagous mammals is unique and can potentially be identified in the fossil record.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RE-EXAMINING THE AFFINITIES OF *MOSASAURUS GRACILIS* – IS IT TRULY A *MOSASAURUS*?

STREET, Hallie P., University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada

In 1822, the genus *Mosasaurus*, based on remains from the Maastrichtian of the Netherlands, became the first named taxon of mosasaur, followed in 1829 by the addition of the specific epithet to the specimen of "*hoffmanni*". *Mosasaurus missouriensis* (originally described as *M. maximilliani*) from the Upper Campanian of North America was the second described species of *Mosasaurus,* followed in 1849 by the description of *M. gracilis* from very fragmentary remains from the Middle to Upper Turonian (Upper Chalk) of the southeast English Coast. The type material of *M. gracilis* includes an associated pair of right and left dentaries, an isolated vertebra, and three articulated vertebral fragments, all from the Middle to Upper Turonian sections of the Offham Pit, near Lewes; and a right dentary originally described as a maxillary fragment, from the Chalk at Dorking. Examination of the type specimens of *M. hoffmanni* and *M. missouriensis,* with comparisons to *M. gracilis,* reveals that the latter taxon does not share any generic-level anatomical features with either the generic type, or these two other species of *Mosasaurus*. In fact, *M. gracilis* exhibits more shared characters, such as a short rostrum on the dentary anterior to the first tooth, with russellosaurine mosasaurs. In addition, *M. gracilis* is known from Turonian-aged deposits, while other species belonging to *Mosasaurus* are Upper Campanian to Masstrichtian in age. Based on the evidence of shared characters and contemporaneity, we suggest that *M. gracilis* be removed from *Mosasaurus* because it shares more affinities with russellosaur-like mosasaurs.

Technical Sesssion XII (Friday, October 19, 2:15 pm)

AGE AND PALEOECOLOGY OF MOSASAURS AND PLESIOSAURS FROM THE LATE CRETACEOUS SOUTH ATLANTIC MARGIN AT BENTIABA, ANGOLA

STRGANAC, Christopher, Southern Methodist University, Dallas, TX, United States; FERGUSON, Kurt M., Southern Methodist University, Dallas, TX, United States; JACOBS, Louis L., Southern Methodist University, Dallas, TX, United States; POLCYN, Michael J., Southern Methodist University, Dallas, TX, United States; MATEUS, Octávio, Universidade Nova de Lisboa, Caparica, Portugal

The geology of coastal Angola reflects the rifting of Africa and South America and the development of the South Atlantic Ocean. This study utilizes stable carbon isotopes derived from mollusk shells to constrain the age of mosasaur and plesiosaur teeth recovered from a single horizon, and uses carbon isotopic values derived from tooth enamel to refine the marine vertebrate niche partitioning. The vertebrate-bearing horizon is near the top of a marine section unconformably overlying continental syn-rift deposits. A basalt flow intercalated within the marine sequence is dated at 84.5 Ma (Santonian), and reflects a widespread magmatic interval along the South Atlantic margin. The age of the basalt ties $\delta^{13}C$ chemostratigraphy to the secular $\delta^{13}C$ curve of the English Chalk and Tunisia. Low in the section is a 4‰ positive excursion interpreted as Oceanic Anoxic Event 2 at the Cenomanian-Turonian boundary (93.5 Ma), indicating the sediments were deposited from

the Late Cenomanian to Early Maastrichtian. The $\delta^{13}C$ values derived from mosasaur and plesiosaur tooth enamel range from -5 to -16‰, showing a negative trend with increasing body size. This pattern is similar to that observed in modern marine mammals, in which more negative $\delta^{13}C$ values correlate with deep diving behavior and foraging habitats distant from the shoreline. Specimens of the mosasaur *Globidens* yielded values more negative than expected for their body size and are interpreted as reflecting long diving durations required by their durophagous feeding behavior. Plesiosaur specimens yielded $\delta^{13}C$ values between -5 to -14‰. The large range in values reflects taxonomic variation or habitat partitioning among individuals. The diversity of niches utilized by large bodied marine amniotes implied by these results suggests a high level of productivity during the Late Cretaceous across a range of habitats along the coast of Angola.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

LATE CRETACEOUS FISH OTOLITHS FROM NORTHEAST MISSISSIPPI: IMPLICATIONS FOR NORTH AMERICAN TELEOSTEAN EVOLUTION AND DISTRIBUTION

STRINGER, Gary L., University of Louisiana at Monroe Museum of Natural History, Monroe, LA, United States

Well-preserved and relatively abundant fish otoliths from the Late Cretaceous Ripley Formation at the Blue Spring Site (MS 73.033) in southeast Union County in northeastern Mississippi (USA) have contributed to a better understanding of teleostean evolution and distribution in North America. Extensive leaching of Cretaceous strata often destroys the aragonitic fish otoliths and limits otolith occurrence to primarily clays and marls. Fortunately, highway construction exposed a large area of the Ripley Formation, which included the Coon Creek beds that contain aragonitic remains. Ten collections were acquired from the aragonitic clay beds through bulk sampling and surface collecting. These collections resulted in approximately 800 fish otoliths for study. The number of specimens from the Blue Springs Site is quite significant in that many previous North American Cretaceous otoliths studies have been based on 100 to 300 otoliths. Bulk samples were taken at four measured sections at the site with seven samples ranging from 11.5 to 25 kilograms (total of 102 kilograms). Bulk samples produced 446 otolith specimens, while three surface collections supplied an additional 355 otoliths. Statistical analysis for abundance was limited to the bulk sample otoliths.

The majority of the otoliths were sagitta, but there were lapilli from several ariid taxa (marine catfish). Some of the otoliths exhibited crenulated and lobated margins, which was an indication of their excellent state of preservation. The abundance and preservation of the fish otoliths contributed to the first North American Cretaceous occurrence of several taxa. Furthermore, the larger sized otoliths from the surface collections made it possible to identify several taxa with greater specificity than previously possible based on smaller, immature specimens. Otolith specimens that compare favorably with the synodontids (lizardfishes) *Saurida* and *Synodus* are reported for the first time from the Cretaceous in North America. Also, a small serranid otolith was identified as most likely belonging to *Centropristis* and represents the first *Centropristis* otolith from the North American Cretaceous. The specimen is especially significant in that it provides additional evidence for the presence of perciforms in the Cretaceous. Perfciforms were long believed to be restricted to the Cenozoic, but otoliths studies from North America and Europe have clearly shown their presence in the Mesozoic. Well-preserved, larger otoliths from the surface collections made it possible to more precisely identify several forms. The otoliths previously identified as Polymixidae indeterminate appear to be closely related to *Polymixia*, and "genus Trachichthyidarum" *oscitans* may be in the genus *Hoplostethus.*

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

COMPUTER TOMOGRAPHY INVESTIGATIONS INTO CRANIAL PNEUMATICITY IN A SMALL OLIGOCENE SULID (STEGANOPODES:SULIDAE)

STUBBS, Alyssa E., North Carolina State University, Raleigh, NC, United States; KSEPKA, Daniel T., North Carolina State University, Raleigh, NC, United States

Sulidae is a family of coastal seabirds known for their ability to plunge-dive from great heights to catch prey. Extant sulids possess a series of sub-dermal air sacs and exhibit high levels of skeletal pneumatization, which together are hypothesized to cushion the bird during high-velocity impacts with the water surface. A skull from a new fossil sulid taxon reveals details of skull morphology, cranial pneumaticity and neuroanatomy of a basal member of this waterbird lineage. This taxon is smaller than any living species of Sulidae and lacks several derived features of extant *Sula* and *Morus*, suggesting it may represent a stem lineage sulid. The fossil was recovered from deposits of the Ashley Formation of South Carolina at the Charleston Airforce Base. These deposits are Early Oligocene to Late Oligocene in age.

Computed tomography scans were taken of the skulls of the fossil sulid, the extant *Sula leucogaster,* and the cormorant *Phalacrocorax auritus* to explore the endocranial morphology of Sulidae and a closely related non-plunge-diving waterbird. Virtual endocasts were generated using the volumetric rendering program Avizo. The endocranial anatomy of the fossil sulid and *S. leucogaster* are highly similar, as evidenced in both the brain endocasts as well as cross sections of the skulls. Within the brain, a number of parallels can be seen: a small flocculus, a well-developed optic tectum, and an expansive cerebellum. The cerebrum of *S. leucogaster* is more expansive than the cerebrum of the fossil sulid. Skull cross-sections reveal a high level of pneumaticity in the skulls of both the fossil sulid and *S. leucogaster*, while there is a low level of pneumaticity within the skull of *P. auritus*. Together with evidence from sulid postcranial elements recovered from the same horizon of the Ashley Formation, the high level of pneumaticity found within the braincase of the fossil sulid implies that this basal member of the sulid lineage also employed plunge-diving despite its small size.

Technical Session XVIII (Saturday, October 20, 4:00 pm)

BIOSTRATIGRAPHY AND CORRELATION OF VERTEBRATE AND PLANT FOSSILS FROM THE WIND RIVER FORMATION (YPRESIAN, EARLY TO MIDDLE EOCENE) OF CENTRAL WYOMING IN NORTH AMERICA

STUCKY, Richard, Denver Museum of Nature & Science, Denver, CO, United States; MILLER, Ian, Denver Museum of Nature & Science, Denver, CO, United States; CLYDE, William, University of New Hampshire, Durhan, NH, United States; BOWRING, Samuel, Massichusetts Institute of Technology, Cambridge, MA, United States; CHINNERY, Brenda, University of Texas, Austin, TX, United States

Over the past five years, a concentrated effort has been made to investigate previously unexplored areas in the Wind River Basin, Wyoming, that further clarify the biostratigraphy and correlation of the early to middle Eocene Wind River Formation. A comprehensive stratigraphic framework incorporates chronostratigraphic, magnetostratigraiphic, biostratigraphic and seismic data for local correlation of many formerly isolated exposures of the formation in the northwestern part of the basin and global correlation to the time scale. In addition, new discoveries of plant localities in this area can now be tied directly into the vertebrate biostratigraphic sequence. The Wind River Formation is the stratotype for the Wasatchian Biochronological Zone WA7 and the Bridgerian Biochronological Zone BR1A and is critical to the assessment of the Early-Middle Eocene boundary in North America. Data from plants and vertebrates indicate that peak Paleogene temperatures during the Early Eocene Climatic Optimum encompass this time interval. New samples of volcanic ash for isotope dating provide ages for the lower part of WA7 and the upper part of BR1A. New magnetostratigraphic data should further help clarify the age of the Wind River Formation as well. Well-log data shows a subsurface horizon that has been used to determine positions of different surface exposures of the Wind River Formation across the northeastern part of the basin from Hells Half Acre west to the Boysen Reservoir area. Records of Siluriformes fish and pristichampsine crocodiles are known in the Wind River Formation only from BR1A and along with records of other early Bridgerian mammals (*Eotitanops, Hyrachyus, Trogosus*) establish the base of the Bridgerian (BR1A . Current work is focused on refinement of the magnetostratigraphy, isotopic dating, sampling of plant and vertebrate localities across the WA7-BR1A boundary, and exploration in new areas.

Technical Session I (Wednesday, October 17, 9:45 am)

TYRANNOSAURID DINOSAURS FROM THE UPPER CRETACEOUS WANGSHI GROUP OF ZHUCHENG, SHANDONG PROVINCE, CHINA: COEXISTING GIANT CARNIVORES AND A TYRANT WITH A TOOTHACHE

SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; HONE, David W., University of Bristol, Bristol, United Kingdom; ROTHSCHILD, Bruce M., University of Kansas, Lawrence, KS, United States; WANG, Kebai, Zhucheng Dinosaur Museum, Zhucheng, China; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Since the 1960s, vast and highly productive dinosaur quarries have been known to exist near the city of Zhucheng, Shandong Province, China. Excavations at the three Upper Cretaceous (probably Campanian) sites of Kugou, Zangjiazhuang and Longgujian have yielded thousands of bones from giant hadrosaurids and a smaller number from ceratopsians, ankylosaurs, small coelurosaurs, sauropods and tyrannosaurids. Much of this material remains undescribed. Tyrannosaurid teeth were among the initial specimens recovered from the quarries, and were first referred to the North American *Tyrannosaurus rex* and later assigned with an isolated metatarsal to the new putative species *"Tyrannosaurus zhuchengensis"*.

Although these finds are taxonomically indeterminate, more diagnostic tyrannosaurid material has recently been collected and is being studied by our research group. An associated maxilla and dentary comparable in size and gross morphology to the corresponding elements in the Mongolian species *Tarbosaurus bataar* were recently described by some of us as a new large tyrannosaurine, *Zhuchengtyrannus magnus*. *Z. magnus* is distinct from *T. bataar* in important details of the maxilla, including the lack of a subcutaneous flange, the presence of a horizontal shelf on the lateral face of the ascending process, and the shape and position of the maxillary fenestra. A second tyrannosaurid maxilla and second dentary are known from the same quarry, and disarticulated postcranial bones and teeth have also been collected from the Zhucheng sites. The second maxilla is distinct from that of *Z. magnus* in many respects, including all three features mentioned above, but could be referable to *T. bataar* despite minor differences from previously described maxillae of that taxon. It is clear that two very large tyrannosaurine species coexisted in what is now the Zhucheng area during the Late Cretaceous, an unusual situation that presumably required some form of niche partitioning.

The second tyrannosaurid dentary shows clear pathological features, including a swollen, mediolaterally thickened overall shape and a mound-like prominence on the medial surface below the foramen intramandibularis oralis. CT scans suggest that the prominence represents the surface expression of a dental abscess, from which an osteomyelitic infection probably spread diffusely and altered the shape of the entire dentary. Although a dental abscess has previously been documented in a hadrosaurid dinosaur, the presence of this type of

pathology in a theropod is novel. Dental abscesses appear to have been uncommon in dinosaurs, but in rare cases they clearly did occur. The abscess in the dentary from Zhucheng would certainly have interfered with feeding and been detrimental to the animal's overall health.

Preparators' Session (Thursday, October 18, 10:15 am)

USING A GLYCEROL-WATER SOLUTION TO CONTROL RELATIVE HUMIDITY IN A CLOSED ENVIRONMENT

SUPPLEE, Jeffrey, East Tennessee State University, Johnson City, TN, United States; COMPTON, Brian, East Tennessee State University, Johnson City, TN, United States

Glycerin is a tri-hydric alcohol that is water-soluble, viscous, and hygroscopic. Consequently, it has many industrial uses in areas such as pharmaceuticals, food and beverages, textiles, paper and printing, among others. The hygroscopicity of glycerin (also called glycerol) is its ability to take moisture from the atmosphere and hold it. In order to achieve a desired relative humidity in an enclosed environment, a given amount of water can be added to a glycerin solution which achieves evaporative equilibrium with the enclosed atmosphere. To slowly dry fossils, we utilized glycerol's properties to incrementally lower the relative humidity over extended time periods. Prior to this use of glycerol solutions, wet Pleistocene fossils from Saltville, VA were tested using other methods to control the rate of water evaporation. The fossils were dried at different rates (quick dry, 1 month, 3 months, and 6 months), attempting to control the rate of drying by slightly opening or adding damp towels to closed containers housing the fossils. We had remote sensors that recorded temperature and relative humidity inside each of these closed containers. A uniform decrease in relative humidity from wet (98%) to the relative humidity in collections (47%) was calculated to use as a standard for each of these time frames. Trying to match this calculated rate of drying without using glycerin was very difficult. The original method resulted in large variations in relative humidity, while the glycerol method enabled us to precisely control the relative humidity of the environment. We used a food grade glycerol product (vegetable glycerin 99.9%) for a three-month test. Glycerol placed in a beaker with no added water in a closed container equilibrated to a relative humidity of about 20% after several days. We then added water to create a solution that equilibrated with the closed atmosphere to a relative humidity of 98%. At this point we added the wet fossil to the container and incrementally added glycerol in order to reproduce the calculated three-month drying curve. Use of glycerol solutions has been successful in controlling the rate of drying inside the containers housing the Saltville fossils.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

MECHANISM OF THE CRUROTASAL JOINT

SUZUKI, Daisuke, Department of Anatomy, Sapporo Medical University, School of Medicine, Sapporo, Japan; CHIBA, Kentaro, Natural History Sciences, Hokkaido University, Sapporo, Japan

The movable astragalus-calcaneum joint is a key feature diagnosing crurotarsan archosaurs. This joint plays an important role in forming the posture of crurotarsans, whether semi-erect and/or fully-erect. The calcaneum of all crurotarsans has a large calcaneal tuber, which is thought to produce a large moment arm during plantar flexion at the ankle by sagittal movement. This morphology of crurotarsan ankles may affect their posture and locomotory system, but the detailed mechanisms of this joint have not been investigated. In this study, six crocodile specimens (three *Crocodylus porosus*, two *C. siamensis*, and one *Tomistoma schlegelii*) were used to study the ankle joint mechanism of crocodiles, the sole survivor of the crurotarsans. These specimens were CT scanned at five different positions, from maximum dorsiflexion (approximately 65 degrees) to maximum plantar flexion (approximately 145 degrees). In addition, three formalin fixed crocodylian specimens (two *Caiman crocodilus*, one *C. porosus*) were dissected to observe their macroscopic morphology. The dissected specimens show that the calcaneal tuber projects posterolaterally, and possesses a pulley-like central groove. The tendon of the gastrocnemius passes through the groove, and partially extrudes onto the medial surface of the calcaneal tuber. The analysis of the CT images shows that the horizontal movement is larger than the sagittal movement in the astragalus-calcaneal joint while changing from dorsiflexion to plantar flexion. The sagittal movement increases when changing from the neutral position to maximum plantar flexion, although the horizontal movement increases constantly during dorsiflexion to plantar flexion. The results indicate that the calcaneum tuber is an enlarger of the moment arm during plantar flexion. However, the calcaneal tuber is more important for the horizontal movement than for the sagittal movement. This might be generated by the gastrocnemius tendon wrapping around the medial calcaneal tuber. The horizontal movement (mainly external rotation) at the astragalus-calcaneum joint creates propulsion and generates crurotarsan semi-erect or fully-erect posture. This mechanism, however, may be less effective than the dinosaurian mesotarsal joint mechanism with fully-erect posture, in that the sagittal movement could propagate the power effectively in erect postures.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PARAMETRIC COMPUTATIONAL FLUID DYNAMICS SIMULATION OF THE RESPIRATORY HEAT LOSS IN SAUROPODOMORPH DINOSAURS: THE ROLE OF LONG TRACHEA

SVERDLOVA, Nina S., Ruhr-Universität Bochum, Bochum, Germany; FECHNER, Regina, Ruhr-Universität Bochum, Bochum, Germany; PERRY, Steven F., Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn, Germany

High metabolic rate in sauropodomorphs has been proposed and discussed in the literature. Due to the high volume to surface ratio of large sauropodomorphs, the temperature control using respiratory system gains importance. Previously measured respiratory heat and water loss and our recent computational fluid dynamics simulations of breathing cycle in domestic fowl showed that the evaporative respiratory heat loss takes place mainly in the trachea. In the present study we test the hypothesis that the remarkably long neck of some sauropodomorphs facilitate an effective system of evaporative cooling able to sustain high metabolic heat production of these extinct species. To this end we select several sauropodomorphs, for which both the neck length estimates and body mass estimates are available based on the fossil material. We consider smaller sauropodomorphs (*Plateosaurus and Shunosaurus*) with estimated body masses under 5 tons and large sauropodomorphs (*Brachiosaurus*, *Diplodocus*, *Mamenchisaurus*) with estimated body masses above 10 tons. For the dimensions of the trachea and respiratory parameters (tidal volume, respiration rate, and inspiration time) we use allometric relationships from avian data. The tidal volume values are obtained in two different ways: based on the allometric relationship for the tidal volume and derived from the allometric oxygen consumption rate as the amount of air that contains enough oxygen to sustain the body weight. We use these data and generate three different computational fluid dynamics models as simplified representations of the respiratory system of sauropodomorphs and simulate a breathing cycle. The tracheal diameter is varied for each model to reach the heating and humidification of air at the caudal end of trachea for different body temperatures. Our results show that allometric relationships have limitations for the determination of the geometry of the trachea of long-necked sauropodomorphs as well as for the estimation of the tidal volume, which plays an immediate role in predicting the heat loss in the system. The estimation of the tidal volume based on oxygen consumption, which takes into account the large dead space due to the long trachea, seems more meaningful and produces more realistic results. Computational fluid dynamics simulations and parametric analysis present a powerful tool for the understanding of the function of the respiratory system in temperature control due to convective and evaporative cooling, especially when the information on geometry and physiology of the system is lacking. We conclude that even though the present study relies essentially on the accuracy of the mass estimates for the extinct animals, it still gives an insight into the physiological constraints compatible with life.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DIAGENESIS AND PALEOENVIRONMENTAL CHANGES IN NEOGENE FOSSILS AND ENVIRONMENTS FROM PANAMA: EVIDENCE FROM REE PROXIES

SYMISTER, Chanika D., University of Florida, Gainesville, FL, United States; MACFADDEN, Bruce J., University of Florida, Gainesville, FL, United States; HENDY, Austin J., University of Florida, Gainesville, FL, United States; PIMIENTO, Catalina, University of Florida, Gainesville, FL, United States; DEGRACIA, Carlos, Smithsonian Tropical Research Institute, Panama City, Panama

Previous studies have shown that vertebrate taxa have undetectable amounts of rare earth elements (REEs) in their skeletons during life; little has been reported about fossil invertebrates. So far as is known, after death and during the early stages of diagenesis, REEs are quickly incorporated into the mineral lattice of the bones and teeth, and as reported here, shells and otoliths. The REE uptake in fossil specimens potentially can be used to determine the diagenetic environments of these fossils. The present study was designed to evaluate the REE uptake in samples taken from 69 specimens collected from the Culebra, Cucaracha, Gatun, and Chagres formations, and late Miocene strata in Darien Basin of Panama. Our overall goals were to use REEs to understand patterns of diagenesis and changes in terrestrial and oceanic environments in South America during the Miocene. The specimens were sampled using a rotary drill. They were then acid digested and diluted using University of Florida Department of Geological Sciences' laboratory protocol. The samples were analyzed for their bulk REE concentrations on an Inductively Coupled Plasma Mass Spectrometer (ICPMS). Because REEs can be correlated to the REE of the pore waters in which the fossils were fossilized, ratio analysis of La/Sm compared to La/Yb either confirmed paleo-depths of previous studies, or provided new evidence from the other poorly known localities. The plots of the vertebrate tooth and bone specimens from the five formations showed higher REE concentrations than those of the invertebrate plots, confirming a greater degree of porosity and relative diagenesis. The data also demonstrate that the Cucaracha and some Culebra samples were diagenetically altered in a terrestrial environment due to a continental signal, the Gatun sharks were altered in coastal environments, and the Darien and Chagres samples were altered in an oceanic environment. In contrast to the vertebrate bone samples, the Gatun snail *Strombina* sp., and Gatun otoliths display different REE patterns, with concentrations declining from La to Lu. These likely differ from the other REE plots due to their aragonitic composition. The Gatun echinoid, *Encope,* and oyster *Hyotissa,* both showed lower REE uptake indicating relatively little diagenesis. Our study demonstrates that REE analyses of fossils composed of hydroxylapatite or calcite are a useful proxy to determine early fossil diagenesis and paleoenvironment.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ADDITIONAL MATERIAL OF THE TYPE SPECIMEN OF THE TAPIROID *COLODON KAYI* (HOUGH) FROM THE SAGE CREEK BASIN, MONTANA

TABRUM, Alan R., Carnegie Museum of Natural History, Pittsburgh, PA, United States

Carnegie Museum of Natural History specimen (CM) 9561, a right maxilla with P3-M3 (P3 and P4 not supported by bone), is the holotype specimen of the tapiroid *Colodon kayi*. This specimen was collected in 1939 from late Uintan beds exposed in the Sage Creek

Basin of southwestern Montana and is one of several specimens from the same small locality assigned the field number 18/39. Two additional maxilla fragments of *C. kayi* were discovered several years ago in the specimen tray containing CM 9559, a skull and jaws of *Protoreodon* also collected in 1939 and assigned the field number 18/39. The two "new" maxilla fragments of *C. kayi* preserve (1) right P2 and roots of right P1, and (2) somewhat eroded left P1-P3. The right P2 of one of the "new" maxilla fragments tightly contacts the right P3 of CM 9561; hence, the two "new" maxilla fragments clearly pertain to the type specimen of *C. kayi.* Furthermore, a pair of lower jaws of *C. kayi*, CM 12088, was also collected in 1939 and bears the field number 18/39. Based on similarities in preservation, dental wear stage, and fairly tight occlusion between the right upper cheek teeth of CM 9561 and the right lower cheek teeth of CM 12088, the lower jaws of CM 12088 seem almost certain to represent the same individual as CM 9561, the type specimen of *C. kayi.*

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE FIRST RECORD OF A HESPERORNITHIFORM FROM JAPAN

TANAKA, Tomonori, Hokkaido University, Sapporo, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; KANO, Manubu, Mikasa City Museum, Sapporo, Japan; KURIHARA, Kenichi, Mikasa City Museum, Sapporo, Japan

Hesperornithiforms are marine foot-propelled diving birds and one of the most widely distributed group of birds in the Cretaceous. Here, we report the first record of a hesperornithiform from the Upper Cretaceous Kashima Formation (Coniacian to Santonian) of the Yezo Group, Japan. In 1996, a calcareous concretion was collected from siltstone-dominant marine deposits of the formation in Kumaoizawa Creek in Mikasa City of central Hokkaido. It contained a partial, semi-articulated skeleton of a hesperornithiform and the ammonites *Polyptychoceras psudogaultinum* and *Damesites damesi,* which suggest that the age of the horizon is early Santonian. The skeleton is represented by three cervical and three dorsal vertebrae, distal ends of left and right femora, and a middle part of left fibula. All of the preserved vertebrae are heterocelous with saddle-shaped articular surface. The foramen transversarium of the cervical vertebra is large. The fibular condyle of the femur is expanded laterally as seen in many diving bird taxa (hesperornithiforms, gaviiforms, and podicipediforms). The concavitas lateralis of the dorsal vertebrae is deep, which is present only in hesperornithiforms. The combination of the characters in the dorsal vertebrae and the femur indicates that this specimen belongs to Hesperornithiformes. Prior to the Santonian, all of hesperornithiforms were reported from Cretaceous deposits in North America, except for *Enaliornis* from Albian of England. During the latest Santonian to Maastrichtian, hesperornithiforms appear to have radiated widely into Europe (Sweden, Russia, Ukraine, and Kazakhstan) and Asia (Mongolia). This Japanese hesperornithiform is the first report from the eastern margin of the Eurasian Continent and the oldest record outside of North America for the Cretaceous, except for *Enaliornis*. It also implies that the distribution of hesperornithiforms was expanded to Asia in, or prior to, the Santonian age.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ANOTHER LOOK AT THE ORIGIN OF THE ENIGMATIC GANGES RIVER DOLPHIN *PLATANISTA*, AND THE CONTENT OF THE SUPERFAMILY PLATANISTOIDEA (ODONTOCETI: CETACEA)

TANAKA, Yoshihiro, University of Otago, Dunedin, New Zealand; FORDYCE, Robert E., University of Otago, Dunedin, New Zealand

The history and relationships of the Ganges River dolphin *Platanista* (Odontoceti, Cetacea) have been contentious since Flower's pioneering studies of "river dolphins" in the mid 1800s. Do living "river dolphins" – *Platanista*, *Inia*, *Pontoporia* and *Lipotes* - form a clade, or does the Platanistoidea exclude the latter three genera? Recent osteological, paleontological and molecular studies have not yet reached consensus. We are now reassessing the cladistic relationships of fossils in the odontocete families Waipatiidae, Allodelphinidae, Squalodontidae and Squalodelphinidae, to see which, if any, belong to Platanistoidea rather than in to stem Odontoceti. The study includes some new marine fossils from Oligo/Miocene rocks in New Zealand, with a total of 14 taxa (*Zygorhiza, Agorophius, Allodelphis, Waipatia, Squalodon, Platanista, Zarhachis, Prepomatodelphis, Squalodelphis, Notocetus vanbenedeni, "N." marplesi,* un-named *Notocetus*-like OU 22306, *Kogia* and *Mesoplodon*), and 123 characters from previous studies by direct study of specimens (optimal) or casts, personal notes or photographs and published literature. Branch-bound algorithms of PAUP 4.0b produced following tree, in which 17 characters support monophyly of Platanistoidea (sensu Muizon), with this order of families: (Mesoplodon +Kogia (Allodelphinidae (Squalodontidae (Waipatiidae (paraphyletic "Squalodelphinidae" (Platanistidae)))))). If correct, this result indicates a higher diversity for Platanistoidea in the past than now, and deep (Late Oligocene) origins. Of note, "Squalodelphinidae" appears as a paraphyletic cluster immediately stem-ward of Platanistidae, with the species of *Notocetus* being paraphyletic. The addition of more fossil putative platanistoids from New Zealand may better resolve the relationships of the Squalodelphinidae and Platanistidae.

Technical Session III (Wednesday, October 17, 1:45 pm)

EAR MORPHOLOGY OF *CAENOMERYX* AND RELATIONSHIPS OF CAINOTHERIIDS

THEODOR, Jessica M., University of Calgary, Calgary, AB, Canada; DREGER, Sonya, University of Calgary, Calgary, AB, Canada; WIGG, Jacqueline, Universoty of Calgary, Calgary, AB, Canada; RUF, Irina, Steinmann-Institut für Geologie, Mineralogie und Paläontologie Bereich Paläontologie, Bonn, Germany

The phylogenetic relationship of cainotheriids to other cetartiodactyls has been difficult to resolve, with recent analyses placing them either within Tylopoda or as basal ruminants. Previous description of a skull of *Cainotherium* showed several features which may bear on the question of cainotheriid relationships, but additional data on other cainotheriids was lacking.

Micro-CT investigations of the ear region of two specimens of *Caenomeryx* show that the preserved morphology is very similar to *Cainotherium*, including a greatly enlarged cancellous auditory bulla. The prominent ridge separating the endocranial cerebral and cerebellar faces of the periotic seen among ruminants and protoceratids is lacking. The pars canalicularis of the periotic contains a massive, anteriorly directed subarcuate fossa, which faces more anteriorly than in *Cainotherium*. The subarcuate fossa contains a deeper mastoid fossa within it. As in *Cainotherium*, the foramen acusticum superius (leading into the facial canal) and internal acoustic meatus are separate, not set into a submeatal depression as in other known cetartiodactyls, suggesting that this separation of these foramina is synapomorphic for at least the Cainotheriinae, if not Cainotheriidae. On one specimen of *Caenomeryx*, ventral to these foramina, the periotic bears a subtle flange bordering the lateral edge of the petrobasilar canal. This feature is similar to, but less well-marked, the condition in Cainotherium, and is not preserved in the second specimen. The sinus venosus temporalis is present, but appears to be mediolaterally compressed relative to that of Cainotherium.

The morphology of *Caenomeryx* based on these two specimens indicates that cainotheriid ear morphology is relatively consistent and is likely to be phylogenetically informative. The separation of the foramen acusticum superius form the internal acoustic meatus appears to be autapomorphic for at least the cainotheriines; additional data for the oxacronine cainotheriids is necessary to verify the status for Cainotheriidae as a whole. The enlarged subarcuate fossa with a deep mastoid fossa is shared with a number of tylopodan taxa, including extant llamines, *Bunomeryx*, anoplotheres and xiphodontids, but is also known among basal ruminants such as hypertragulids. The ventral flange bordering the petrobasilar canal appears to be poorly marked overall in cainotheriids and clearly differs from the overhanging condition in camelids and *Bunomeryx.* The overall morphology is more similar to that observed in camelids, xiphodontids, and anoplotheres, but additional data will be needed to resolve the polarity of these characters.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ASSESSING THE DIFFICULTIES OF GENUS-LEVEL DIAGNOSES OF FOSSIL RODENTS

THIES, Monte L., Sam Houston State University, Huntsville, TX, United States; TUTALO, Richard, Sam Houston State University, Huntsville, TX, United States; LABBE, Micky D., Sam Houston State University, Huntsville, TX, United States; LEWIS, Patrick J., Sam Houston State University, Huntsville, TX, United States

When accurately identified, the fossil remains of rodents and other small mammals can often provide detailed ecological and environmental insights about the past. In many small mammal fossil deposits, the maxillae, mandibles and dentition are the best preserved and most abundant fossil elements. As such, these specimens are commonly used in the identification of rodent taxa in the fossil remains. Previous research at various fossil sites throughout southern and eastern Africa has yielded taxonomic lists with species-level identifications based on cusp patterns of cheek teeth. However, accurate species-level identifications seem unlikely due to a lack of consistent and identifiable dental apomorphies. Our research, involving an examination of 16 genera of extant rodents collected in association with an extensive array of small mammal fossils from a cave in Ngamiland Province of northwestern Botswana, has attempted to address this problem. Since fossil remains of small mammals often lack complete sets of dentition due to various taphonomic processes, using the extant members of each taxon (via barn owl pellets, live trapping, and museum specimens) allowed for the best assessment of the diagnostic dental apomorphies present in each genus. Once the dental apomorphies of each extant genus were identified, those characteristics could then be applied in the identification of the fossil taxa. Using both molar cusp and alveolar patterns, comparisons were made between and among the sixteen taxa to determine which tooth/alveolar patterns were the most diagnostic for genus-level identifications. Generally, alveolar patterns were not specific enough to warrant a single genus-level identification, although they are useful for eliminating certain taxa. Additionally, the upper and lower M1s are the most diagnostic teeth while the upper and lower M2s and M3s are the least diagnostic for genus-level identification. For most taxa, a complete set of both maxillary and mandibular dentition was necessary for a genus-level identification. Nonetheless, the rarity of complete sets of teeth in fossil deposits presents a potential problem in the identification of fossil rodent specimens.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SEARCHING FOR EVIDENCE OF FOSSIL FEATHER COLOR WITH SPECTROSCOPY

THOMAS, Daniel B., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; JAMES, Helen F., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; CARRANO, Matthew T., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; MADDEN, Odile, Museum Conservation Institute, Smithsonian Institution, Washington, DC, United States

Fossilized melanin-bearing organelles (melanosomes) have recently given insight into the original coloration of fossil feathers in both extinct birds and their non-avian dinosaur relatives. Although melanin contributes part of the color palette to Neornithes, the full spectrum of modern feather color is achieved with a more diverse array of biochemicals. Therefore, expanding the color palette of fossil feathers may require analyses from a set of complementary techniques. Spectroscopic methods provide a good supplement to the existing morphological approach as they can rapidly differentiate each of the modern feather pigments without destruction of the original sample. We have explored the descriptive potential of Raman spectroscopy for analyses of modern and fossil feathers. Each of the reported feather pigments could be differentiated by in situ analyses of modern feathers, and spectral variations between chemically related pigments reflected shifts in hue. This allowed construction of a spectral library for identifying feather pigments in fossils. The presence or absence of fossil feather pigments may be rapidly determined, and potentially provide color descriptions from point to point, or inform about the benefit of subsequent destructive analyses.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NO ENVIRONMENTAL PARTITIONING OF CERATOPSIDAE WITHIN THE LOWER DINOSAUR PARK FORMATION (CAMPANIAN) FAUNAL ZONE OF WESTERN CANADA

TOKARYK, Timothy T., Royal Saskatchewan Museum, Eastend, SK, Canada; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

The Dinosaur Park Formation (DPF) (Campanian) of Alberta, Canada, is one of the best sampled Late Cretaceous dinosaur-bearing units in the world, and has produced hundreds of articulated skeletons and skulls of more than 40 taxa. It also preserves the last terrestrial sediments of the Belly River Group before the transgression of the Western Interior Seaway (WIS) deposited the marine Bearpaw Formation across the western interior of Canada. Limited exposures of the DPF occur in southern Saskatchewan (SK). The most northern exposures occur near the village of Unity, SK, while the most western outcrops are near Diefenbaker Lake, SK, approximately 300 km to the east of the primary DPF exposures in Alberta. A vertebrate fossil locality from approximately the middle portion of the DPF at Diefenbaker Lake represents the proximal-most occurrence of the formation to the WIS in North America. It preserves a multitaxic bone bed dominated by the disarticulated, fragmentary cranial elements of a centrosaurine ceratopsid that closely resemble those of *Centrosaurus apertus* from the DPF of Alberta, and is probably congeneric with it; unfortunately, no diagnostic parietal material has been collected. Of note is a small, adult-sized, centrosaurine nasal (Royal Saskatchewan Museum P1990.6) with a modified nasal horn core collected from near Unity. Although the complete nasal horn core is preserved, it is reduced in size and shape to a thin, laterally compressed, forwardly projecting spine. There is no indication of broken bone surface, rehealed injury, or other surficial texture abnormalities to account for this unusual morphology; however, it does closely resemble the nasal horn core preserved on Canadian Museum of Nature 8795, a complete *C. apertus* skull with diagnostic parietal ornamentation. The only chasmosaurine, '*Mojoceratops perifania*', identified from Saskatchewan was collected from the Diefenbaker Lake locality, but it is now considered a junior synonym of *Chasmosaurus russelli*, well known from the DPF of Alberta. The available material from the DPF of Saskatchewan indicates that both *C. apertus* and *C. russelli* appear to be ubiquitous throughout the geographic range of the lower to middle portions of the DPF (Dinosaur Park faunal zone 1) and can therefore not be inferred to have a preference for nearshore or more inland environments. The DPF does record replacement of dinosaur taxa between each of its three successive faunal zones that appears to be correlated to the transgressing shoreline; however within each of the three DPF faunal zones a hypothesis can be made that at any given time at least some dinosaur distributions were not limited by the position of the transgressing shoreline of the WIS.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A NEW GENUS OF THE FAMILY OCHOTONIDAE (LAGOMORPHA, MAMMALIA) AND LAGOMORPH FAUNAL CHANGES AT THE AOERBAN AREA IN CENTRAL INNER MONGOLIA, CHINA

TOMIDA, Yukimitsu, National Museum of Nature and Science, Tsukuba, Japan

An international research team, composed of paleontologists from China, USA, and Japan, performed extensive fieldwork in the Miocene deposits of the Aoerban area, central Inner Mongolia from 2004 to 2008, and collected numerous small mammal fossils. Ochotonid lagomorphs are among the most abundant fossils in this area. Major fossil bearing deposits consist of the Aoerban Formation (late early Miocene), Balunhalagen bed (late middle Miocene), and Bilutu bed (late late Miocene), and four major fossil faunas are recognized as Lower and Upper Aoerban faunas, Balunhalagen Fauna, and Bilutu Fauna in ascending order. A new genus was found in the Lower Aoerban Fauna and is characterized by 1) its much smaller size, 2) rootless cheek teeth, 3) p3 with the anterior reentrant angle as deep as or deeper than external reentrant angle, and 4) length/width ratio of p3 is smaller than that of *Sinolagomys*. The p3 enamel pattern differs distinctly from those of *Desmatolagus*?, *Alloptox*, *Bellatona*, *Ochotona*, and other genera. It is somewhat similar to *Sinolagomys*, but can easily be distinguished by its deep anterior reentrant angle and length/width ratio. The new genus is restricted to the Lower Aoerban Fauna (the late early Miocene) so far. *Desmatolagus*? (with large rooted cheek teeth, known since the Oligocene), is recorded from the Lower Aoerban through Balunharagen faunas, while *Sinolagomys* (common in Oligocene) is recognized only in the Lower Aoerban Fauna in this area. *Alloptox* is recorded from the Upper Aoerban to Balunharagen faunas (from the late early to middle Miocene), which is conformable with the known range of the genus. *Bellatona* and *Ochotona* are recorded from the Balunhalagen to Bilutu faunas, and the former may be the latest record of the genus.

Technical Session VIII (Thursday, October 18, (Thursday, October 18, 1:45 pm)

GENERIC DURATIONS OF TERRESTRIAL MAMMALS IN THE OLIGO-HOLOCENE OF NORTH AMERICA AND IMPLICATIONS FOR THE UTILITY OF BODY SIZE AS A PREDICTOR OF SUPRASPECIFIC EXTINCTION RISK

TOMIYA, Susumu, University of California Museum of Paleontology, Berkeley, CA, United States

Phylogenetic comparative analyses of extinction vulnerability in mammals have typically focused on population statuses of extant species as well as biological traits of recently-extinct, predominantly insular species. In this regard, the mammalian fossil record in deep time is uniquely valuable because of its potential to illuminate general patterns of extirpation and extinction (1) on continents, (2) in the absence of human impacts, and (3) at various scales of phylogeny. Here I examine the North American record of terrestrial mammals to test whether there is a general correlation between body size and extinction risk at the genus level across a body-weight spectrum that spans 7 orders of magnitude. Phylogenetic generalized least-square regression analyses of 220 Oligo-Holocene genera showed no significant correlation between their estimated body weights and sampling-adjusted durations. Thus, expectations from population-biological observations at the species level are not supported at the genus level. These findings suggest that extinction processes are distinct across levels of phylogenetic hierarchy and that prediction of future extinctions at supraspecific levels cannot simply rely on extrapolation of our current understanding of biological correlates of extinction risk at the species level.

Technical Session IV (Wednesday, October 17, 2:00 pm)

ANATOMY OF ARCHOSAUR PELVIC SOFT TISSUES AND ITS SIGNIFICANCE FOR INTERPRETING HINDLIMB FUNCTION

TSAI, Henry P., University of Missouri, Columbia, MO, United States; HOLLIDAY, Casey M., University of Missouri, Columbia, MO, United States

Reconstructing joint anatomy and function of extinct vertebrates is critical to understanding their posture, locomotor behavior, ecology, and evolution. Major changes occurred in hip joint morphology during archosaur evolution, resulting in a spectrum of postures. However, the lack of joint soft tissues in many fossil taxa makes inferences of joint function difficult. Previous studies showed that bony articulation alone is insufficient for producing lifelike locomotor postures in archosaur hip joints. Moreover, the apparent incongruence of the bony acetabulum and femoral head of many extinct archosaurs suggests large volumes of missing soft tissue. This study describes the microstructure of crocodilian and avian hip joint and epiphyseal structures and documents osteological correlates for these structures in extinct archosaurs. Circumference and depth of the femoral head and the acetabulum were measured in basal and derived archosaurs to quantify the amount of missing soft tissues. The alligator proximal femur exhibited distinct regions of hyaline and fibrocartilaginous structures which are associated with different areas of joint contact during locomotion. A prominent bony ridge marks the junction between the metaphysis and epiphyseal cartilage in fossil archosaurs. The ligamentum capitis is avascular and similar in microstructure and topology to capsular ligaments. In theropods (i.e., *Allosaurus*), this ligament attaches to the fovea capitis, whereas in suchians it has a cartilaginous attachment on part of the medial protuberance of the femur, which also leaves a shallow fovea on the calcified cartilage. The acetabular labrum attaches ventromedially to the bony supraacetabular crest in alligators, whereas in birds, the labrum comprises the dorsal border of the acetabulum, and is continuous with the antitrochanter. This suggests that supraacetabular structures can be variably ossified at different regions of the acetabulum, perhaps in response to the primary directions of loading. In fossil archosaurs such as *Postosuchus*, *Poposaurus*, and *Coelophysis*, the bony supraacetabular crest appears to constrain abduction and dorsocranial dislocation of the proximal femur during parasagittal locomotion. On the other hand, the cartilaginous supraacetabular labrum was likely present in derived theropods to articulate with the facies articularis antitrochanterica (FAAN) of the femur, as substantial portions of FAAN lies outside of the acetabulum during reconstructed hip joint articulation. These data suggest major evolutionary transformations in the position and shape of the femoral head, fovea, and FAAN in different clades of archosaurs which impact our hypotheses of homology and function.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

EVIDENCE FOR PRESENCE OF CLAVICLES AND INTERCLAVICLES IN SAUROPOD DINOSAURS AND ITS IMPLICATIONS ON THE FURCULA-CLAVICLE HOMOLOGY

TSCHOPP, Emanuel, CICEGe-FCT, Universidade Nova de Lisboa, Caparica, Portugal; MATEUS, Octávio, CICEGe-FCT, Universidade Nova de Lisboa, Caparica, Portugal

Clavicles and interclavicles are plesiomorphically present in Reptilia. However, several groups show reduction or even loss of these elements. Crocodylomorpha, e.g., lost the clavicles, whereas dinosaurs are generally interpreted to only preserve the clavicles, the theropod furcula representing an unique case of fused clavicles. In sauropods, reports of clavicles are relatively frequent in non-titanosauriforms. These elements are elongated,

curved, and rather stout bones with a spatulate and a bifurcate end. However, they were always found as single bones, and differ from the relatively short and unbifurcated clavicles found articulated with the scapulae of basal sauropodomorphs. Elements from the Howe Quarry (Late Jurassic; Wyoming, USA) shed new light on these interpretations. Besides the elongated, curved bones (herein named morphotype A), also pairs of symmetric, L-shaped bones were recovered (morphotype B), associated with diplodocid dorsal and cervical vertebrae. Elements resembling morphotype B - articulated between the scapulae - have recently been reported from a diplodocid found near Ten Sleep, Wyoming. Taphonomic evidence, as well as the fact that they were preserved in symmetrical pairs, therefore implies that morphotype B represents the true sauropod clavicles. Contrary to earlier reports, morphotype A elements from the Howe Quarry, as well as previously reported specimens show a symmetry plane following the long axis of the elements. It is thus possible that the morphotype A elements were single bones from the body midline. The only such elements present in the pectoral girdle of tetrapods are the interclavicle and the furcula. Comparison with crocodilian and lacertiform interclavicles indicates that the bifurcate end of the sauropod elements might represent the reduced transverse processes of the anterior end, and the spatulate end would have covered the coracoids or sternal plates ventrally. The presence of both clavicles and interclavicles in the pectoral girdle stiffens the anterior trunk, and enhances considerably its stability. Such reinforcement might have been needed in diplodocids due to the strong lateral forces imposed on the forelimbs by the posteriorly placed center of mass (due to shorter forelimbs than hindlimbs), as well as lateral movements of the enormously elongated necks and tails. The absence of clavicles and interclavicles in titanosauriforms coincides with the development of the wide-gauge locomotion style. The presence of interclavicles in sauropods supports the recently proposed homology of the furcula with the interclavicle, instead of representing fused clavicles. Interclavicles were thus not lost, but may have remained cartilaginous or have yet to be found in basal dinosauriforms.

Romer Prize Session (Thursday, October 18, 11:30 am)

CONVERGENT EVOLUTION AND ITS FUNCTIONAL MECHANISMS: A CASE STUDY OF BONE-CRACKERS

TSENG, Zhijie J., University of Southern California, Los Angeles, CA, United States

The past 65 million years of evolution in carnivoran mammals exhibits numerous cases of convergence in ecomorphologies, stereotypical morphotypes that represent unique ecological adaptations. Such specialist niches are often occupied by unrelated species over evolutionary time and space, indicating the filling of critical ecological roles by functional convergence. To examine proposed mechanistic explanations underlying convergent evolution of ecomorphologies, I document and review feeding specializations in one particular hypercarnivore (meat specialist) niche, the bone-crackers. Bone-cracking specialists evolved at least three times in Carnivora, in the hyaenid, percrocutid, and borophagine canid lineages. An integrative approach to the study of evolutionary change using data from skull shape, enamel microstructure, enamel microwear, and craniodental biomechanics shows that the suite of adaptive morphological characters that correlate with bone-cracking performance, and which are commonly found as a functional complex in hyaenids and canids, evolved in a mosaic manner. Microstructural changes in the enamel were related to increased durophagy as inferred from microwear analysis, followed by subsequent skull shape changes toward increased robustness and strength. Following these changes, skull stress dissipation patterns became adapted to handle mechanical demands of processing larger bones. Given these findings, an updated definition of Carnivoran bone-cracking specialization is presented. This ordered evolutionary sequence of adaptive traits in a functional complex represents a flexible mode of evolution that accommodates different degrees of specialization in increasingly durophagous lineages. Such data indicate that "partial" specialization can nonetheless enhance bone-cracking capability, and this phenomenon may serve as a logical foundation to explain a gradient of adaptations in other carnivorans and non-carnivoran mammal clades.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ESTIMATING BODY MASS OF FOSSIL LAND MAMMALS USING THE ASTRAGALUS

TSUBAMOTO, Takehisa, Hayashibara, Setouchi, Japan

In mammalian skeletons, astragalus is a compact and easily handleable bone, and its fossil remains have relatively higher chances to be discovered as undamaged specimens. Astragalar fossils have been well studied as an indicator of the functional morphology and phyletic relationships of mammals. On the other hand, body mass of animals strongly correlates with their ecology and physiology and is used in paleoecological studies. Therefore, the body mass of fossil taxa has been intensively estimated by several methods. However, only a few studies have investigated the relationship between astragalar size and body mass. The previous studies on the relationship between astragalar size and body mass were intended only for a few selected taxonomic groups.

To expand the application of the astragalus to more extensive groups of mammals in estimating body mass, we examined the allometric relationship between body mass and astragalar size in an extensive sample of extant land mammals (11 orders, 48 species, 80 individuals; body mass ranging from 18 g to 3.4 metric tons) using regression analysis. The results indicate that the best body mass estimator for extensive land mammals is the tibial trochlear size rather than the total size of the astragalus. For example, the body mass is estimated using the medio-lateral width of the tibial trochlea by the following formula (R^2 = 0.985; %SEE = 42.0; %PE = 28.8): ln (body mass [g]) = 2.789 X ln (width of tibial trochlea [mm]) + 2.078.

Using the results, the body masses of several Paleogene land mammals were estimated. The estimated body masses are consistent with those by previous studies that used head-body length and long limb bones. For example, the body mass of the largest terrestrial mammal that ever lived, '*Baluchitherium*,' was estimated to be about 10–15 metric tons. Therefore, the regression equations by this study using the astragalus are useful for estimating body masses of fossil land mammals and have the potential to be widely applied to quantitative ecological and physiological studies of ancient land mammals.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RECONSTRUCTION OF MUSCULAR AND PNEUMATIC SYSTEMS IN THE NECK AND ANTERIOR TRUNK OF ABELISAURIDAE: INSIGHTS FROM *MAJUNGASAURUS CRENATISSIMUS* (DINOSAURIA: THEROPODA)

TSUIHIJI, Takanobu, The University of Tokyo, Tokyo, Japan; O'CONNOR, Patrick M., Ohio University, Athens, OH, United States

Abelisaurid theropods are characterized by specialized morphology of the cervical axial skeleton. The cervical pneumatic system and axial musculature were reconstructed based on two well-preserved, nearly complete presacral series of *Majungasaurus crenatissimus*. By using the location of pneumatic features to hypothesize the distribution of pneumatic soft tissues (i.e., diverticula), the attachment sites of axial muscles may be better constrained. Detailed identification of osteological correlates was possible for several axial muscles and the cervical pneumatic system. For example, cervical pneumatic diverticula are here modeled as tubular projections that extended anteriorly to the level of the axis. The limited distribution of pneumatic features around the periphery of the vertebrarterial canal indicates relatively simple diverticular organization. Regarding musculature, a tubercle on the posterodorsal corner of the neural spine in the trunk represents the attachment for the tendon of insertion of *m. semispinalis* of the *m. transversospinalis* group. Similar to the condition observed in extant crocodylians, this tubercle shifts ventrally in the anterior dorsal through posterior cervical regions and eventually disappears anteriorly. The notably low cervical neural spines suggest that the medial part of the *m. transversospinalis* system was not well-developed. In contrast, the relatively large epipophyses suggest that lateral portions of this system (*m. tendinoarticularis* / *m. ascendens cervicalis*) were emphasized, likely serving as the main extensors, lateral flexors, and stabilizers of the neck. Moreover, the large surface of the neural arch lateral to the prezygapophyseal lamina provided a large attachment area for the *m. longissimus* system, supporting this general model. A strong rugosity on the dorsal edge of the cervical rib shaft suggests possibly strong development of the *m. serratus* complex attaching to the shoulder girdle. Overall, the anatomy of the axial muscular system in abelisaurids was likely to be specialized compared to other non-avian theropods. The results demonstrate that detailed reconstruction is possible for some aspects of soft tissue anatomy in extinct dinosaurs.

Technical Session XIV (Saturday, October 20, 9:00 am)

CRANIAL ANATOMY, PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF *BUNOSTEGOS AKOKANENSIS* (PARAREPTILIA: PAREIASAURIDAE)

TSUJI, Linda A., University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States

Bunostegos akokanensis is a pareiasaurian reptile known from the Upper Permian Moradi Formation of northern Niger. Recently collected cranial material permits a redescription of the taxon in addition to inclusion of new information in a phylogenetic analysis of pareiasauromorphs. *Bunostegos* is highly autapomorphic, with diagnostic cranial features including the presence of two or three hemispherical bosses located at the anterior end of the snout, an elongate, laterally projecting supraorbital 'horn' formed by an enlarged postfrontal, a large foramen present on ventral surface of postfrontal, and a hemispherical supratemporal boss located at posterolateral corner of skull roof. We included *Bunostegos* in a cladistic analysis of 29 parareptilian taxa and 127 cranial and postcranial characters. The results of this analysis place *Bunostegos* as more derived than the South African Middle Permian forms such as *Bradysaurus* and *Embrithosaurus*, and as the sister taxon to the Upper Permian taxa including the Russian genus *Deltavjatia* plus Velosauria. Characters such as the morphology of the cranial sculpture and the size and placement of the tabulars appear to be similar to more derived pareiasaurs such as *Arganaceras* from Morocco and *Elginia* from Scotland, but the most parsimonious tree topology indicates that these features evolved independently in *Bunostegos*. The relationships of velosaurian pareiasaurs, including *Anthodon*, *Nanoparia*, and *Scutosaurus*, were consistent with those of previous analyses.

Pareiasaurs are important biostratigraphic markers within the Permian assemblage zones established for South Africa's Beaufort Group and the occurrence of *Pareiasuchus* and *Anthodon* in the Ruhuhu Basin of Tanzania and *Pareiasuchus* in the Luangwa Basin of Zambia has contributed to the regional correlation of these Upper Permian strata. The tetrapod fauna of the Moradi Formation, however, has proven difficult to correlate with other African assemblages because it contains genera unknown elsewhere (viz. *Bunostegos*, *Moradisaurus*, *Nigerpeton*, and *Saharastega*). An indeterminate gorgonopsid, the only therapsid known from Niger, suggests an Upper Permian assignment, while all other taxa from the formation have Lower and Middle Permian associations. Moreover, the lack of both dicynodont herbivores and *Glossopteris* in the Permian of Niger indicates a community

structure markedly different from roughly contemporaneous areas, and supports the theory that central Pangaea was geographically isolated from the rest of the supercontinent by desert-like conditions.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ARTIODACTYLS FROM THE LATE MIOCENE (HEMPHILLIAN) WYMAN CREEK LOCAL FAUNA, KEYA PAHA COUNTY, NEBRASKA

TUCKER, Shane T., University of Nebraska State Museum, Lincoln, NE, United States; VOORHIES, Michael R., University of Nebraska State Museum, Lincoln, NE, United States

The biostratigraphic record of the central Niobrara River Valley is well represented by strata younger than 4.5 million and older than 9 million years. An un-named intraformational channel fill in the uppermost portion of the Merritt Dam Member of the Ash Hollow Formation partially fills this regional gap in the rock record. Volcanic ash clasts incorporated into these unconsolidated, fossiliferous fluvial sands and gravels correspond with the Blacktail Creek Ash (6.62 ± 0.03 Ma) and establish a maximum geochronologic age for the Wyman Creek local fauna. Carnivore and rodent taxa further constrain the age of the deposit to the late Hemphillian (Hh3) NALMA.

Artiodactyls make up a small percentage (3%) of the overall fauna but several dozen isolated teeth and postcranial elements are sufficiently preserved to identify seven taxa from five families. Three camelids are present in the fauna including a large cameline (*Megatylopus* sp.) and two lamines, *Pleiolama vera* and an intermediate-sized taxon (?*Alforjas*). An adult female skull (total length = 328 mm) with a full complement of premolars in late wear is the only reported specimen of *Pleiolama vera* with its basicranium preserved. An indeterminate taxon of tayassuid is represented by several isolated teeth as well as a palate with moderately worn bunodont teeth and non-molariform premolars (P2-M3 length = 93.0 mm). The presence of the brachydont gelocid *Pseudoceras* documents a rare Great Plains occurrence during the late Hemphillian (Hh3). In addition, the site preserves widely distributed late Hemphillian taxa including the hypsodont antilocaprid (cf. *Texoceros*) and palaeomerycid *Pediomeryx* cf. *P. hemphillensis*.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

MIO-PLIOCENE ELASMOBRANCH FAUNAS OF WESTERN CAPE, SOUTH AFRICA: SALDANHA STEEL VERSUS LANGEBAANWEG 'E' QUARRY

TULU, Yasemin I., University of Cape Town, Cape Town, South Africa; CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa

Elasmobranch fossils discovered at Saldanha Steel, an iron and steel plant in Western Cape, South Africa indicate a similar depositional setting and faunal composition to that of Langebaanweg. Here we report on the diversity of the locality of Saldanha Steel and compare it to the fauna of Langebaanweg.

The Saldanha Steel fauna is moderately diverse, with representation from approximately 10 genera: *Galeorhinus*, *Carcharias*, *Dasyatis*, *Squatina*, *Carcharodon*, *Carcharoides*, *Galeocerdo*, *Isurus*, and material from the Carcharhinidae and the Myliobatiformes. Material consists largely of teeth with some representation of dermal denticles, tail spines, and a solitary centrum. Previous study shows that the Langebaanweg fauna is also a moderately diverse group consisting of nine genera from the hexanchiforms, lamniforms, carcharhiniforms, rajiforms, and myliobatiforms (genera *Galeorhinus*, *Carcharias*, *Dasyatis*, *Squatina*, *Carcharodon*, *Squalus*, *Notorynchus*, the family Carcharhinidae and order Myliobatiformes) that inhabited a shallow marine environment with colder water taxa also present. Saldanha Steel and Langebaanweg share five genera, *Galeorhinus*, *Carcharias*, *Dasyatis*, *Squatina*, *Carcharodon*, and Carcharhinidae, and Myliobatiformes. However, they differ in species within *Carcharodon* and also differ in the remaining genera. The overlap in fauna would imply a similarity in the overall paleoenvironment, particularly as both Saldanha Steel and Langebaanweg are in the same geographic region of Western Cape and are of similar or identical ages (Saldanha Steel may be slightly older). This similarity in faunas suggests that Saldanha Steel was also a shallow marine environment with some colder water taxa.

Both sites are overwhelmingly dominated by *Carcharias taurus* teeth 68% (Saldanha Steel) and 76% (Langebaanweg) but differ in quantities in the remainder of the material. Both sites lack material in the small size range, most likely as a result of sampling. The sheer abundance of material, when focusing on clearly identifiable elements, shows that Saldanha Steel at 2533 elements is only 40% of the abundance of Langebaanweg (6381 elements). This disparity in numbers from two similar sites may indicate a sampling issue or a taphonomic assemblage as some of the material from both sites is quite worn and may indicate variations in local environments.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SUPER SPINY OR SPINY SUPPER: *GYRACANTHIDES SHERWOODI* (NEWBERRY), AN UPPER DEVONIAN CARTILAGINOUS FISH FROM PENNSYLVANIA, U.S.A.

TURNER, Susan, Geoscience Consultant, Brisbane, Australia; SNYDER, Daniel, Middle Georgia College, Cochran, GA, United States; DAESCHLER, Edward, Academy of Natural Sciences, Philadelphia, PA, United States; SULLIVAN, Robert, The State Museum of Pennsylvania, Harrisburg, PA, United States

New material of pectoral, pelvic, dorsal, anal fin spines and the endoskeletal shoulder girdle from the Red Hill site and Metzger's Quarry (late Famennian Catskill Formation: Duncannon Member, Rugospora flexuosa–Grandispora cornuta palynomorph zone (Fa2c substage)) of Clinton and Lycoming counties in central Pennsylvania gives a clear picture of the skeletal elements of a large gyracanthid fish, *Gyracanthides sherwoodi*, which lived in non-marine conditions in the eastern Laurentian rivers and deltas. Like its contemporaries in Gondwana (*Gyracanthides* spp. in South Africa and *Gyracanthides murrayi* in southern Australia), it was mainly cartilaginous, and most probably a filter-feeder that swam and lived by facing into the swift currents and, as demonstrated by the wear on the ventral surfaces of the spines, sometimes used its pectoral fin spines for rigid support by inserting them into the substrate. Growth series of *G. sherwoodi* show that this taxon attained over a meter in length with juveniles acquiring some of their pectoral skeletal elements very early. As yet we have found no evidence of scales in this species. Gyracanthid acanthodians might have lived like other large non-marine, primarily cartilaginous fish such as freshwater sharks, catfish or sturgeon and attained wide distributions in similar ways due to a possible marine phase in their life histories. At all stages of their growth they would have been prey for the cohabiting predators such as *Hynerpeton* or *Hyneria* at the Red Hill site. Despite their primarily cartilaginous skeleton, an ornamented pre-pectoral spine is present in the pectoral fin assembly in *Gyracanthides sherwoodi*. The endoskeletal pectoral girdle in *G. sherwoodi*, and in closely related Late Devonian to Early Carboniferous specimens, supports the placement of gyracanth fishes within the Acanthodii although recent work is questioning the monophyly of this group of 'spiny sharks'.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW SPECIMENS OF MIDDLE EOCENE WHALES (CETACEA, PROTOCETIDAE) FROM NEW JERSEY

UHEN, Mark D., George Mason University, Fairfax, VA, United States

The Family Protocetidae was first delimited by Stromer to include the genera *Protocetus* and *Eocetus*, the only two protocetid genera known at that time. Both are from the middle Eocene (Lutetian and Bartonian respectively) of Gebel Mokattam, Egypt. The pace of discovery of protocetids was extremely slow until the 1990s with only three genera (*Pappocetus*, *Indocetus*, and *Babiacetus*) added to the family. Since 1990, an additional 16 genera have been added to the family, greatly expanding our knowledge of their diversity, anatomy, behavior and biogeography. These additions to the family have been in Indo-Pakistan, Egypt and North America, as additional fossils of protocetids thought to be related to *Eocetus* are probably better interpreted as early basilosaurids. Protocetids have yet to be described from Oceania or anywhere in the Pacific Basin or Antarctica.

Here, several protocetid teeth are described from eastern New Jersey, U.S.A. These specimens represent the northernmost discovery of protocetids in the world. These specimens were collected from the basal beds of the Kirkwood Formation (Asbury Park Member). While this unit is considered Aquitanian (= early Hemingfordian, or early Miocene) in age, these protocetid teeth, along with characteristically middle Eocene shark teeth are believed to have been eroded out of the underlying Bartonian (middle Eocene) Squankum Member of the Shark River Formation and were then incorporated into the basal beds of the Kirkwood Formation during the Aquitanian transgression represented by the basal Kirkwood. Several of the specimens described here were collected by avocational paleontologists, while others were discovered in museum collections misidentified as entelodonts, squalodonts, or indeterminate mammals. The specimens described here represent both molars and incisors of protocetids. They are similar to other contemporaneous protocetids from North America, Egypt, and Indo-Pakistan, and they lack the well-developed accessory denticles of more derived basilosaurids. Additional prospecting in the Middle Eocene deposits of the mid-Atlantic of North America may yet provide more complete specimens for more in-depth phylogenetic analysis.

Romer Prize Session (Thursday, October 18, 11:45 am)

ENAMEL MATURATION AND INTRATOOTH STABLE ISOTOPE PROFILES IN ELEPHANT (*LOXODONTA AFRICANA*) MOLARS: A NEW TOOL FOR EVALUATING SEASONALITY IN TERRESTRIAL PALEOENVIRONMENTS FROM PROBOSCIDEAN TEETH

UNO, Kevin T., University of Utah, Salt Lake City, UT, United States

Multi-year stable isotope records from serially sampled fossil teeth are potential archives of an individual's life history and the environment in which it lived. Carbon isotopes in enamel are a tool for evaluating shifts in diet resulting from seasonal vegetation change, whereas oxygen isotopes provide information about physiology and seasonality of precipitation. Proboscidean molars are attractive as archives of past environments because a single molar plate may contain up to a decade of information, and due to their large size and thick enamel, they are often well preserved in the fossil record. The formation of tooth enamel entails a protracted maturation period, leading to an attenuated and temporally shifted isotope record. Sampling geometry adds further complexity, limiting serial enamel isotope records to qualitative interpretations of seasonality.

To address this problem, I adapt existing models and determine key model parameters to describe enamel formation in modern elephant (*Loxodonta africana*) molars. Inverse model results produce estimated input signals (i.e., $\delta^{13}C$ of diet and $\delta^{18}O$ of body water) from measured isotope data in elephant molar plates, which in turn provide estimates of seasonal vegetation change and the frequency of seasonal precipitation. I establish accurate model parameters that include the growth rate of molar plates, initial enamel density, and enamel

maturation length along a plate. Bomb-curve ^{14}C dating of the last lower molar (m3) in two elephants reveals plate growth rates of 1.3 to 1.6 cm/yr; molar histology suggests similar rates. Micro-CT data show the initial enamel matrix is ~65% of the density of mature enamel. Coupled micro-CT and histological data indicate a maturation length of 7.6 ± 0.7 cm. The forward and inverse models are validated using remote sensing data, precipitation and oxygen isotope data sets, and by comparing synchronous, high-resolution molar and tusk isotope records in two elephants. The updated models for enamel formation in elephant molars provide a new technique for quantitatively assessing seasonality and proboscidean life history. Extension of this technique to fossil proboscidean teeth, particularly from the Neogene, will enable the study of seasonality in terrestrial paleoenvironments such as East African hominin sites or sites that bracket the late Pleistocene megafaunal extinction events. It will also be useful for studying key periods of proboscidean evolution.

Technical Session VI (Thursday, October 18, 3:00 pm)

NEW INFORMATION ON THE ANATOMY AND RELATIONSHIPS OF TITANOSAURIFORM SAUROPODS FROM THE CRETACEOUS OF EAST ASIA
UPCHURCH, Paul, University College London, London, United Kingdom; D'EMIC, Michael D., Georgia Southern University, Statesboro, GA, United States; MANNION, Philip D., Imperial College London, London, United Kingdom; BENSON, Roger B., University College London, London, United Kingdom; PANG, Qiqing, Shijiazhuang University of Economics, Shijiazhuang, China

There are approximately 90 valid, or potentially valid, species of titanosauriform sauropod. A significant proportion of these taxa (27%) come from East Asia, with this region yielding 17 new forms since 2000. However, many of these new taxa have received only brief preliminary descriptions; consequently their evolutionary relationships within Titanosauriformes remain problematic. First-hand examination of seven Cretaceous titanosauriforms from China (*Baotianmansaurus*, *Borealosaurus*, *Gobititan*, *Huabeisaurus*, *Huanghetitan ruyangensis*, *Ruyangosaurus* and *Xianshanosaurus*) enables revision and strengthening of their diagnoses and a clarification of their phylogenetic positions. For example, *Huabeisaurus* possesses autapomorphies such as a tubercle on the anterodorsal part of the lateral surface of the coracoid and relatively short haemal canals in anterior chevrons. Moreover, some derived states occur in more than one taxon and are potentially phylogenetically informative (e.g., absence of ribs from caudal 10-11 onwards in *Huabeisaurus* and *Alamosaurus*, lateral projections at the distal ends of haemal blades in *Gobititan* and *Huanghetitan ruyangensis*). Preliminary phylogenetic analyses (based on two data sets) suggests that all Cretaceous East Asian taxa are somphospondylans, but their precise relationships are sensitive to taxon/character sampling and treatment of quantitative characters. There is growing evidence for a group within Somphospondyli that includes *Euhelopus*, *Erketu*, *Phuwiangosaurus*, *Huabeisaurus* and several other Cretaceous East Asian taxa, characterised by derived states such as deep U-shaped bifurcation of presacral neural spines and strongly ventrally deflected cervical parapophyses. Most tree topologies suggest that several Early and mid-Cretaceous sauropods formed a monophyletic clade that was endemic to East Asia, suggesting that this region was physically and/or environmentally isolated at this time. Other taxa display unexpected similarities with derived South American saltasaurines, including the presence of somphospondylan tissue structure in the neural arches of anterior caudals and steeply reclined neural spines in anterior and middle caudal vertebrae. This indicates that some of the Early and mid-Cretaceous East Asian titanosauriforms might also hold clues to the origins of one or more of the advanced titanosaur clades of the Late Cretaceous.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

MICROSTRUCTURE OF THE SERRATED MARGIN OF EXTANT AND FOSSIL SHARKS WITH ORTHODENTINE AND OSTEODENTINE
USHIMURA, Eri, University of Hyogo, Tatsuno, Japan

Serrated tooth margins have arisen a number of times throughout the evolution of carnivorous vertebrates, however, little is known about their formation. Shark teeth may provide ideal models to study serrae formation, since shark teeth are continuously replaced and both immature and mature teeth can be found in a single specimen. In this study I examined two types of extant and fossil shark teeth. The first type (the tiger shark, *Galeocerdo cuvier*, and the silvertip shark, *Carcharhinus albimarginatus*) has orthodentine, in which dental pulp is localized at the center of the tooth. The second type (the great white shark, *Carcharodon carcharias*) has osteodentine, in which the dental pulp diverges irregularly. I also studied teeth from the fossil tiger shark *G. aduncus* from the Miocene of Aurora, North Carolina, US, and the great white shark *C. carcharias* from the Shimosa Group, Middle Pleistocene. Microstructure of serrae was examined with ground sections of teeth and Hematoxylin-Eosin stained sections of fetus jaws with an optical microscope, and surface etched teeth with a scanning microscope.

In the tiger sharks (extant and fossil, with orthodentine), a serra was composed of enameloid and dentine. A large triangular dental pulp was found in the center of the tooth, but not in serrae. In the great white shark (extant and fossil, with osteodentine), a serra was composed not only of enameloid and dentine, but also a divergent dental pulp entering into the center of the serra. In either type of teeth, with orthodentine or osteodentine, extant or fossil, numerous black spots, presumptive isolated odontblasts, were found in the enameroid of each serra. In Hematoxylin-Eosin stained sections of jaws of the fetus of the tiger shark and the silvertip shark, isolated odontblasts were also found in the enameloid in a serra. Furthermore, before the stage of mineralization in the silvertip and great white sharks, the inner enamel epithelium was found to make folds that probably correspond to the outline of the future serrae. In surface etched teeth in extant tiger shark, bended bundles were found associated with the serrations as in the fossil carcharhiniform and lamniform sharks.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PINNIPED TURNOVER IN THE SOUTH PACIFIC OCEAN: NEW EVIDENCE FROM THE PLIO-PLEISTOCENE OF THE ATACAMA DESERT, CHILE
VALENZUELA-TORO, Ana M., Universidad de Chile, Santiago, Chile; GUTSTEIN, Carolina S., Universidad de Chile, Santiago, Chile; VARAS-MALCA, Rafael M., Museo de Historia Natural - UNMSM, Lima, Peru; SUÁREZ, Mario E., Museo Paleontológico de Caldera, Caldera, Chile; PYENSON, Nicholas D., Smithsonian Institution, Washington DC, DC, United States

Modern pinnipeds distributed along the coasts of continental South America consist almost entirely of otariids (sea lions and fur seals). In contrast, phocids (true and elephant seals) are present only on the southernmost extreme of Chile. This recent biogeographic pattern is consistent with the zooarchaeological record, but it is incompatible with the pinniped fossil record during the Neogene. From the middle Miocene to the Pliocene, true seals exclusively dominated pinniped assemblages, and they were only replaced by the fur seals and sea lions sometime after the Pliocene. Here, we describe pinniped material collected from two new localities in the Atacama Desert, northern Chile, that clarify this marine mammal faunal turnover. Specifically, these finds provide records of the first occurrence of Otariidae and the last ocurrence of Phocidae in Chile, which in turn, these records constrain the timing of this turnover to the early Pliocene through to late Pleistocene interval. The stratigraphic context of these findings provide new insights into hypotheses that explain this faunal turnover in South America, and we briefly discuss them in the context of turnover events within other marine vertebrates throughout the Southern Hemisphere.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSES OF URSIDAE ARE ABLE TO PREDICT FUNCTIONAL ADAPTATIONS OF FOSSILS
VAN HETEREN, Anneke H., University of Roehampton, London, United Kingdom

Limited work has been done on reconstructing the diets of *Ursavus*, *Ursus minimus* and *U. etruscus*, because only few and fragmentary fossils are available. Three-dimensional (3D) geometric morphometrics might be able to determine the position of rare fossils in the morphospace of more abundant species, from which their diet may be inferred. To test this, the mandibular morphology of the eight extant Ursidae species, fossil *U. arctos*, *U. spelaeus* and *U. deningeri* was analysed using 3D geometric morphometrics and the positions of *Ursavus*, *U. minimus* and *U. etruscus* determined relative to the extant morphospace.

Landmarks for 3D digitisation of the mandible were chosen to reflect functional morphology relating to the temporalis muscle. Extant and extinct Ursidae, were digitised with a Microscribe G2. Generalised Procrustes superimposition was performed on the raw coordinates and allometric effects removed by regressing the Procrustes coordinates onto the natural logarithm of centroid size pooled per species. Principal component analysis (PCA) was conducted on the regression residuals, and analysis of variance (ANOVA) conducted. Subsequently, Ursidae phylogeny was overlain onto the PCA graphs, allowing for dietary predictions for *Ursavus*, *U. minimus* and *U. etruscus*.

PCA of mandibular landmarks differentiates between known dietary niches in extant Ursidae. ANOVA indicates that the most important food item in the diet has a highly significant effect on PCs 1 and 2. The positions of the nodes and the directions of the branches of the Ursidae phylogeny indicate that *Ursavus* may have been adapted to increased amounts of invertebrates in its diet relative to its carnivorous ancestor *Cephalogale*. The diet of *U. minimus* is predicted to have consisted of greater intake of vertebrates relative to *Ursavus* and *U. etruscus* is predicted to have smaller invertebrate intake relative to *U. minimus*.

These results are consistent with analyses of individual teeth and two-dimensional geometric morphometrics from the literature. This indicates that overlaying a phylogeny onto morphospace can provide valuable information on taxa that are rarely or incompletely preserved in the fossil record.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

CERVICAL FUSION IN ANKYLOSAURIA: ANATOMY AND FUNCTION
VANBUREN, Collin S., University of Toronto, Toronto, ON, Canada; ARBOUR, Victoria M., University of Alberta, Edmonton, AB, Canada; EVANS, David C., University of Toronto, Toronto, ON, Canada

Fusion of the anterior cervical vertebrae occurs convergently in extant fossorial, arboreal, and marine mammals. In non-avian dinosaurs, fusion of the anterior cervicals occurs in neoceratopsians and at least three ankylosaurian taxa. The syncervical of ceratopsians is well known, but the occurrence and anatomy of ankylosaur syncervicals is poorly documented. Here we describe the ankylosaur syncervical in detail and assess possible mechanisms for its evolution.

Syncervicals are known in two nodosaurids (*Edmontonia, Panoplosaurus*) and one ankylosaurid (*Saichania*). Cervical fusion in ankylosaurs occurs between the first and second cervical vertebrae in all three taxa. The atlas forms a hemispherical cup-shaped cotylus that forms a ball-and-socket union with a spherical occipital condyle, which would have increased mobility at the cranio-cervical joint. The atlantal neural arches are fused ventrally to the centrum and posteriorly to the axial neural arches but are not fused to each other. Fusion of the single-headed atlantal rib and double-headed axial cervical rib to their respective vertebrae occurs in all three ankylosaur taxa.

Currently, understanding the evolutionary patterns of the ankylosaurian syncervical is problematic because of poor phylogenetic resolution within this clade. However, the atlas-axis complex remains unfused in the nodosaurid *Sauropelta* and the ankylosaurids *Ankylosaurus, Euoplocephalus,* and *Shanxia* and suggest that that cervical fusion evolved at least twice in Ankylosauria, although the anterior cervicals are not known in most taxa.

The morphology of the ankylosaurian syncervical closely resembles that of ceratopsians in the ball-and-socket cranio-cervical joint and the morphology of the neural spine. The ceratopisan syncervical is often linked with the evolution of a massive head. Despite the convergence in ankylosaurs and neoceratopsians, no functional hypotheses for fusion have been proposed for cervical fusion in ankylosurs. However, the head-support hypothesis can be rejected because the ankylosaurs with syncervicals lack enlarged heads compared to other closely related taxa with unfused cervicals (e.g., *Sauropelta* and *Ankylosaurus*). These results question the head-support hypothesis in neoceratopsians, and suggest that the cervical fusion in these taxa may have evolved in response to ecological or behavioral factors, perhaps related to feeding or head-to-head combat behavior, and stresses the need for more comparative studies of cervical fusion in extant taxa (e.g., mammals, hornbills) within an ecological context.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE NEOCERATOPSIAN HORIZONTAL SHELF IS NOT HORIZONTAL, AND OTHER NEW INFORMATION ABOUT THIS STRUCTURE

VARRIALE, Frank, King's College, Wilkes-Barre, PA, United States

The "horizontal shelf" is a conspicuous structure located on the labial side of the dentary dentition in many non-ceratopsid neoceratopsians, resulting from the incomplete shear of dentary teeth past their maxillary counterparts. The shelf was originally described based on the dentition of *Leptoceratops gracilis*; subsequent workers have noted the horizontal orientation of this structure, its possible function in grinding food, and its significance as a synapomorphy of Leptoceratopsidae. However, examination of *Archaeoceratops*, *Liaoceratops*, and *Protoceratops* (all non-leptoceratopsid neoceratopsians), as well as the leptoceratopsids *Cerasinops*, *Leptoceratops*, and *Prenoceratops* reveals that the shelf is neither limited to leptoceratopsids nor uniformly horizontal. All taxa show a common morphology among shelves, suggesting in turn a common genesis of this structure.

When present, shelves in labial view most often take the appearance of a scalene triangle. The legs of the triangle represent distinct mesial and distal occlusal surfaces. The contribution of each surface varies across the dentition. If a single dentary tooth occluded equally with two maxillary counterparts, then the shelf has a near equilateral shape. The mesial and distal occlusal surfaces are not planar but concave in appearance, supporting a semicircular, palinal model of mastication. The labial distance that a shelf extends from the side of a dentary tooth is also variable both within a single individual and among taxa, its size a result of the amount of time since tooth eruption.

Dental microwear was recovered from shelves in both *Cerasinops* and *Leptoceratops*, and both taxa show a similar pattern. Pits are a common feature, as would be expected of a grinding surface. The orientation of the scratches does not support the traditional strict orthal model of grinding mastication and also indicates that food on the labial side of the dentition moved rostrolaterally, presenting circumstantial evidence for a containing structure to prevent loss of food from the mouth.

The distinct lack of a universal horizontal orientation in the shelf supports abandoning the use of this descriptor; simply "labial shelf" is favored here. The common pattern in genesis of the labial shelf across many non-ceratopsid neoceratopsians necessitates a reexamination of the coding of this character in phylogenetic analysis. The appearance of a labial shelf in taxa as basal as *Liaoceratops* suggests that the character may be a neoceratopsian synapomorphy that is lost in Ceratopsoidea, and not limited to Leptoceratopsidae as previously thought.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 10:30 am)

LATE CRETACEOUS (SANTONIAN-MAASTRICHTIAN) VERTEBRATE FAUNAS FROM THE ARCTIC OF APPALACHIA

VAVREK, Matthew J., Royal Ontario Museum, Toronto, ON, Canada; LARSSON, Hans C., Redpath Museum, Montreal, QB, Canada

Although fossil vertebrates were first discovered in the Canadian Arctic over 150 years ago by crews in search of the lost Franklin Expedition, the region has remained relatively poorly known in relation to more southerly parts of North America. We have begun a project to collect and describe fossil vertebrates from the Late Cretaceous of the eastern Canadian Arctic, and have discovered a much more diverse fauna than initially suspected. At present, we have identified seven chondrichthyans, an osteichthyan fish, a turtle, a mosasaur, a plesiosaur, a hadrosaurid, three non-avian theropods, and a hesperornithid bird from Santonian-Maastrichtian deposits on Bylot Island, Nunavut. Although some of the material is generically indeterminate, it nonetheless is a very important data set to estimate species distributions and biogeographic patterns of diversity. The eastern Canadian Arctic has a complex geographic history, and during the Late Cretaceous it was likely isolated from other areas of North America, including southern Appalachia, by the inland Western Interior and Hudson seaways. During these periods when it may have been an insular landmass, it was still located above the Arctic Circle. Any terrestrial organism, such as the dinosaurs, would have been severely limited in their ability to migrate during these times. However, climactic conditions would have been much warmer and more equable, with average temperatures up to 15ºC higher than today and a smaller difference between winter and summer temperatures. The global warming at this time had a much more intense effect at the poles as well, resulting in a reduced equator-to-pole thermal gradient. Comparing the chondrichthyan diversity at the site with other regions in North America has shown that there may also have been a reduced gradient in species diversity, possibly related to the reduction in the temperature gradient. The species composition of the Late Cretaceous chondrichthyan fauna of Bylot Island is intermediate between the faunas from Appalachia and Laramidia, and presents a more complex large-scale ecological pattern in North American Late Cretaceous marine chondrichthyans.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:45)

PALEOGENE VERTEBRATE FAUNAS FROM THE GREATER ANTILLES

VELEZ-JUARBE, Jorge, Laboratory of Evolutionary Biology, Department of Anatomy, Howard University, Washington, DC, United States; DOMNING, Daryl P., Laboratory of Evolutionary Biology, Department of Anatomy, Howard University, Washington, DC, United States

The origins of the Greater Antillean vertebrate faunas have been a topic of extensive research. Here we focus on the Paleogene faunas which include the middle Eocene of Jamaica and the early Oligocene of Puerto Rico. The fossils studied come from exposures of the middle Eocene Guys Hill Formation at Seven Rivers, Jamaica and from exposures of the early Oligocene San Sebastian and Juana Diaz formations in northwestern and southwestern Puerto Rico, respectively. The Seven Rivers fauna includes elasmobranches, osteichthyans, pelomedusoid turtles, varanid and polychrotid lizards, crocodylians, sirenians and rhinocerotoids. This fauna includes some of the earliest sirenians, as well as some terrestrial taxa that share affinities with coeval North American taxa. The early Oligocene fauna of Puerto Rico so far includes elasmobranches, osteichthyans, pelomedusoid turtles, gavialoid crocodylians, megalonychid sloth, and caviomorph rodents. Whereas the fish fauna (osteichthyans and elamobranches) is very similar between the islands the terrestrial and semiterrestrial fauna are not. The Jamaican fauna reflects a more Holarctic origin, which differs from later faunas from the region, including the Oligocene ones from Puerto Rico, which are almost exclusive of South American affinities. These differences reflect the diverse geotectonic history of the islands constituting the Greater Antilles.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SPECIES DELIMITATION BASED ON THE LIMITS OF CLIMATE AND MORPHOLOGY IN PALEONTOLOGY: A GEOMETRIC MORPHOMETRIC ANALYSES OF CHRYSEMYS PICTA PLASTRONS

VERMILLION, Wesley A., Indiana University, Bloomington, IN, United States; POLLY, P. D., Indiana University, Bloomington, IN, United States

Aquatic turtles have great promise as paleoclimatic indicators. Their ectothermic physiology gives them sharp geographic boundaries defined by winter cold, and their freshwater environment and diet give the istopic signature in their bones a clear relationship to the signature of precipitation within their environment. The North American pond turtle, *Chrysemys picta*, originated in the Miocene and persists to the present day, with its northern boundary following isothermic lines around New Brunswick, along the northern Great Lakes, and into southern Saskatchewan and Manitoba. This species is not homogenous; however, it is divided into four subspecies *C.picta picta* (Atlantic seaboard), *C. p. marginata* (Midwest), *C. p. bellii* (upper Great Plains and northwoods), and *C. p. dorsalis* (southern Mississippi River drainage). The latter group has an entirely different climatic regime and has been considered a distinct species by many authors.

The possibility of distinguishing these four phylogeographic groups, especially, *C. p. dorsalis*, based on its shell, was examined in this study. Seventeen landmarks were taken on the plastrons of individuals within each of the four subspecies. A Principal Component Analysis of the Procrustes superimposed landmarks shows morphological variation within *C. picta* is determined by subspeciation. Differentiation of subspecies accounts for ~8% of the total morphological variation. *C. picta picta* was determined to be marginally more similar to *C. dorsalis* than to the other subspecies. Compared to morphological differentiation between subspecies, there is considerable within group variation. While there are phenotypic differences between subspecies, a reasonable sample size is necessary to distinguish them. Future work tracing the differentiation of *C. picta* in relation to the climatic transition from Miocene to Quaternary will have to be based on more than individual specimens.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

QUANTIFYING BONE WEATHERING STAGES USING RA, A SURFACE ROUGHNESS PARAMETER MEASURED FROM 3D DATA

VIETTI, Laura A., University of Minnesota, Minneapolis, MN, United States

Bone surface texture is known to degrade in a predicable fashion due to subaerial exposure, and can thus act as a relative proxy for estimating post-death/ pre-burial temporal intervals, which is relevant information for assessing time-averaging. To date, the majority of bone weathering data is collected on an ordinal scale based on observation. While this qualitative classification of weathering data is well established and quite successful, 3D surface analyses may provide means to quantify weathering stages. Here I test if different weathering stages are characterized by statistically distinct surface textures. Results indicate that the surface roughness parameter Ra, which is the average distance of valleys and peaks from the mean line of surface profiles measured from 3D scans, can quantitatively distinguish bone weathering stages from rib surfaces. I first determined the natural variation of fresh rib surface textures by measuring the Ra from several locations on 80 unweathered ribs belonging to 4 mammal groups that weigh over 20kg (Equidae, Camelidae, Suidae, Cervidae). I found that all ribs are statistically similar when compared using paired Student's t-test at a 0.05 significance threshold (Ra = 2.7 µm ± 0.08 µm). The dorsal and ventral portion of the rib are statistically different from the rest of the rib bone (Ra= 4.30 ± 0.22 µm) likely due to a more rugose bone texture related to tissue connectivity. After establishing natural bone texture variation, I measured Ra values from 30 weathered ribs, excluding rib heads and terminations. These same elements were also assigned a qualitative weathering stage. Paired Student's t-tests at a 0.05 confidence level indicate that each ordinal weathering stage is statistically distinguishable. Mean Ra values for each weathering stage are as follows: Stage 1= 4.47µm ± 0.76µm, Stage 2= 6.82µm ± 0.76µm, Stage 3=13.78µm ± 0.88µm, and Stage 4=22.26µm ± 0.9µm. To date, this has only been applied to large mammal ribs; however, investigations are underway to determine fresh surface texture variance of other bone types and other vertebrate groups, and the plan is to expand this work by analyzing additional weathered bones previously classified using the ordinal scale with this new technique. In conclusion, my results indicate that rib surface texture is similar across large mammal taxa and can thus be used for comparative bone weathering analyses. Using Ra to measure bone weathering characteristics may enable more reliable comparative taphonomic analyses by reducing inter-observer variations and by providing numerical data compatible for use in multivariate statistics.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A TALE OF TWO BASINS: COMMUNITY STRUCTURE DYNAMICS THROUGH SPACE AND TIME IN THE HADAR AND TURKANA BASINS, ETHIOPIA AND KENYA

VILLASENOR, Amelia, George Washington University, Washington D.C., DC, United States; BEHRENSMEYER, Anna K., Smithsonian Museum of Natural History, Washington D.C., DC, United States; BOBE, René, George Washington University, Washington D.C., DC, United States; REED, Kaye E., Arizona State University, Tempe, AZ, United States

Australopithecus afarensis has a dense and geographically widespread fossil record that spans nearly 700,000 years. This taxon has been found in heterogeneous environments and generally does not show a preference for any habitat type (open grassland, woodlands, bushlands etc.). Analyses of dental microwear suggest that during its history the material properties of the foods eaten by *A. afarensis* did not change. To understand the context in which *A. afarensis* successfully avoided major adaptive change through time, this project explores the question of stability in the community structure within *A. afarensis* localities through time and space. To reconstruct these communities, guild structure was compared in localities where *A. afarensis* has been recovered. Mammalian genera (>1 kg) were categorized into guilds based on broad dietary, locomotor, and size classes (defined in the Evolution of Terrestrial Ecosystems Database). To compare guild structure across space, the proportion of guilds from the Sidi Hakoma Member in the Hadar Formation, Ethiopia (n=62 genera) were compared to the proportion of guilds in the Tulu Bor Member of the Koobi Fora Formation (n=19 genera) in East Turkana, Kenya, both dated to ~3.4 Ma. Guild structure was compared between all geological members of the Hadar Formation (the Basal (n=31), Sidi Hakoma (n=94), Denen Dora (n=105) and Kada Hadar Members (n=83)) to examine change through time (3.4–2.95 Ma). A chi-squared test was used to determine whether guild structure was significantly different between pairs of geological members. No differences exist between geological members through time at Hadar, despite a trend toward the environment becoming more arid and seasonal. Significant differences were found across space, however, in that the lower Sidi Hakoma Member was significantly different in guild structure from the lower Tulu Bor Member ($0.02 > p > 0.01$). This study differs from other paleoecological studies by focusing on community dynamics rather than habitat reconstruction. The results of this study highlight the fact that *A. afarensis* is found preferentially within the Hadar Formation as contrasted to the Koobi Fora Formation, possibly due to the environments that were present within the Hadar Formation. Further, these findings suggest that community structure within the Hadar Formation remained stable through time despite environmental change, suggesting a long period of coordinated stasis throughout the Hadar Formation. Future studies will seek to evaluate the mechanisms that allowed this ecological stability within the Afar basin, as well as where *A. afarensis* may have fit within the guild structure.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

USING STABLE ISOTOPES AND TOOTH MORPHOLOGY TO RECONSTRUCT PALEOECOLOGY: A PILOT STUDY USING *MICROTUSCALIFORNICUS*

VILLAVICENCIO, Natalia, Univesrity of California at Berkeley, Berkeley, CA, United States; MAGUIRE, Kaitlin C., Univesrity of California at Berkeley, Berkeley, CA, United States; MCGUIRE, Jenny L., University of Washington, Seattle, WA, United States

The California vole, *Microtus californicus*, has a broad geographic range from southern Oregon to Baja California and a fossil record dating to the early Pleistocene. A change in tooth morphology of the lower first molar (m1) is observed throughout the geographical range of the species: individuals have a more gracile and curved m1 in cooler, moister habitats typical of northern populations while those in warmer, drier habitats typical in the southern portions of its range have a more robust and straight m1. A change in morphology has also been documented through time with a loss in the robust straight morphology from cooler, moister Pleistocene times until today. These findings imply that spatial variability in precipitation and associated changes in vegetation and diet could drive the variation in tooth morphology observed in the California vole. Since the m1 is the most abundant fossil of *M. californicus* in the Pleistocene and Holocene record, the correlation between morphology and differences in precipitation and diet could be a potential metric for shifting functional morphological traits during times of shifting climate. In order to test the possible influence of environmental differences on the tooth morphology of *M. californicus* we used stable isotope analyses of fur in individuals from extant populations collected along the latitudinal range of the California vole. We collected samples of 35 individuals from the Museum of Vertebrate Zoology at UC Berkeley: 27 from the northern portion of the geographic range, and 8 from the southern part. Specifically we analyzed the oxygen isotope ratio to test for a correlation between morphology and precipitation. On a broad geographic scale comparing the northern population to the southern population, we find no difference between oxygen isotope values. However, when we looked at the southern specimens and analyzed the difference between individuals from different environments, we do find a significant correlation between oxygen isotope values and habitat type (t-Test; p=0.009) of populations with different m1 morphologies. This suggests precipitation is influencing morphological variation at a local scale. Analyses of carbon, nitrogen and sulfur isotopes were undertaken to detect signs that the morphological variation is due to dietary differences that result from differing vegetation. This study helps determine the extent to which isotope data can be employed to understand the causes of fine-scale morphological changes.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW MARINE TURTLE FROM THE MAASTRICHTIAN OF ANGOLA

VINEYARD, Diana P., Southern Methodist University, Dallas, TX, United States; MATEUS, Octávio, Universidade Nova de Lisboa, Monte de Caparica, Portugal; JACOBS, Louis L., Southern Methodist University, Dallas, TX, United States; POLCYN, Michael J., Southern Methodist University, Dallas, TX, United States; SCHULP, Anne S., Natuurhistorisch Museum Maastricht, Maastricht, Netherlands

Well preserved skull, jaw and associated postcranial material of a new marine turtle was recovered from the mid Maastrichtian (Late Cretaceous) Mucuio Formation, Bentiaba, Angola, during the 2010 Project PaleoAngola expedition. Preliminary analysis was performed showing that the new material represents a sister-taxon of *Euclastes* based on synapomorphies such as extensive secondary palate, shovel-like mandible, low tomial ridge, and broad skull, and places the new Angolan specimen as the most basal *Euclastes*. This new taxon, plus *Angolachelys mbaxi*, and at least two other distinct taxa show a diversity of marine turtles previously unknown in the Cretaceous of Africa.

Technical Session IX (Friday, October 19, 8:30 am)

VARIATION IN COMPLEX SYSTEMATIC PROBLEMS: A CASE STUDY

VITEK, Natasha S., The University of Texas at Austin, Austin, TX, United States; BURROUGHS, Robert W., The University of Texas at Austin, Austin, TX, United States

Levels of variation in one population that exceed interspecific levels known to be expressed between sister species can make specimen identification within a clade problematic. The situation is particularly difficult for the fossil record, where levels of variation within many species remain poorly understood. Box turtles of the extant genus *Terrapene* exemplify this problem. The clade is currently split into six species and ten subspecies. Morphological variation has been noted in many of those taxa, but remains poorly characterized. The situation presents a circular problem; characterizing variation across the temporal and geographic range of the clade remains intractable until lineages can be separated and studied individually, but lineages remain unidentifiable, especially in the fossil record, due to a lack of understanding of variation. In systematics, this problem can translate into poor understanding of apomorphies and a lack of resolution in phylogenetic analyses.

We used Pleistocene and recent specimens of *Terrapene* as a test case to approach the problem of variation and systematic resolution in phylogenetic analyses that include fossils. We used specimen-level phylogenetic analyses to explore whether variation between specimen-level terminals still allowed for species-level resolution. We scored multiple specimens of extant species of *Terrapene* as well as multiple fossils from several localities. We hypothesized that specimens would cluster in polytomic assemblages by species, if variation had a minimal effect on resolution. However, in our analysis not all specimens clustered together into species assemblages. Examination of character distribution indicated that coding specimen-level, as opposed to species-level, terminals caused signal from

intraspecific variation to overwhelm potential apomorphies that were traditionally used to separate species. We then collapsed recent specimens into species-level terminals and fossil specimens into locality-level terminals. That approach resulted in traditionally recognized clades.

Our results indicate that the complement of species- and specimen-level analyses provides a starting point for elucidating different sources of variation that affect systematic resolution. In this case, we find that currently recognized apomorphies for species of *Terrapene* are insufficient for specimen-level identification against the backdrop of broad intraspecific variation. In this context, reliable, apomorphy-based identification of isolated specimens in the fossil record is currently impossible. Adding extinct 'species' known from only single specimens to an analysis presents a comparable situation. Some currently recognized species and subspecies are not immune to this problem.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

INSIGHTS FROM A NEW SPECIMEN OF THE GAVIALOID CROCODYLIAN *THORACOSAURUS NEOCESARIENSIS* FROM THE MAASTRICHTIAN-DANIAN HORNERSTOWN FORMATION, SEWELL, NJ

VOEGELE, Kristyn K., Drexel Universtiy, Philadelphia, PA, United States; PATEL, Athena K., Drexel Universtiy, Philadelphia, PA, United States; ULLMANN, Paul V., Drexel Universtiy, Philadelphia, PA, United States; SCHEIN, Jason P., New Jersey State Museum, Trenton, NJ, United States; LACOVARA, Kenneth J., Drexel Universtiy, Philadelphia, PA, United States

A recently discovered specimen of the gavialoid crocodylian *Thoracosaurus neocesariensis* from the Inversand Company glauconite pit in Sewell, NJ, yields new phylogenetic and ontogenetic information about this rare taxon. Collected from the end-Cretaceous Main Fossiliferous Layer (MFL) thanatocoenosis of the Hornerstown Formation, these fossils represent a disarticulated but associated subadult individual, roughly half the size of those previously published. This new specimen includes a nearly complete lower jaw and the first well preserved articular, tibia, and ischium for *T. neocesariensis*. Novel taxonomic insights from the lower jaw include: 1) the angular-surangular suture passes broadly along the ventral margin of the external mandibular fenestra; 2) uniform size of teeth alveoli in the dentary posterior to the 4th alveolus; 3) anterior processes of the surangular are unequal in length; 4) surangular does not extend posteriorly to the tip of the retroarticular process of the articular; and 5) presence of a dorsoventrally oriented sulcus between the articular and surangular anteriorly. The later three features are synapomorphic with congeneric *T. macrorhynchus*. With respect to previously described larger *T. neocesariensis* specimens, this smaller individual possesses two unique features: 1) a linear frontoparietal suture between the supratemporal fenestrae instead of a concavoconvex suture, and 2) the 3rd and 4th dentary alveoli are not confluent and are equal in size, instead of separated with the 4th alveolis larger than the 3rd. The linear frontoparietal suture of this specimen is similar to that of *T. macrorhyncus*. In addition, the lingual foramen for the articular artery and alveolar nerve is solely on the articular in this individual, while for close phylogenetic relatives, including *T. macrorhyncus*, the lingual foramen is on the surangular entirely. These differences may reflect ontogenetic variation within *T. neocesariensis* and possibly independent evolution among gavialoids in the case of the location of the lingual foramen.

Symposium: Phylogenetic and Comparitive Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 12:00 pm)

THE IMPACT OF CORAL REEFS ON FISH DIVERSIFICATION

WAINWRIGHT, Peter, University of California, Davis, Davis, CA, United States

Coral reefs harbor spectacular organismal diversity in a wide range of metazoan groups. Perhaps nowhere is this more conspicuous than teleost fishes where one in every six species lives on reefs and a stunning range of ecotypes and morphological specializations are found. But, did this diversity accumulate on reefs or have reefs been the site of this evolutionary creativity? We set out to explore the impact of reefs on ecomorphological diversification in two major reef radiations of teleosts. Over 500 of the approximately 600 labrid species live on reefs, and the group includes spectacular ecological diversity, including detritivorous parrotfishes, cleaner wrasses, coral mucous feeders, zooplanktivores and a wide range of generalized invertivores. Patterns of diversification in the iconic labrids were contrasted with Haeumulidae, which, although an important component of New World reef faunas, is actually more species rich in non-reef habitats and shows modest trophic diversity on reefs. Using an analysis pipe-line that accounted for phylogentic relationships among species, the time available for diversification and model uncertainty we compared the rate of evolution of functional morphological traits associated with feeding and locomotion in reef and non-reef lineages. We found that reef labrids occupy 68.6% more trophic morphospace than non-reef species and have rates of trait evolution that are on average twice as fast as non-reef lineages. Remarkably, when we remove species representing niches only found on reefs we get about the same difference in rates of trait evolution. Such a pattern might be expected in the quintisciential radiation of reef fish, but we find an even stronger pattern in Haemulidae where trophic traits evolve up to 12 times faster in reef lineages, in spite of the fact that there are no niches unique to reefs have evolved in this group. In haemulids, locomotor traits evolve faster on reefs, but the difference is not as pronounced as we find in trophic traits. Together these analyses present a strong signal that reef habitats cause a higher rate of morphological diversification in fishes. Exactly why this is cannot yet be determined, but the extremely high physical and biological complexity on reefs may offer tremendous ecological opportunity that drives diversification.

Technical Session I (Wednesday, October 17, 11:00 am)

A NEW OVIRAPTORID SPECIMEN FROM THE UPPER CRETACEOUS OF SOUTHERN CHINA

WANG, Shuo, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology & Paleoanthropology, Chinese Academy of Sciences, Beijing, China; XU, Xing, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology & Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Oviraptorid theropods were previously restricted in their distribution to the Late Cretaceous Gobi Area of central Asia, but several new oviraptorid species have been recently reported from southern China. Here we report a new oviraptorid based on a specimen recovered from the Upper Cretaceous Nanxiong Group (Campanian-Maastrichtian), Hongcheng Basin, Ganzhou City, Jiangxi Province, southern China. The new specimen preserves a partial mandible, three articulated caudal vertebrae, nearly complete articulated right pes, a piece of the right ilium and the middle part of the shaft of the right femur. This new oviraptorid differs from other oviraptorids in having a unique combination of plesiomorphic and derived features: relatively shallower dentary with a weakly downturned mandibular anterior end (this portion is strongly downturned in *Nemegtomaia* and *Heyuannia*); the external mandibular fenestra is relatively posteriorly located, and its anterior margin located posterior to the downturned curve of the dentary (extends beyond the anteroventral corner of the dentary in *Banji*). The lateral surface of the dentary is smooth (lacks the anterior fossa in *Gigantoraptor*). A weak ridge is located on the anterior margin of the external mandibular fenestra, thus the dentary forms a depression or shelf around the anterior margin of external mandibular fenestra but this is much shallower than the corresponding portion of *Nemegtomaia* and *Heyuannia*. The slender posteroventral branch of the dentary slightly twists ventrally (horizontally oriented in *Citipati*, *Khaan* and *Banji*). The angular forms most of the ventral border of the external mandibular fenestra, and bears a longitudinal groove along its ventrolateral edge. The groove receives the posteroventral branch of the dentary, and gradually becomes shallower posteriorly, a feature unknown in any other oviraptorids. Phylogenetic analysis based on 185 osteological characters indicates that the new Ganzhou specimen falls within the derived oviraptorids, together with *Heyuannia huangi* from the possibly correlative beds in Heyuan County in nearby Guangdong Province, and *Nemegtomaia* and *Ingenia* from the Gobi Desert of Mongolia. Both the previously known *Banji* and this new specimen were collected from the Nanxiong Group in Ganzhou, but they differ significantly in their osteological morphology.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ASYMMETRIC VANES OF LIVING AND FOSSIL BIRD FEATHERS INDICATE MECHANICAL FUNCTION RATHER THAN FLIGHT ABILITY

WANG, Xia, University College Dublin, Dublin, Ireland; DYKE, Gareth, University of Southampton, Southampton, United Kingdom

In modern bird feathers, vane asymmetry is caused by the rachis lying towards the leading edge, which is thicker, narrower and stiffer. Asymmetry is thus found in feathers with leading edges in close contact with the airflow in flight. A great deal of attention has been directed at the aerodynamic function of vane asymmetr,y and it has been suggested that degree of asymmetry is related to flapping flight. The mechanical role that vane asymmetry plays has never been explored.

We measured vane asymmetry (trailing-vane width: leading-vane width) at 25%, 50% and 75% of feather length from first or second primaries in the wings of 38 living species. Species were grouped by different flight styles, wing beat frequency, and flexural stiffness. ANOVA was conducted to determine if these parameters can be predicted from asymmetry.

Results show that neither mean vane asymmetry (mean asymmetry value of the three points) nor vane asymmetry at any of the three points we measured is significantly different in birds classified with different flight styles (P=0.13) or wing beat frequency (P=0.64). However, mean vane asymmetry and vane asymmetry at the 25% point do differ significantly between birds that have markedly different feather flexural stiffness.

This research does not support the long-held dogma, "*Archaeopteryx* must have been a flapper because it has asymmetric feathers"; alternatively, data suggest that the less asymmetric feathers of this fossil bird, compared with those of modern birds, indicates that *Archaeopteryx*'s feathers were relatively more flexible. Because direct correlations between flight style and vain asymmetry cannot be established, conclusions about dinosaur flight capabilities from the vane asymmetry of fossils should be treated with caution.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

EXPLORING UNCERTAINTY IN THE CALIBRATION OF THE MOLECULAR CLOCK

WARNOCK, Rachel C., University of Bristol, Bristol, United Kingdom; JOYCE, Walter G., Institut für Geowissenschaften, University of Tübingen, Tübingen, Germany; PARHAM, James F., Alabama Museum of Natural History, University of Alabama, Tuscaloosa, AL, United States; LYSON, Tyler R., Department of Geology and Geophysics, Yale University, New Haven, CT, United States; DONOGHUE, Philip C., Department of Earth Sciences, University of Bristol, Bristol, United Kingdom

Calibration is a critical step in every molecular clock analysis but it has been the least considered. Bayesian approaches to divergence time estimation make it possible to incorporate the uncertainty in the degree to which fossil evidence approximates the true time of divergence.

We explored the impact of different approaches in expressing this relationship, using Testudines as an example for which we established novel calibrations. We demonstrate that the parameters distinguishing calibration densities have a major impact upon the prior and posterior of the divergence times, and it is critically important that users evaluate the joint prior distribution of divergence times used by their dating programs. We also show that the inclusion of informative fossil maxima increases concordance between raw palaeontological and molecular estimates of divergence times – however, the timescale always remains sensitive to the choice of calibration priors. This highlights the urgent need for innovative ways of incorporating palaeontological knowledge into molecular clock analyses.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DINOSAURIAN OOFAUNA FROM THE UPPERMOST CRETACEOUS NEMEGT FORMATION IN MONGOLIA

WATABE, Mahito, Hayashibara Museum of Natural Sciences, Setouchi, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

Dinosaur eggs and nests are abundant in Cretaceous beds, especially in the Upper Cretaceous. The oofaunas from these beds are widely diverse, especially in China and North America. The uppermost Cretaceous Nemegt Formation (Maastrichtian) yields many dinosaur bone fossils and has been intensively searched for dinosaur eggs and nests. These eggs and nests were carefully collected from the ground surface, and detailed geologic and geographic records were made. The surveyed dinosaur fossil localities of Nemegt age are: Bugin Tsav, Gurilin Tsav, Khaichin Ula I, Tsagaan Khushuu, Ulaan Khushuu, Altan Ula II, III, and IV, and Khermeen Tsav (Upper White Beds with Nemegtian dinosaur fossil assemblage).

The dinosaur bone fauna of the Nemegt Formation is represented by: theropods (*Tarbosaurus*, *Gallimimus*, alvarezsaurid, the oviraptorid *Nomingia*, and *Avimimus*), sauropods, hadrosaurids (*Saurolophus* and *Barsboldia*), an ankylosaurid (*Tarchia*), and a pachycephalosaurid. The dinosaur ichnofauna (footprints) from the formation is characterized by: variably-sized bipedal forms (small to large theropods), large to medium-sized bipedal ornithopods, and medium and large-sized quadrupedal forms (sauropods and a possible ankylosaurid).

The dinosaur oofauna of the bed contains: dendroolithid (variably-sized forms), spheroolithid, elongatoolithid (variably-sized forms), and laevisoolithid (thin-shelled forms) eggs. Other egg groups belonging to the dinosauroid basic type, faveoloolithids (usually assigned to sauropods), and ovaloolithid (?ornithopod) eggs are absent, in spite of the existence of sauropods in the associated bone fauna. Eggs assigned to ankylosaurids have not yet been reported.

More intensive and careful searching for, and collecting of, dinosaur eggs is necessary in order to collect sedimentologic and geographic data associated with those eggs. Additionally, morphological variations in egg ultrastructures between individuals and within the same egg need to be understood as a basis for further comparisons and the erection of new ootaxa. Such careful methods will provide a concrete basis for bone-egg-footprint correspondence among the Nemegt dinosaurs.

Technical Session IX (Friday, October 19, 11:15 am)

THE ONTOGENY OF CRANIAL MORPHOLOGY IN CROCODILIANS AND ITS PHYLOGENETIC SIGNIFICANCE: A GEOMETRIC MORPHOMETRIC APPROACH

WATANABE, Akinobu, Florida State University, Tallahassee, FL, United States; SLICE, Dennis E., Florida State University, Tallahassee, FL, United States

The degree to which ontogenetic data can facilitate our understanding of phylogenetic relationships has long been a subject of contention in evolutionary biology. In vertebrate paleontology the availability of fossil specimens at multiple developmental stages has permitted studies on the ontogeny of extinct taxa, a topic of growing interest in the field. However, morphological changes associated with ontogeny are generally considered a hindrance for resolving phylogenies in paleontological studies due to their confounding effects on taxonomic identification and the tendency of juvenile individuals to exhibit plesiomorphic features. Nevertheless, whether the patterns, or trajectories, of ontogenetic changes are phylogenetically informative remains to be tested. Here, I used extant members of Crocodylia to investigate whether the trajectories that describe the morphological changes associated with ontogeny contain significant phylogenetic signal. Using three-dimensional landmark-based geometric morphometric methods, I digitized the crania of ten extant crocodilian species and generated allometric trajectories for each sampled species to test whether the similarities in the orientation of these trajectories correlate with phylogenetic relatedness. Crucial to this study was the availability of molecular phylogenies that provided phylogenetic reconstructions independent from morphological data, with which the phylogenetic signal of these trajectories could be tested. I employed a suite of methods, including (1) the K-statistic; (2) a likelihood ratio test based on Pagel's lambda; (3) permutational regression analysis; (4) topological comparisons between the dendrogram constructed from a clustering method and the molecular phylogeny; and (5) a Mantel test. All tests produced a non-significant result, indicating that the shape changes associated with growth are not phylogenetically informative. Interestingly, the topology of the dendrogram constructed from a clustering algorithm also differs markedly from the topology of published morphological trees, which suggests that the underlying signal in these trajectories is largely uncorrelated with similarities in adult cranial morphologies. The results of this study counter the assumption that patterns of morphological changes that occur throughout ontogeny contain significant phylogenetic signal and give caution to the use of ontogenetic data for phylogenetic inference.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A REGIONALLY EXTENSIVE LANCIAN SEISMITE SERVES AS A TIME SYNCHRONOUS STRATIGRAPHIC MARKER FOR MAPPING DINOSAUR BONEBEDS IN NORTHEASTERN WYOMING

WEEKS, Summer, Southwestern Adventist University, Keene, TX, United States; CHADWICK, Arthur, Southwestern Adventist University, Keene, TX, United States

The Lance Formation in northeastern Wyoming and other correlative Upper Cretaceous deposits in the region are notoriously resistant to stratigraphic studies. The beds can change character completely over a few meters, and it is not unusual to find an entire change in sediments between adjacent outcrops. An informal stratigraphic look at the Lance Formation leaves the impression that prominent sandstone ledges could serve as stable marker beds, but these are secondarily cemented with carbonate, and they can disappear and reappear at a higher or lower stratigraphic position without consistency. Without a dependable stratigraphic framework, it is difficult to correlate remote bone outcrops with the main quarry area. In the past, the most useful stratigraphic marker had been the major bonebed which is exposed for several hundred meters. The persistence of the bonebed suggested to us that a stratigraphic framework was possible. During the 2011 season, we identified a prominent seismite in the region of our quarries that is traceable across the extent of the quarries. The seismite is a tan, fine-grained, immature sandstone which exhibits distorted, undulating to crumpled bedding features and overlies an undisturbed sandstone. A flat, undisturbed sandstone lies above the seismite. We have thus far been able to map the seismite over an area of 50 square kilometers and we are presently working to ensure the seismite is everywhere a single event and to extend the seismite as far as possible. Using this time synchronous bed as a mappable horizon, we have been able to tentatively establish the relationship between the thirteen quarry sites we have worked. The majority of the quarries (eleven) occur in the main bonebed at a horizon 27 meters below the seismite. A microsite quarry is 15 meters below the seismite and a unique bonebed is 37 meters below the seismite. While the eleven quarries are paucispecific *Edmontosaurus* sites, the unique bonebed is remarkable in that excavation thus far (500 bones, teeth and mappable fragments) has revealed no Edmontosaurus remains, but bones and teeth from most other taxa of dinosaurs reported from the Lance (*Pachycephalosaurus, Triceratops, Nanotyrannus, Tyrannosaurus, Dromaeosaurus, Nodosaurus, Struthiomimus,* and several not yet identified) as well as remains of turtles, lizards, frogs, crocodiles and mollusks. We now know the stratigraphic relationship of this bed to the main bonebed, and we are now working to piece together a more comprehensive taphonomic model for the entire site.

Preparators' Session (Thursday, October 18, 11:15 am)

LOST AND FOUND: THE CHALLENGES, OPPORTUNITIES AND SIGNIFICANCE OF A FOSSIL RHINOCEROS SPECIMEN FOUND DURING A STORAGE CLEANING EVENT

WEILER, Matthew W., University of North Dakota, Grand Forks, ND, United States; SCHUMAKER, Karew K., University of North Dakota, Grand Forks, ND, United States; HARTMAN, Joseph H., University of North Dakota, Grand Forks, ND, United States

Museums and other institutions frequently have specimens hiding in field jackets for decades on back shelves in storage rooms. The collection facilities at the University of North Dakota (UND) are no exception, but have some extra challenges to overcome. First, UND has no staff fossil curator, which means this responsibility falls to the main paleontology professor and student volunteers. Second, is the lack of space for large vertebrate fossils, both in terms of cabinet space and jacket storage. As a result, specimens are stored in numerous places throughout the building. Third, UND has a history of hiring invertebrate paleontology faculty, which can result in vertebrate fossil specimens receiving less attention. These factors led to the peculiar situation of an Oligocene rhinoceros (UND-PC 16162), collected in 1966, being rediscovered in the North Dakota Geological Survey (NDGS) Wilson M. Laird Core and Sample Library in 2012. UND-PC 16162 is from the Brule Formation, White River Group, Stark County, North Dakota. Some elements of the specimen were collected with partial field jackets, while other elements were simply wrapped in newspaper. The specimen was placed into two wooden crates, brought back to UND and never prepared. The specimen was moved to the NDGS Core Library during the mid-1980s. The specimen remained in storage, with no record of the move, until 2012, when the crates were rediscovered in a cleaning effort at the NDGS Core Library. Once rediscovered, the search began for any field notes in order to determine the specific geographic location and stratigraphic horizon of the specimen. During this time, preparation of the fossil was undertaken with limited vertebrate fossil preparation equipment. To overcome the lack of equipment, a local orthopedic clinic was contacted and a surgeon volunteered the use of a spare cast cutter. A few UND paleontology students prepared the specimen and were able to involve one of the orthopedic doctors from the clinic in the process. Once prepared, the goal is to create a display with the specimen at the orthopedic clinic in order to promote paleontology, and positive interactions between the public and the paleontology program at UND. The rediscovery of the rhinoceros specimen is fortuitous in that the specimen represents *Diceratherium tridactylum*, which prior to this study was known in North Dakota only from specimens from the Arikaree Formation. UND-PC 16162 is the first *D. tridactylum* specimen recovered from the Brule Formation of North Dakota and could assist with refinement of the biostratigraphic zonation of the Brule Formation in North Dakota.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 9:30 am)

HADROSAURIDS FROM THE 'LOST CONTINENT' OF APPALACHIA

WEISHAMPEL, David B., Johns Hopkins School of Medicine, Baltimore, MD, United States; SARTIN, Catherine E., Johns Hopkins School of Medicine, Baltimore, MD, United States; NABAVIZADEH, Ali, Johns Hopkins School of Medicine, Baltimore, MD, United States

During the Cretaceous, dinosaurs in America occupied both Laramidia and Appalachia. A great deal of attention has been given to the former, to the extent that the latter might be regarded as a 'lost continent'. In this study, we refocus attention on the Cretaceous Appalachian ornithopod dinosaur fauna, specifically the hadrosaurids. We begin an examination of teh available material by focusing on three specimens: first, the first dinosaur skeleton ever put on exhibit, Hadrosaurus foulkii from the Woodbury Formation of Haddonfield, NJ, to which we add several new autapomorphies; second, a putative subadult hadrosaur from the Navesink Formation of Sewell, NJ, which we conclude is near Edmontosaurus on the basis of the morphology of the pubis; and third, a robust humerus suggests the presence of a lambeosaurine in Appalachia. We then use this information to explore the biogeography of hadrosaurids (and proximate outgroups) as it pertains to Appalachia, Laramidia, Asia, Europe, and elsewhere.

Technical Session XVI (Saturday, October 20, 10:30 am)

COLLAPSE OF THE EASTERN AFRICAN LARGER CARNIVORE GUILD: CAUSES AND CONSEQUENCES

WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden

For this study I analyzed the history of the eastern African carnivore guild using a set of 16 craniodental variables. This dataset was subjected to correspondence factor analysis to create a morphospace that could be further analyzed, focusing in temporal patterns of variation. The variables derived for analysis were functional richness (size of morphospace) and functional evenness (distribution of taxa in morphospace). These were compared in a series of time slices from 3.5 Ma to the present. The results show that the larger carnivore guild (species ≥21 kg) suffered a collapse of functional richness that began at or slightly before 2 Ma and is historically extreme today, with only a handful of hypercarnivores in the guild. Functional evenness has also changed, in that prior to 2 Ma, species were significantly positively associated (clumped) in morphospace, whereas today they tend to be randomly distributed or negatively associated (dispersed). Neither of these effects is seen in smaller carnivores. Thus, both the size and structure of the present day larger carnivore guild suggest that it is far from a natural equilibrium. These changes do not in any way resemble changes to carnivore guilds associated with different climatic or environmental regimes today. The beginning of the collapse coincides broadly with the evolution of hominins with derived dietary strategies (*Homo erectus* sensu lato) that came to be in ever increasing competition with large carnivores during the course of the Pleistocene. This may represent the first instance of major environmental impact of the human lineage. These guild changes are likely to have had important consequences for the structure of herbivore guilds as well, though these still remain to be explored. My results show that the African larger carnivore guild is not as pristine as it is often made out to be. The consequences for the conservation of the African biota, given the disequilibrium of the larger carnivore guild, are likely to be considerable.

Technical Session VII (Thursday, October 18, 3:00 pm)

HOW DOES A "TYPICAL" MAMMAL GROW? SAMPLING AND THE INTERPRETATION OF FOSSIL BONE TISSUE

WERNING, Sarah, University of California, Berkeley, CA, United States

Extant marsupials grow at slower rates than placental mammals of similar body size and ecology. Their ossification patterns also differ; marsupials delay epiphyseal fusion much longer than placentals do. Because placentals and marsupials have different growth strategies, their bone microstructure might be expected to differ in important ways; but because both groups mainly comprise relatively tachymetabolic endotherms and heterotherms, they might look similar compared to ectotherms. Bone tissue expression is influenced by growth dynamics, metabolism, phylogeny, mechanics, and the environment. These relationships were established in living taxa, and can be used to infer growth/metabolic rates for extinct taxa. If marsupial-placental growth differences are critical, our growth and metabolic inferences for some extinct mammals may be suspect. Because our general understanding of endotherm bone biology is based partly on mammalian data, our inferences for stem mammals, dinosaurs, and other archosaurs could also be inaccurate. The mammalian osteohistological sample is strongly biased toward placentals of human economic importance, and only two marsupials have been usefully described. I expanded the marsupial database by sampling the mid-diaphyseal femur of more than 30 subadult/adult euaustralidelphian extant and extinct species across a broad size range (10g-2500kg). Marsupials generally produce well-vascularized woven bone early in life, but rarely exhibit complex vascular patterns. All taxa that grow two years or longer before achieving adult size have lines of arrested growth (LAGs) and after 1-2 years of growth deposit poorly vascularized lamellar bone that comprises at least half of the adult cortex. This region strongly resembles the bone of extant squamates and amphibians, despite great differences in growth strategy and physiology. I also reanalyzed published accounts of placental histology. Bone deposited by young marsupials is similar to bone deposited in young placentals, despite stark differences in growth strategy. Though some placentals transition to lamellar bone late in ontogeny, it rarely characterizes much of their growth. In this respect, marsupials do not resemble primates, murine rodents, or large-bodied ungulates, but do resemble some xenarthrans. Highly vascularized woven bone has yet to be shown in any ectothermic, slow-growing, or bradymetabolic taxon, but histological characters traditionally associated with slow growth (LAGs, lamellar bone, avascularity) are more common in mammals (including placentals) than previously appreciated. These characters cannot by themselves be used to diagnose extant taxa as bradymetabolic, ectothermic, or even as slow growers, so their interpretation in extinct taxa must be cautious.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A REANALYSIS OF CM 11162, A SKULL OF *APATOSAURUS* (SAUROPODA: DIPLODOCIDAE)

WHITLOCK, John A., University of British Columbia, Vancouver, BC, Canada; LAMANNA, Matthew C., Carnegie Museum of Natural History, Pittsburgh, PA, United States

Although relatively common by sauropod dinosaur standards, few diplodocoid skulls have received thorough description in the post-war era. One of the first specimens to benefit from a modern treatment was Carnegie Museum (CM) specimen 11162, a large, nearly complete skull assignable to *Apatosaurus louisae*. With the recent resurgence in interest in diplodocoid evolution and ecology, this specimen is of great significance: it is the most complete described skull of *Apatosaurus*, and is a primary source of information regarding the facial skeleton of flagellicaudatans other than *Diplodocus* and *Dicraeosaurus*. Here, we revisit this specimen following additional preparation and the recent publication of several descriptions of diplodocoid skulls that have highlighted new characters and regions of interest.

We identify or confirm six size-independent cranial character states that distinguish *Apatosaurus* from *Diplodocus*. We confirm that *Apatosaurus* lacks a basipterygoid recess, and that the basipterygoid processes are autapomorphically flared distally, as previously published. We also confirm the presence of globose basal tubera, as opposed to the sheet-like tubera of *Diplodocus*; we further observe that the tubera of *Apatosaurus* face posteriorly, not posterolaterally as in *Diplodocus*. In lateral view, the squamosal and quadratojugal of *Apatosaurus* do not appear to closely approximate each other as they do in *Diplodocus*. Finally, the supraoccipital crest of *Apatosaurus* is massive, prominent, and flanked by deep nuchal fossae, unlike the relatively low crest and shallow fossae of *Diplodocus*. We are unable to confirm the absence of a sharp-lipped fossa surrounding the preantorbital fenestra; this fossa has been proposed as an autapomorphy of *Diplodocus*, but the poor preservation of this region of CM 11162 obscures the condition in *Apatosaurus*.

In addition, we document the presence in CM 11162 of two character states that were previously identified as autapomorphies of *Diplodocus*: no contact between the vomer and premaxillae, and pterygoid at least partially medial to ectopterygoid on transverse palatal hook. The presence of these character states in *Apatosaurus* suggests that they are synapomorphies of a more inclusive diplodocoid clade, probably Diplodocidae.

Technical Session XVI (Saturday, October 20, 11:15 am)

THE ISOTOPIC RECORD OF LAGOMORPHS AT HALL'S CAVE

WICKS, Travis Z., The University of Texas at Austin, Austin, TX, United States; SHANAHAN, Timothy M., The University of Texas at Austin, Austin, TX, United States; MAUPIN, Christopher R., The University of Texas at Austin, Austin, TX, United States; GORMAN, Meaghan K., The University of Texas at Austin, Austin, TX, United States; BELL, Christopher J., The University of Texas at Austin, Austin, TX, United States

The isotopic values of tooth enamel often are used to make paleoenvironmental interpretations. Perhaps the most common way in which these data are employed is in reconstruction of vegetation; specifically, the carbon isotopic values in the teeth of herbivores are used as proxies for the relative proportions of C_3 and C_4 photosynthesizers. $\delta^{13}C$ records from soil organics in various localities in Texas reveal noticeable fluctuations in the ratio of C_3 and C_4 vegetation since the Last Glacial Maximum. Generally speaking, C_4 productivity decreased drastically multiple times during the late Pleistocene and gradually increased since then, peaking at approximately 6 ka. Hall's Cave in central Texas contains a well-dated sedimentary record that spans the last 20,000 years, encompassing the interval during which these changes took place. The cave is also extremely fossiliferous and provided us with the opportunity to investigate the use of teeth from rabbits (Leporidae) as a reflection of the relative proportions of C_3 and C_4 productivity. Leporids appear to be good candidates for a proxy of local vegetation because of their small home ranges, ever-growing cheek teeth, varied diet, and abundance in the fossil record. This is as opposed to many large herbivores, such as *Equus* and *Bison*, which are used as proxies specifically for grass. Here we indicate that although vague trends can be seen, leporid $\delta^{13}C$ is insensitive to changes in relative C_4 plant productivity, when compared our record of $\delta^{13}C$ records from soil organics. This is likely due to dietary preferences of individuals. Despite the observation that leporids are generalist herbivores, an individual may exhibit strong preferences for one type of plant or another. This is clearly exhibited in our dataset, which contains specimens with nearly all C_3 diets and specimens with nearly all C_4 diets occurring at the same stratigraphic level.

Although several factors make leporids appear to be good for paleovegetation reconstructions, comparison with soil organic $\delta^{13}C$ records reveals that individual diet preferences overwhelm the generalist herbivorous tendencies of the group as a whole. We emphasize the need to use caution when using vertebrate isotopic records to reconstruct paleoenvironments due to biases in the diet of the taxon used as proxy.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A RE-EVALUATION OF TOROSAURUS UTAHENSIS: IMPLICATIONS FOR MAASTRICHTIAN CERATOPSIAN DIVERSITY IN WESTERN NORTH AMERICA

WIERSMA, Jelle P., Natural History Museum of Utah and Dept of Geology and Geophysics, University of Utah, Salt Lake City, UT, United States; LOEWEN, Mark A., Natural History Museum of Utah and Dept of Geology and Geophysics, University of Utah, Salt Lake City, UT, United States; IRMIS, Randall B., Natural History Museum of Utah and Dept of Geology and Geophysics, University of Utah, Salt Lake City, UT, United States

There is considerable ongoing debate about taxonomy and ontogeny of late Maastrichtian chasmosaurine ceratopsid dinosaurs from western North America (e.g., *Triceratops* and *Torosaurus latus*). However, recent studies have all but ignored another coeval taxon, *Torosaurus utahenisis* from the North Horn Formation of central Utah. We conducted a comprehensive re-analysis of ceratopsid specimens from the North Horn Formation; five diagnostic specimens are identified as *Torosaurus utahensis*, and three others are assignable to *Torosaurus* sp. We conclude that *T. utahensis* is a valid taxon based on two autapomorphies and a unique combination of character states. Autapomorphies for *T. utahensis* are proximally "waisted" postorbital horncores and with an anterior margin situated anterior to the orbit. In addition, *T. utahensis* preserves a unique combination of character states including the presence of epiparietal P_0, and the shape of the squamosal. Synapomorphies that are shared with *T. latus* include: five epiparietals on each side of the parietal; dorsoventrally thin and rostrocaudally broad transverse parietal bar; subcircular parietal fenestrae; and a C-shaped cross section of the median portion of the midline parietal bar. A recent hypothesis suggests that *Torosaurus latus* is the adult ontogenetic stage of *Triceratops*, based on specimens from the northern part of western North America. In the north, well-sampled assemblages such as the Hell Creek Formation produce abundant *Triceratops* remains and rare *Torosaurus latus* specimens (ratio ~10:1), whereas assemblages with smaller sample-sizes (e.g., Denver Basin) preserve exclusively *Triceratops*. In contrast, diagnostic ceratopsid specimens from the North Horn Formation are assignable only to *Torosaurus,* a relative abundance which would be aberrant if it were simply an old adult of *Triceratops*. This could be an artifact of low sample size; however, the probability of finding only eight *Torosaurus* specimens from a Hell Creek-like relative abundance distribution of *Torosaurus* and *Triceratops* is <<0.001, indicating that the North Horn assemblage is significantly different from that of the Hell Creek. Two possible hypotheses could explain these data: first, *T utahensis* is an adult of *Triceratops*, and only old adult animals are preserved in the North Horn Formation; or, *T. utahensis* and *T. latus* are valid and sister taxa, and the lack of *Triceratops* specimens in the North Horn Formation is a real biogeographic difference. We suggest the latter hypothesis is more likely.

Romer Prize Session (Thursday, October 18, 12:00 pm)

A SOLUTION TO THE "LONGIROSTRINE PROBLEM"? A PHYLOGENETIC REAPPRAISAL OF THALATTOSUCHIAN RELATIONSHIPS AND ISSUES SURROUNDING THEIR LABILITY

WILBERG, Eric W., University of Iowa, Iowa City, IA, United States

One of the most persistent issues affecting our understanding of crocodylomorph phylogenetics is the "longirostrine problem." Several groups of long-snouted crocodylomorphs, traditionally thought to be unrelated are recovered as a clade in some analyses, but distantly related in others. Thalattosuchians, an early occurring group of marine-adapted crocodylomorphs, lie at the heart of the debate. Thalattosuchia has a controversial phylogenetic position – they have been recovered in either a basal position, nested high up in the tree, or as the sister-group of Crocodyliformes. Thalattosuchians lack several crocodyliform apomorphies, but share a longirostrine skull shape with the highly derived neosuchian groups, Dyrosauridae and Pholidosauridae. These groups share a similar ecological habit, suggesting the derived position of thalattosuchians may be the result of convergent evolution. The present study suggests that the "longirostrine problem" results from two fundamental phylogenetic issues: character state descriptions and outgroup sampling. Several of the "shared" characters uniting these groups result from ambiguously worded character state descriptions – structures that are superficially similar, but anatomically different in detail, are scored the same. Additionally, previous studies of crocodylomorph and crocodyliform phylogeny have rooted trees on outgroups that in many cases are either quite distantly related to the group under study (e.g. *Gracilisuchus stipanicicorum*, a basal suchian), or may belong within the ingroup. A detailed reinterpretation of phylogenetic characters, increased taxon sampling, and careful outgroup sampling generates a new phylogenetic hypothesis in which thalattosuchians are the sister-group to Crocodyliformes, distantly related to long-snouted crocodyliforms. The exclusion of thalattosuchians from Crocodyliformes has numerous implications for large scale evolutionary trends within the group, including extensive convergence in the evolution of the elaborate secondary palate characteristic of the group. Additionally, as thalattosuchians are exclusively marine, this phylogeny implies multiple independent transitions from the terrestrial to the aquatic realm. Given that the earliest appearing thalattosuchian (*Peipehsuchus*; Sinemurian) already possesses the cranial specializations diagnostic of Thalattosuchia, it seems likely that we are missing some important fossils from this region of the tree. This study demonstrates the importance of outgroup sampling and clarity in character state descriptions.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FURTHER CONSIDERATIONS OF THE OSTEOLOGY OF *TERMINONATATOR PONTEIXENSIS*

WILHELM, Benjamin C., McGill University, Montreal, QB, Canada; TOKARYK, Timothy T., Royal Saskatchewan Museum Fossil Research Station, Eastend, SK, Canada

Terminonatator ponteixensis is known from an exceptionally well-preserved and mostly complete sub-adult holotype, lacking only portions of the skull, vertebral column, and most of the pectoral girdle. A second specimen, consisting of 12 adult posterior cervical vertebrae, has also been tentatively referred to *Terminonatator.* Here we describe previously unprepared material of the holotype including portions of the braincase, the atlas/axis complex, 20 vertebrae from various regions of the vertebral column, and elements of the pectoral girdle. This new material fills in many of the missing details of the anatomy of *Terminonatator*, and provides additional overlapping material with the second specimen. Comparison of these specimens provides further support for the referral to *Terminonatator* on the basis of the morphology of the zygapophyses and the presence of two pairs of foramina subcentralia in the posterior cervical vertebrae. The large number of new vertebrae also allows us to provide an updated length estimate for the sub-adult holotype. Using the adult material referable to *Terminonatator,* we can scale this estimate to determine the size of an adult individual. Lastly, we provide new details on previously described elements of the type specimen, including the pathological femur and mass of gastroliths. These descriptions and comparisons provide new details on an exceptionally well-preserved plesiosaur and will help clarify the taxonomic position of this taxon through future studies.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A PALEONTOLOGICAL AND NEONTOLOGICAL INVESTIGATION OF THE CLAIM THAT THE PTEROSAUR *SCAPHOGNATHUS CRASSIROSTRIS* SURVIVED INTO THE SEVENTEENTH CENTURY

WILKINS, Pondanesa, Fayetteville State University, Fayetteville, NC, United States; SENTER, Phil, Fayetteville State University, Fayetteville, NC, United States

In an attempt to discredit evolutionary theory by "proving" that humans and pterosaurs coexisted until recently, some young-Earth creationist (YEC) authors claim that a skeleton exhibited in Italy in the seventeenth century was that of a recently-killed pterosaur, specifically *Scaphognathus crassirostris*. It is important that paleontologists not simply dismiss such claims but instead investigate them and publish the results of the investigations. This is because YEC literature shows that the YEC community generally accepts the results of such investigations and drops falsified claims (e.g. alleged human footprints in Cretaceous limestone near Glen Rose, Texas) from its arsenal of anti-evolution claims. The skeleton in question was exhibited, and an anatomically detailed drawing of it was published in 1685, in which it was claimed that the specimen was a dragon that had recently been killed in the marshes near Rome. According to recent YEC literature, the winged skeleton's cranial crest and long tail diagnose it as the pterosaur *S. crassirostris*. We compared the skeleton to that of *S. crassirostris* and note that its skull shape, dentition, hindlimb morphology, and tail vertebrae differ markedly from those *S. crassirostris* and all other known pterosaurs. Furthermore, *S. crassirostris* has no crest; the YEC claim that it is crested is based on misidentification of an uncrested frontal bone on a juvenile *S. crassirostris* fossil. Osteological comparison with extant animals reveals that the skeleton that was originally exhibited is a taxidermic composite. It combines the skull of a dog; the mandible of a second, smaller dog; and the tail of an eel. It's "hindlimb" is actually the forelimb of a small bear. Fake skin covers and conceals junctions between bones of different animals. The wings are fake and do not resemble pterosaur wings in shape. The claim that *S. crassirostris* survived until three centuries ago can therefore be put to rest, thanks to a combination of paleontological and neontological investigation of osteology. This piece of anti-evolution "evidence" is therefore invalid.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

TAPHONOMIC AND PALEOENVIRONMENTAL IMPLICATIONS OF A NEW MASS DEATH ASSEMBLAGE OF BAENID TURTLES FROM THE HELL CREEK FORMATION (LATEST MAASTRICHTIAN) OF SOUTHEASTERN MONTANA

WILLIAMS, Scott A., Burpee Museum of Natural History, Rockford, IL, United States; LYSON, Tyler R., Department of Geology and Geophysics, Yale University, New Haven, CT, United States

A new microvertebrate locality in the Hell Creek Formation of southeastern Montana has yielded the remains of several complete baenid turtle shells and postcranial elements, as well as elements from trionychid turtles, *Myledaphus bipartitus* teeth, *Lepisosteus* sp. scales, *Champsosaurus* sp. vertebrae, crocodilian teeth and skeletal elements, shed ceratopsian and theropod teeth, and a partially disarticulated *Thescelosaurus* sp. All material is preserved within a fine grained sandstone that is rich in small (d<.5 cm diameter) clay rip up clasts. The vertebrate-bearing sandstone layer sits directly on top of a structure-less, finer grained sandstone that we interpret as a point bar, which itself is on top of a homogeneous mudstone. Based on these geologic features we interpret this locality as a meander belt channel. The preferred carapace up orientation of the baenid shells, as well as the small size of the rip up clasts and excellent preservation of the material, indicates the material was deposited under a low energy flow regime. As is typical for baenid turtles, the shells are mostly fused. The presence of anterior supernumerary scales, a well-developed scalloped shell margin posteriorly, and small gular scales indicate the material likely belongs to *Eubaena* sp. The discovery of an additional mass death assemblage of baenid turtles indicates that the

region experienced periods of drought. In addition, the fact that all of the turtle mass death assemblages from the Hell Creek of North America (N=6) are predominantly made up of baenid turtles indicates that these freshwater aquatic turtles were not well adapted for such environmental stresses.

Technical Session XIII (Friday, October 19, 2:30 pm)

NEW DISCOVERIES OF PRIMATES FROM THE EARLY PALEOCENE NACIMIENTO FORMATION (TORREJONIAN NALMA), SAN JUAN BASIN, NEW MEXICO: A WINDOW ON THE FIRST PRIMATE ADAPTIVE RADIATION

WILLIAMSON, Thomas E., New Mexico Museum of Natural History & Science, Albuquerque, NM, United States; SILCOX, Mary T., University of Toronto Scarborough, Toronto, ON, Canada

Primates were one of several mammalian orders that underwent a rapid period of diversification following the extinction of the non-avian dinosaurs. Although the Order first appeared near the Cretaceous-Paleogene boundary, it is not until the Torrejonian (the second North American Land Mammal Age [NALMA] of the Paleocene) that a diversity of families began to emerge. One of the critical places to study this first primate adaptive radiation is the San Juan Basin (SJB), which extends from northwestern New Mexico into southwestern Colorado, and includes deposits that range from the Late Cretaceous to the early Eocene. Of particular importance to the study of early primate evolution are fossils from the Nacimiento Formation, dated to between 64.5 and 62 mya, which comprise the type faunas for the early Paleocene Puercan and the Torrejonian NALMAs. Although there are currently no primates known from the Puercan deposits, Torrejonian fossils previously described from the Formation represent 6 different species of "palaechthonid" and paromomyid plesiadapiforms. However, all of these species are known from very limited material—prior to this report the total number of primate specimens described from the Nacimiento Formation of the San Juan Basin was less than 25.

The current report increases the sample of primate specimens more than fivefold. Included is the first picrodontid plesiadapiform specimen from the Torrejonian of the SJB, referable to *Picrodus calgariensis*. Also included in the new sample is the first paromomyid specimen complete enough to allow for a species level taxonomic assignment, which represents a new species of *Paromomys*. With respect to the "Palaechthonidae", the current report includes the first new specimens attributed to *Plesiolestes nacimienti* and *Anasazia williamsoni*, and large collections pertaining to *Torrejonia wilsoni* and *Palaechthon woodi*. These collections demonstrate previously unknown morphological variants, including the presence of a metaconid on the p4 of some specimens of *T. wilsoni*, which supports previous inferences about a close relationship to *Plesiolestes problematicus*. This new sample considerably enhances our knowledge of the poorly understood "Palaechthonidae", and about the biostratigraphy, biogeography, and early evolution of North American primates. In particular, the rarity of paromomyids, the continuing absence of purgatoriid, plesiadapid and carpolestid plesiadapiforms, and the presence of a number of endemic "palaechthonid" species in the SJB are all contrasts with contemporaneous deposits to the north. These contrasts suggest that already by the latter part of the Early Paleocene primates had developed not only an impressive diversity, but patterns of regional endemism.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

AGE AND GROWTH IN *MYLEDAPHUS BIPARTITUS,* A LATE CRETACEOUS FRESHWATER GUITARFISH FROM ALBERTA, CANADA

WILSON, Alycia E., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; NEWBREY, Michael G., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; BRINKMAN, Donald B., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; NEUMAN, Andrew G., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

The freshwater guitarfish, *Myledaphus bipartitus*, is commonly represented by teeth and vertebral centra in the Late Cretaceous (Campanian, 75 Ma) deposits of North America. The species was first described in 1876, but until now, very little was known about its ecology. We analyzed the age and growth of 117 centra (74 hemisectioned) from the Oldman and Dinosaur Park formations of southern Alberta. The estimated maximum age was 16 years. Radial distance (RD) at the estimated asymptotic growth was calculated, and average RD at birth and 3 years were compared with two modern *Rhinobatos* species (*R. productus* and *R. rhinobatos*). Birth ring size ranged from 0.9–1.8 mm RD, which is smaller than those of *R. productus* (2.0–3.2 mm RD) and plot outside 95% C.I. At age 3, centrum RD of *M. bipartitus* ranged from 2.8–4.6 mm RD, which is smaller than those of *R. productus* and *R. rhinobatos* (5.0–6.6 mm RD) and plot outside the 95% C.I. for both species. *Myledaphus* approached "asymptotic" growth at 7.8 mm RD; extant species examined reached 'asymptotic' sizes at a RD greater than 11 mm. The growth trajectory of *Myledaphus* had a similar slope to the *Rhinobatos* species. *Rhinobatos rhinobatos* was also longer lived than *Myledaphus* by 8 years. This study is the first to quantify age and growth of *Myledaphus bipartitus* and it shows that modern *Rhinobatos* spp. can live longer and have larger centrum sizes at age to suggest a longer total length (TL).

Technical Session X (Friday, October 19, 11:45 am)

A PARTIAL SKULL OF *DIDELPHODON VORAX* FROM THE LANCIAN-AGE HELL CREEK FORMATION OF SOUTHWESTERN NORTH DAKOTA, U.S.A.

WILSON, Gregory P., University of Washington, Seattle, WA, United States; EKDALE, Eric G., San Diego State University, San Diego, CA, United States; HOGANSON, John W., North Dakota Geological Survey, Bismarck, ND, United States

Late Cretaceous mammals from North America are known mostly from large collections of isolated teeth and dentulous jaw fragments. Though considerable data about the taxonomy, phylogeny, community structure, and ecomorphology of these mammals have been gleaned from these collections, fossil skulls and postcranial elements would provide a complementary and, by some accounts, more phylogenetically informative source of data to illuminate this critical interval of mammalian evolution.

A partial cranium of the stagodontid metatherian *Didelphodon vorax* (NDGS 431) was recovered from a sandstone unit in the Hell Creek Formation near Marmarth, North Dakota. This unit has also produced a typical Lancian vertebrate microfossil assemblage. NDGS 431 includes a partial rostrum that preserves parts of the zygomatic arches, maxillae, palate, and P3 through M4. 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 semicircular canals of the inner ear are complete on the right side only. Based on dentition, NDGS 431 represents a small individual of a young adult.

Didelphodon vorax is among the largest mammals of the late Cretaceous of North America. Dental morphological traits have led to interpretations of *D. vorax* as a faunivore and possibly a scavenger with specializations for feeding on hard objects. Dental similarities with pinnipeds and analyses of postcranial elements questionably attributed to *D. vorax* have further led to hypotheses that it was semiaquatic. NDGS 431 provides new anatomical details. For example, in the inner ear, the cochlea completes approximately one and three-quarters turns, and the anterior semicircular canal is largest among the three canals in terms of length and arc radius of curvature. The aspect ratio of the anterior canal arc is lower than the other two canals, although the course of the anterior canal is distorted along its midsection. These and other data can be used to newly address the paleoecology of this important late Cretaceous metatherian and shed light on the phylogeny and morphological transformations of early Marsupialiformes.

Technical Session XI (Friday, October 19, 4:00 pm)

SMALL THEROPOD DINOSAURS FROM THE LATEST CRETACEOUS OF INDIA

WILSON, Jeffrey A., University of Michigan, Ann Arbor, MI, United States

Records of small theropod dinosaurs from southern landmasses are rare, but such remains have been known from India for nearly a century. Excavations by Charles Matley in Upper Cretaceous (Maastrichtian) sediments at Bara Simla, central India in 1917 and 1919 produced vertebral and limb elements that historically have been separated into at least six species (*Compsosuchus solus*, *Laevisuchus indicus*, *Jubbulpuria tenuis*, *Coeluroides largus*, *Ornithomimoides mobilis*, *O. barasimlensis*) or left as indeterminate 'coelurosaurians.' Relatively recent discoveries of the small theropod species *Noasaurus leali* and *Masiakasaurus knopfleri* from contemporaneous rocks in South America and Madagascar, respectively, and advances in basal theropod systematics have led to a revised interpretation of several of these small theropod specimens as noasaurid abelisauroids. Here we present a revision of some of the small theropods from the latest Cretaceous of India, based on study of the Matley collection at the Indian Museum (Kolkata) and newly collected material from Pisdura, central India. Remains attributed to *Laevisuchus* and *Jubbulpuria* are approximately the same size, bear diagnostic features, and differ in features attributable to intracolumnar variation. It is likely that they are the same or closely related species, but the current absence of morphological overlap between them precludes testing that hypothesis. *Compsosuchus*, *Coeluroides*, and *Ornithomimoides* pertain to individuals slightly larger than *Laevisuchus*/*Jubbulpuria*. The latter two are morphologically distinct from *Laevisuchus*/*Jubbulpuria* and share autapomorphies with one another suggesting that they can be grouped together as *Coeluroides*, the first-named of the two genera. The new remains collected from Pisdura include a partial dentary that bears the characteristic procumbent dentition of *Masiakasaurus*, which appears to be absent in the *Noasaurus* maxilla. Likewise, the syntypic cervical vertebrae of *Laevisuchus indicus* more closely resemble those of *Masiakasaurus* than *Noasaurus*. These data imply that the Indian and Malagasy noasaurids are more closely related to each another than either is to the South American form. The Bara Simla sediments were deposited during chron 29R, and the Pisdura sediments during chrons 30N–29R. To date, no small theropod remains have been reported from relatively rich localities in western India (chron 30N), where hundreds of sauropod and theropod bones have been collected, nor among the numerous bones recovered from Late Cretaceous Pab Formation in Balochistan, Pakistan, whose precise age relative to the Indian localities is unknown.

Technical Session XVII (Saturday, October 20, 2:45 pm)

THE EFFECTS OF CLIMATE AND BEHAVIOR ON AVIAN BONE MICROSTRUCTURE: A COMPARATIVE OSTEOHISTOLOGY STUDY OF HESPERORNITHIFORMS FROM THE LATE CRETACEOUS WESTERN INTERIOR SEAWAY

WILSON, Laura E., University of Colorado, Boulder, Boulder, CO, United States

Bone microstructure patterns in *Hesperornis* femora and tibiotarsi from Kansas and the Canadian Arctic are compared to determine if migration or Late Cretaceous polar climate affected avian bone growth. The biogeography and flightlessness of these birds has led to speculation about their life histories, including whether they endured polar winters or migrated to more temperate climates. Consequently, the distribution of *Hesperornis* fossils in Late Cretaceous Western Interior Seaway deposits presents a unique opportunity to test the hypotheses that the energy expenditure required of long-distance migration or the limited food resources available during polar winters would cause a decrease in bone growth rate and be reflected in bone microstructure. Restricting the study to *Hesperornis* allows for comparison of phylogenetically close individuals with similar functional adaptations within an ontogenetic framework, leaving environment and/or behavior as likely explanations for variation in bone microstructure.

Histologic analysis reveals no notable differences in vascular canal patterns or zonation between high- and mid-latitude *Hesperornis* specimens. The lack of histologic differences prompts two working hypotheses: (1) *Hesperornis* migrated, but migratory behavior does not leave a record in their bone microstructure; (2) *Hesperornis* did not migrate, but overwintering in the Cretaceous Arctic did not leave a record in their bone microstructure. To determine how migration and climate influence bone growth in modern birds, extant avian analogs were examined. Comparisons among *Pygoscelis* penguin (Adélies, Chinstraps, Gentoos) bone microstructure reveals no histologic evidence for growth rate changes attributable to migration. Adélie and Chinstrap (both migratory species) bones show no zonation or changes in microstructure different from expected ontogenetic patterns, suggesting that migration is not necessarily recorded in avian bone microstructure. Additionally, Gentoos (a sedentary species) show evidence of rapid bone growth possibly associated with increased chick growth rates in higher latitude populations, suggesting that the effects of polar climate do not always lead to a marked decrease in bone growth rate. These patterns may be explained by plasticity in bone growth of taxa, overestimates of the physiological strain of migration or polar environments on bone growth, and/or the attainment of skeletal maturity within one year in most birds. Ultimately, this study emphasizes the lack of clear evidence for migration or polar seasonality in avian bone microstructure, and leaves the question of long-distance migration in *Hesperornis* unresolved.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PATTERNS OF CRANIOFACIAL SHAPE CHANGE IN THE EXTINCT SPECIES FLOCK OF THE ACTINOPTERYGIAN FISH GENUS *SAURICHTHYS*: PALAEOBIOLOGICAL AND PALAEOECOLOGICAL IMPLICATIONS AND A COMPARISON WITH EXTANT SPECIES FLOCKS

WILSON, Laura A., Palaeontological Institute and Museum, University of Zurich, Zurich, Switzerland; FURRER, Heinz, Palaeontological Institute and Museum, University of Zurich, Zurich, Switzerland; COLOMBO, Marco, University of Basel, Basel, Switzerland; SALZBURGER, Walter, University of Basel, Basel, Switzerland; SÁNCHEZ, Marcelo R., Palaeontological Institute and Museum, University of Zurich, Zurich, Switzerland

Understanding the dynamics of species diversification in the wake of extinction is a fundamental issue in reconstructing the evolutionary history of clades and has implications for modern day attempts to assess the impact of biodiversity loss. The actinopterygian fish genus *Saurichthys* reached a near worldwide distribution in the Early Triassic, a time following the most devastating extinction event in earth history. The morphological diversification of *Saurichthys* is poorly understood because diagnostic features are limited and have been only partly examined and a quantitative approach has rarely been adopted. Herein we examine the evolution of shape change in the opercule, a prominent craniofacial bone supporting the gill cover, across representatives of the genus. The opercule is of particular interest because among 'model' extant teleosts such as sticklebacks its development is well documented and it has been shown to change shape under varying ecological settings over a short evolutionary time scale. Herein, opercule shape was quantified using outline-based geometric morphometrics on 2D images. We examined shape change between representatives of six species, comprising 167 specimens and including newly prepared material of the Middle Triassic deposits from Monte San Giorgio (Switzerland), a key locality from which four species have already been described from abundant, well-preserved fossils. Our results show a diversity of opercule shape, and importantly provide key indicators of species-specific shape changes in the anterior margin, which will be used to aid delimitation of unidentified materials, and for reconstructing the palaeobiology of *Saurichthys*. These results are compared, and discussed in the light of shape data we collected on opecules of representatives for two extant species flocks, to elucidate patterns of shape dynamics and assess the comparative magnitude of disparity in the context of an adaptive speciation model. Our comparisons for extant species were based on the same morphometric protocol and comprised representatives from 61 species of cichlids (East Africa) and 40 species of notothenioids (Antarctica). By examining extant models in tandem with *Saurichthys* we are able to consider the relation between extant shape change dynamics and habitat occupation and its potential to contribute to inferences about the palaeoecology of *Saurichthys*.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

QUANTITATIVE ANALYSIS OF THE TAPHONOMIC PATTERNS OF VERTEBRATE ASSEMBLAGES FROM THE OLIGOCENE POLESLIDE MEMBER OF THE BRULE FORMATION, BADLANDS NATIONAL PARK, SOUTH DAKOTA

WILSON, Paige K., Dartmouth College, Hanover, NH, United States; MOORE, Jason R., Dartmouth College, Hanover, NH, United States

The spectacular fossil assemblages preserved in Badlands National Park have long been a major focus for paleontologists studying the mammalian faunas of the White River Group. The paleoecological study of White River Group faunas is, however, made more complex by the potentially confounding variation of taphonomic biases in both time and lithology. In this study taphonomic and paleoecological data were collected from four mammal-dominated fossil assemblages (two mudstone hosted and two sandstone hosted) from the Poleslide Member of the Brule Formation, in the less well studied Palmer Creek Unit of Badlands National Park, South Dakota. Previous work in the region has confirmed that the two major lithologies represent aeolian- and fluvial-dominated depositional environments, respectively.

A suite of quantifiable taphonomic and ecological variables were recorded for each of the more than 600 specimens. Variation in taphonomic patterns was assessed using a range of bivariate and multivariate statistical techniques, and the ecological structure of the assemblages was compared using standard diversity metrics. Results revealed distinctly different patterns of taphonomic biasing between the aeolian and fluvial samples, with some variability between all four sites. Little conclusive change in overall faunal composition was exhibited between the mudstone and sandstone samples, however. This suggests that, whereas species composition in the region did not respond to the environmental changes seen in the sedimentological record, the differing preservational environments produced a noticeable taphonomic overprint on the samples during and after fossilization.

Technical Session III (Wednesday, October 17, 3:45 pm)

HABITAT STRUCTURE AND HINDLIMB FUNCTIONAL MORPHOLOGY IN AN EARLY MIOCENE EQUID FROM PANAMA

WOOD, Aaron R., Florida Museum of Natural History, Gainesville, FL, United States; RINCON, Aldo F., Florida Museum of Natural History, Gainesville, FL, United States; MORENO RODRIGUEZ, Federico, Smithsonian Tropical Research Institute, Panama City, Panama; BLOCH, Jonathan I., Florida Museum of Natural History, Gainesville, FL, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Panama City, Panama

Paleoenvironmental conditions of the Las Cascadas Formation of Panama are relatively unknown but are integral to understanding the evolution of the oldest terrestrial assemblage of vertebrates (middle-late Arikareean) in southern Central America. Here, we describe postcrania of an abundant equid taxon from the Las Cascadas assemblage and apply a morphology-based proxy to infer habitat structure during the early Miocene of Panama. The Las Cascadas equid is tentatively identified as a small (45-55 kg via regression analysis of limb dimensions), primitive parahippine based on dental morphology. Postcranial elements discovered in a single quarry include a scapula, proximal radii, femora, tibiae, astragali, calcanea, a third metatarsal, and several phalanges. Qualitative comparisons with the well-studied, time-averaged population of "*Parahippus*" *leonensis* from the Hemingfordian of central Florida reveal functionally-relevant dissimilarities between the taxa: 1) the femoral head and neck are rotated more anteriorly relative to the long axis of the femur, 2) the astragalar neck is shorter and more perpendicular to the axis of the trochlea, 3) reduced lateral and medial ligamentous attachments sites on the astragalus, and 4) a more parallel orientation of the sustentacular facet relative to the plantar plane. These features suggest a more flexed neutral posture of the hindlimb in the Las Cascadas equid as well as a reduced lateral component of ligament-mediated stability during locomotion. Our paleoenvironmental proxy, measured using three-dimensional geometric morphometric (3DGM) techniques, is built on the observed correlation between mammalian tarsal morphology and substrate complexity, which differs between open and closed habitats. 3DGM analysis of Miocene equid astragali shows the Las Cascadas equid outside the morpospace occupied by predominantly closed-habitat, early Miocene morphotypes but within the region occupied by mixed open/closed habitat horses from the late Miocene. These results, combined with abundant volcaniclastics of the Las Cascadas Formation, suggest a mosaic of open and closed habitats created by intense volcanic disturbance of tropical forests during the early Miocene of Panama.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A RE-EVALUATION OF THE VERTEBRAL SOFT TISSUE RECONSTRUCTION WITHIN DINOSAURIA BASED ON ALTERNATE EXTANT ANALOGUES

WOODRUFF, Cary, Museum of the Rockies, Bozeman, MT, United States; HORNER, John R., Museum of the Rockies, Bozeman, MT, United States

Vertebral neural spine bifurcation has historically been treated as an archaic adaptation restricted to sauropodomorph dinosaurs. Primarily recognized within select sauropod clades such as Diplodocidae, Dicraeosauridae, and Camarasauridae, this vertebral feature is inferred to be an adaptation to certain life and feeding styles. Sauropods believed to have exhibited a horizontal neck posture and employed lateral sweep feeding, such as *Diplodocus*, have extensive neural spine bifurcation, while more vertical-necked sauropods (interpreted as

high browsers) such as *Brachiosaurus*, lack any neural spine bifurcation. Recently it has been proposed that neural spine bifurcation in Diplodocoidea is ontogenetic, suggesting that the origination of bifurcation in *Diplodocus* is a response to the increasing weight from the horizontally extended cervical column. As there are no terrestrial vertebrates with massive, horizontally extended necks alive today, extant forms with large cranial masses were examined for the presence of neural spine bifurcation. Here we demonstrate and report on for the first time, the soft tissue surrounding neural spine bifurcation in a terrestrial quadruped through the dissection of three Ankole-Watusi cattle. With horns weighing up to a combined 90 kg, the Ankole-Watusi is unlike any other breed of cattle in terms of horn weight and presence of neural spine bifurcation. Specifically, in regards to the soft tissue, the presence of bifurcated neural spines is most vividly expressed in the form of a highly modified and specialized nuchal ligament. Inferring from the information attained from the Ankole-Watusi, it would appear that neural spine bifurcation is critical when supporting a large mobile weight positioned off of the shoulders, which may explain the presence and absence of bifurcation within *Diplodocus* and *Brachiosaurus*. During this study neural spine bifurcation was also observed in several additional families of sauropods, within several other clades of avian and non-avian dinosaurs, and within numerous extinct and extant species of mammals. Contrary to the previous hypotheses that neural spine bifurcation was a basal feature that was evolutionarily lost in many clades, bifurcation should now be recognized as a critical anatomical component for potentially any terrestrial vertebrate with a large, mobile weight positioned off of the shoulders.

Technical Session XV (Saturday, October 20, 9:45 am)

PALEOBIOLOGICAL IMPLICATIONS OF GROWTH HISTORY AND HISTOVARIABILITY IN A POPULATION OF THE HADROSAURID DINOSAUR *MAIASAURA PEEBLESORUM*

WOODWARD, Holly N., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; HORNER, John R., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; FARLOW, James O., Indiana Purdue University Fort Wayne, Fort Wayne, IN, United States

Forty-eight tibiae of the hadrosaurid dinosaur *Maiasaura peeblesorum* were used in a histologic analysis to assess the ontogenetic and individual variation present within a non-avian dinosaur taxon. Tibial measurements reveal strong relationships (R^2 >0.9) between tibia length and diaphyseal circumference, cortical area, and bone wall thickness, and histology shows woven tissue was present throughout ontogeny, indicating growth was rapid until skeletal maturity was attained. A switch in vascular arrangement between lines of arrested growth (LAGs) similar to that recently described in Arctic *Edmontosaurus* was also found between LAGs in every *Maiasaura* specimen two years of age and older: immediately following a LAG, vascular canals were relatively small and longitudinal, and then became reticular, laminar, or plexiform for the majority of the zone. The presence of this vascular pattern in a taxon found far from the Arctic Circle casts doubt on a correlation with polar endemism. Apposition rates and growth curves illustrate that approximately half of the 7 m adult body length was attained within the first year of growth. Adult size, signified by the presence of an external fundamental system, was attained between 9–10 years of age by three individuals. Ontogenetic growth rates of *Maiasaura* were directly compared with the ontogenetic growth rates of skeletally mature captive reared male alligators by scaling the annual cortical growth of each taxon. Annual cortical increase is low and constant for the alligators, while *Maiasaura* cortical increase is very high early in life and steadily decreases to skeletal maturity. By directly comparing the taxa, it becomes evident that even alligators raised in optimal conditions never attain the elevated growth observed in *Maiasaura*, providing additional evidence that the presence of LAGs in non-avian dinosaurs is not an indicator of ectothermy or reduced growth rates. Additionally, both standard and scaled *Maiasaura* growth curves demonstrate that there is considerable variation with regard to body size each year, which is often a lurking variable within ontogenetic studies of dinosaur taxa due to inadequate sample sizes. Finally, the age-size frequency distribution of tibiae suggests a high mortality rate for yearlings and those individuals approaching skeletal maturity. In fact, over half of the sample is from individuals a year or less in age, suggesting that even forty eight specimens are not sufficient to fully assess the histovariability present within this taxon. Regardless, this detailed population histovariability analysis contributes to the already well-studied hadrosaur *Maiasaura*, making the ontogenetic history of this taxon one of the best understood of all non-avian dinosaurs.

Technical Session XVI (Saturday, October 20, 9:15 am)

3D BIOMECHANICAL MODELLING OF MARSUPIAL AND PLACENTAL SABRE-TOOTHS: A DIFFERENT KIND OF BITE FOR AN EXTREME POUCHED PREDATOR

WROE, Stephen, University of New South Wales, Kensington, Australia; CHAMOLI, Uphar, University of New South Wales, Sydney, Australia; PARR, William, University of New South Wales, Sydney, Australia; RIDGELY, Ryan C., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Questions surrounding the striking morphology of sabre-tooths and the presumably deadly purpose to which it was put have long excited the attention of scholars and laypersons alike. Among the dozens of known sabre-toothed species, the iconic North American placental, *Smilodon fatalis,* and the bizarre South American marsupial, *Thylacosmilus atrox* may be the most specialised forms. The two are prominent in discussions of convergent evolution. Here we apply a 3D computational approach to determine the extent of convergence in terms of mechanical performance. Both jaw closing and neck depressing musculatures were simulated. We found that, in many respects, the marsupial and placental were more similar to each other than to a living conical-toothed cat. Predicted bite forces were relatively low particularly at wide gapes and in simulations where jaw muscle forces were scaled to generate bite forces expected on the basis of size the sabre-tooths' skulls showed high stresses. Simulations invoking head depressing musculature adjusted for size differences revealed relatively low stresses in both. Although broadly comparable in these respects our study also demonstrates differences that were likely reflected in the modus operandi of the kill. Jaw adductor driven bite forces were extremely weak in the marsupial and its skull was even better adapted to resist stress induced by neck driven muscles. Considered together with the fact that the centre of the arc described by the canine teeth was close to the jaw-joint in *S. fatalis* our results are consistent with the hypothesis that both jaw closing and head depressing musculature played a role in prey dispatch for the placental. However, for *T. atrox* the jaw adducting muscles probably played no major part in the killing bite and we suggest that the marsupial presents a more complete commitment to the already extreme sabre-tooth lifestyle.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A BASAL SAURICHTHYIFORM (ACTINOPTERGII) WITH A PECULIAR NEUROCRANIUM AND JAW MECHANISM FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

WU, Feixiang, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; SUN, Yuanlin, School of Earth and Space Sciences, Peking University, Beijing, China; HAO, Weicheng, School of Earth and Space Sciences, Peking University, Beijing, China; JIANG, Da-Yong, School of Earth and Space Sciences, Peking University, Beijing, China

A new saurichthyiform is reported here from the Middle Triassic (Anisian) Guanling Formation of Guizhou Province, China, based on an exceptionally 3-D preserved braincase and other material of the lower jaw and pectoral girdle. This taxon provides considerable morphological data, especially those of the neurocranium and the jaws. It displays several primitive features, such as the presence of lateral pillar, paired posterior myodomes, parabasal canal, and convergence of the ramus ophthalmicus trigemini and lateralis in orbital region, etc. This new fish also possesses a series of unique derived traits: the posterior ethmoidal region (covered by vomer) bulging downward, the orbital tectum broad, some denticles delimiting the posterior edge of the spiracular groove, a large deep fossa present in the rear part of orbit housing the origin of some mandibular adductor muscle, the surangular extensively prolonged, the angulars partaking in the mandibular symphysis and the posteroventral process of the triradiate cleithrum long. Phylogenetic analysis places this taxon at the most basal position within Saurichthyiformes and strongly supports the monophyly of this order, which is the sister group of the Acipenseriformes. As for the anatomical features, of special interest is the association of the large deep fossa in the orbit with the prolonged opening of the mandibular adductor fossa, constructing a peculiar jaw mechanism reminiscent of some specializations in that of *Polypterus*. This, together with its blunt crushing-type dentition and downward bulging anterior mouth roof, suggests a different ecologically adaptive strategy in the saurichthyiforms during the rapid radiation period after the end-Permian mass extinction.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

ANATOMY, SYSTEMATICS AND TAPHONOMY OF AN ALLIGATOROID CROCODYLIAN SKELETON FROM THE KAIPAROWITS FORMATION (LATE CAMPANIAN) OF SOUTHERN UTAH

XU, Albert, The Webb Schools, Claremont, CA, United States; HENN, Madison, The Webb Schools, Claremont, CA, United States; WOODWARD, Samuel, The Webb Schools, Claremont, CA, United States; FARKE, Andrew A., Raymond M. Alf Museum of Paleontology, Claremont, CA, United States

Although the dinosaurs of the Kaiparowits Formation (late Campanian) are more widely known, continued fieldwork by several institutions within Grand Staircase-Escalante National Monument of southern Utah is greatly improving the previously fragmentary record of crocodylians from these strata. In 2011, the Raymond M. Alf Museum of Paleontology (RAM) collected a partial skeleton of an alligatoroid crocodylian in the upper portion of the middle unit of the Kaiparowits Formation. The specimen, RAM 14527, comprises 49 osteoderms, a mid-cervical vertebra, dorsal vertebra, two ribs, left humerus (length=94 mm), right femur (length=167 mm), and both lower jaws. The specimen was disarticulated but closely associated across 3 m^2 of the 6 m^2 excavated area, at the base of an indurated tabular sandstone overlying a mudstone containing abundant plant fragments. Associated fauna included rare lepisosteid fish scales and disarticulated unionid clams. We tentatively interpret the site as a pond deposit overlain by a crevasse splay. Phylogenetic analysis recovers RAM 14527 as an alligatoroid, potentially representing a previously undescribed taxon. The largest dorsal midline osteoderms (52 mm in maximum dimension) are square, with slight keeling, arching, and no anterior process. The dentary measures 354 mm long, with the symphysis extending to at least the seventh alveolus. The preserved dentary teeth, representing positions from throughout the length of the tooth row, are elongate and conical. The anterior processes of the surangular are sub-equal in length, and the surangular-dentary suture extends to the posterior corner of the external mandibular fenestra. All of these features are consistent with identification of the specimen as an alligatoroid, but the combination of characters appears to be unique among previously described taxa. Because associated skeletons of alligatoroids (and crocodylians in general) are comparatively rare in the Kaiparowits Formation, RAM

14527 provides important information for characterizing the formation's fauna and their taphonomic associations.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW INFORMATION ON SEXUAL DIMORPHISM AND ALLOMETRIC GROWTH IN THE PACHYPLEUROSAUR *KEICHOUSAURUS HUI* FROM THE MIDDLE TRIASSIC OF GUIZHOU, SOUTH CHINA

XUE, Yifan, Department of Geology and Geological Museum, Peking University, Beijing, China; JIANG, Da-Yong, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Zuo-Yu, Depatment of Geology and Geological Museum, Peking University, Beijing, China; YANG, Peng-Fei, Department of Geology and Geological Museum, Peking University, Beijing, China; JI, Cheng, Department of Geology and Geological Museum, Peking University, Beijing, China

Sexual dimorphism and allometric growth of the pachypleurosaur sauropterygian *Keichousaurus hui* from Middle Triassic of Xingyi, Guizhou, south China, has been previously described but briefly without details of the precise criteria used. After measuring 22 new specimens of *K. hui*, and 15 previously described specimens of the same taxon, we gained new information for discriminating between the two sexual forms and describing the ontogeny. The morphology of the ulna has not previously been used as a criterion to determine the sexual form. However, after measurement we found that the proportion of the length of the ulna versus the length of the radius in most specimens of the sexual form y is less than 0.92, whereas it is greater in the sexual form x and subadult, even reaching 1.06, complementing the previous standards which mainly depended on the ratio of the humerus relative to the femur. Furthermore, the proportion of the width of ulna versus the length of ulna is generally greater in the sexual form y than in the sexual form x.

In the aspect of ontogeny of *Keichousaurus hui*, we found several promising equations to quantify the process of allometric growth, using the model of y=a+b*exp(c*x+d) to fit the graph, in which two formulas stand out. One represents the change of the width of skull versus the width of glenoid compared to the growth of trunk, and the other represents the change in the length of skull versus glenoid-acetabulum distance with the growth of trunk. The r^2 of the former formula is 0.91554 while the latter is 0.94419, being significant, and both of them indicate a more rapid growth in incipient stage which decreases to zero during ontogeny. This result corroborates the hypothesis about the model of growth published before. We also examined the development of glenoid and acetabulum and found that during ontogeny, the width of the two parts changes relatively more rapidly than growth of trunk indicating the development of locomotion. The glenoid is particularly rapid and support for the forelimbs develops more rapidly than that for the hindlimbs, especially in the sexual form y.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

EFFECTS OF DIETARY DIFFERENCES BETWEEN TWO EXTANT RUMINANTS IN SYMPATRIC HABITAT ON ENVIRONMENTAL RECONSTRUCTION BY MESOWEAR ANALYSIS

YAMADA, Eisuke, Kagoshima University, Kagoshima, Japan

Mesowear analysis, a method used to reconstruct diets based on facet development on the occlusal surface of cheek teeth, has been mainly applied to reconstruct the food habits of extinct species and the paleoenvironments they lived in. However, little is known about the effects of dietary differences in a sympatric environment. This limitation can introduce errors when applying the method to fossil assemblages. The aim of this study is to determine the sensitivity of mesowear analysis. An interspecific comparison of mesowear variables (i.e., frequencies of occlusal relief and cusp shape) was conducted using wild populations of the Japanese serow (*Capricornis crispus*, n = 37) and the sika deer (*Cervus nippon*, n = 55) in the deciduous broad-leaved forest of the Nikko National Park, central Japan. Mesowear variables between the two populations were significantly different (Fisher's exact test: $P < 0.05$). The Japanese serow population was classified as browsers and the sika deer population was classified as mixed feeders by hierarchical cluster analysis and principal component analysis. As previous ecological studies provide good support for these results, this study concluded that mesowear analysis was sensitive to dietary differences of several species in a sympatric area. From this perspective, mesowear results of fossil assemblages from the same locality should be interpreted as a reflection of food habits of each species. Thus, the findings of this study will provide basic knowledge for the paleoecological studies based on food availability of fossil herbivorous ungulates.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SANDSTONE DIAGENESIS AS AN INDICATOR OF DIAGENETIC PATHWAYS IN VERTEBRATE SKELETAL REMAINS AND HEMATITE CONCRETIONS FROM A CREVASSE SPLAY SANDSTONE, HELL CREEK FORMATION (UPPER CRETACEOUS), EASTERN MONTANA

YAMAMURA, Daigo, Montana State University, Bozeman, MT, United States; SCHMITT, James G., Montana State University, Bozeman, MT, United States

Enclosing sandstone matrix is often invoked as an entombing medium facilitating preservation of endogeneous molecules in vertebrate skeletal material by isolation from contact with pore fluids. A fossil-bearing crevasse splay sandstone and enclosed fossilized skeletal remains and hematite concretions formed inside and outside of fossil bones in the Upper Cretaceous Hell Creek Formation (Makoshika State Park, Glendive, MT) were analyzed to document pore fluid geochemistry and its interaction with vertebrate skeletal remains during diagenesis and examine the role of sandstone matrix as an entombing agent. Optical petrography indicates: 1) multiple generations of calcite and siderite precipitation, 2) complete/partial dissolution of feldspar grains, 3) feldspar grain alteration to clay mineral, 4) preserved bone microstructure, 5) physical degradation of bone mineral phase. X-ray diffractometry indicates authigenic siderite is present in fossil bone matrices. Scanning electron microscopy coupled with energy dispersive spectroscopy indicates 1) presence of detrital grains within Haversian canals and 2) precipitation of authigenic minerals such as siderite and barite within bone matrices and pores.

Presence of siderite in bone and concretion matrices engulfing traces of vadose/phreatic calcite precipitation (indicated by isopachous fabric) suggests the concretion originally formed as siderite in eogenesis. Acidity of groundwater was elevated during mesogenesis by organic acid produced by degradation of plant material, which in turn accelerated grain alteration and dissolution. Although interaction between fossils and groundwater was restricted by concretion formation, presence of detrital grains and other authigenic minerals within bone matrices and pores indicate fossil bones were subject to groundwater infilteration.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DIVERSITY OF DIVING BEHAVIOR OF MOSASAURS (SQUAMATA: MOSASAURIDAE) INFERRED FROM OPTICAL SYSTEM

YAMASHITA, Momo, Tokyo Gakugei University, Koganei, Japan; KONISHI, Takuya, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; SATO, Tamaki, Tokyo Gakugei University, Koganei, Japan

The Mosasauridae (Diapsida: Squamata) are known to be fully adapted to aquatic life. Previous studies on their bone histology and sedimentary environment suggest that habitual diving depth varied among mosasaurid genera, but there is no definitive consensus about which taxon was more suited for life in deeper water. Recent studies found a strong correlation between the visual function (e.g., an f-number of an eye as an index of visual performance under dark) and the living style of various swimming vertebrates. The f-number (the ratio between focus length and maximum entrance pupil diameter) defines the light-gathering capability of an optical system. Eyes with a low f-number can function better at a low level of light intensity in the dark than those with a high f-number. Deep diving animals need to be equipped with eyes of a high capability for gathering light for their visual perception, if they rely on their eyesight to move around. The eyes of these animals are expected to have a low f-number. The f-numbers of three genera of mosasaurs, *Tylosaurus*, *Platecarpus*, and *Clidastes* were calculated from the measurements of their skulls and scleral rings. We compared two methods to estimate the optical axial length. One method calculates the axial length from the distance between the midline of the skull and the lateral margin of the frontal, which forms the dorsal rim of the orbit. The second method uses the external diameter of the scleral ring for the calculation of the optical axial length. Size of the maximum entrance pupil diameter was estimated from the internal opening diameter of scleral rings. We examined two *Platecarpus*, one *Tylosaurus*, and one *Clidastes* specimens. Among them, only the *Clidastes* specimen was not available for the first method due to the poorly preserved frontal. The f-numbers calculated with the first method were 2.95 in *Tylosaurus*, and 1.22 and 1.31 in *Platecarpus*, whereas those calculated with the second method were 2.47 in *Tylosaurus*, 1.49 and 1.75 in *Platecarpus*, and 1.68 in *Clidastes*. In both methods, the f-numbers of *Tylosaurus* were larger than those of *Platecarpus*; the f-number of *Clidastes* was between those of *Tylosaurus* and *Platecarpus*, and within the range of two *Platecarpus* specimens. From these results, we conclude that *Platecarpus* and *Clidastes* could see objects in darker environments, or deeper sea than *Tylosaurus*. Because the three genera are known from the same horizon of the same area (Santonian–Campanian of the Western Interior Seaway), their different f-numbers are possibly indicative of resource partitioning among these reptilian predators in terms of the water depth, particularly between *Tylosaurus* and the other two genera.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW SPECIES OF *QIANICHTHYOSAURUS* (REPTILIA: ICHTHYOSAURIA) FROM XINGYI FAUNA (LADINIAN, MIDDLE TRASSIC) OF GUIZHOU, SOUTHWESTERN CHINA

YANG, Peng-Fei, Department of Geology and Geological Museum, Peking University, Beijing, China; JI, Cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; JIANG, Da-Yong, Department of Geology and Geological Museum, Peking University, Beijing, China; MOTANI, Ryosuke, Department of Geology, University of California Davis, Davis, CA, United States; SUN, Zuo-Yu, Department of Geology and Geological Museum, Beijing, China

During a half-year's excavation in Wusha, Xingyi, Guizhou, Southwestern China, a middle-sized and well preserved ichthyosaur was discovered from the Zhuganpo Member of the Falang Formation (Late Ladinian, Middle Triassic). It can be referred to *Qianichthyosaurus* according to the following characters: tooth crown enamel without longitudinal striations; propodials and epipodials longer than wide; well-developed epipodial foramen; long, well developed haemal spines; notching present on both leading and trailing edges of flippers; the femur distally remarkably expanded and slightly longer than the humerus; rod-like ilium, without anteromedial process; centra discoidal, but elongate; dorsal rib articulation mainly

bicipital. However, it also bears some characters that are different from the type specimen of *Qianichthyosaurus zhoui*: much longer snout, making up nearly 68.2% of the skull length while the ratio in *Qianichthyosaurus zhoui* is only 54.2%; relatively smaller orbit, accounting for 25% of the skull length while this portion is 30.4% in the type specimen; premaxilla ventral process extending posteriorly and forming most of the ventral margin of the external naris; fibula with a posterior process in the middle peripheral margin; absence of obturator foramen on sub-triangular pubis. Counting these differences, this new specimen found in Wusha probably can be referred to a new species of *Qianichthyosaurus*. The new species is stratigraphically older than the type species, which is from the Carnian (Upper Triassic) Wayao Member of the Falang Formation in Guanling, Guizhou, China.

Qianichthyosaurus from Southwestern China and *Toretocnemus* from the Carnian Hosselkus Limestone of California had formed a monophyletic clade as Toretocnemidae in previous research. The new finding indicates the first appearance of toretocnemids should be earlier than the Carnian, at least down to the Ladinian of the Middle Triassic.

The new finding establishes that *Qianichthyosaurus* existed both in Xingyi and Guanling, as with the case of previously reported askeptosaurid thalattosaur *Anshunsaurus* and shastasaurid ichthyosaur *Guizhouichthyosaurus*. This suggests a closer relationship between Xingyi Fauna and Carnian Guanling Biota.

Technical Session XIX (Saturday, October 20, 2:45 pm)

EFFECTS OF PLEISTOCENE CLIMATIC REGIMES ON DIETARY NICHES AND ENVIRONMENTAL HETEROGENEITY IN FLORIDA

YANN, Lindsey T., Vanderbilt University, Nashville, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States

Stable oxygen and carbon isotopes from fossil tooth enamel can be used to better understand mammalian responses to climate change and the impact of interglacial warming on the dietary niches of Pleistocene taxa. Previous work at two Pleistocene sites in Florida, identified as glacial (Inglis 1A) and interglacial (Leisey 1A) based on geological data, demonstrate dramatic dietary responses to interglacial warming. To further test the hypothesis that differing climatic regimes affect mammalian dietary niches, we examined two additional Pleistocene sites (Haile 8A and Tri-Britton) with multiple sympatric taxa. Mean oxygen isotope values of the most evaporation sensitive taxa (i.e., camelids and deer) are greatest at Tri-Britton (camelids, 3.2‰) followed by Leisey 1A (0.7‰ camelids; 0.8‰ *Odocoileus*), demonstrating that Tri-Britton is warmer and/or more arid than Leisey 1A. Haile 8A is intermediate between Leisey 1A and Inglis 1A with camelid and *Odocoileus* values of -0.5 ‰ and -0.2 ‰, respectively, indicating a transitional site between glacial and interglacial conditions. Rank orders of mean and maximum oxygen isotope values in camelids and *Odocoileus* demonstrate identical patterns, further supporting these climatic designations. Environmental heterogeneity, based on $\delta^{13}C$ values, is greatest at Leisey 1A, Tri-Britton, and Haile 8A, all with statistically greater values than Inglis 1A ($p \leq 0.002$). *Tapirus*, *Palaeolama*, and *Equus* $\delta^{13}C$ values from Tri-Britton are greater than those present at any other site (all yield $p \leq 0.046$); increased $\delta^{13}C$ values indicate the presence of more open forests (*Tapirus*, *Palaeolama*) and abundant C_4 grasses (*Equus*). Grazers at both sites are statistically greater than browsers (taxa with $n > 2$; $p \leq 0.035$), but there are no statistical differences within dietary categories. Despite previous interpretations of *Mammuthus* as an obligate grazer, $\delta^{13}C$ values indicate a mixed diet at Tri-Britton that is not significantly different from browsers, grazers, or other mixed feeders. At Haile 8A *Odocoileus* and *Hemiauchenia* $\delta^{13}C$ values are statistically indistinguishable from Inglis 1A, and *Mylohyus* and *Equus* are statistically indistinguishable from Leisey 1A, reinforcing the idea of a transitional site, ecologically. Increased heterogeneity at Tri-Britton may also be responsible for the existence of closely related taxa (e.g., two peccaries and two camelids), similar to Leisey 1A. Although Haile 8A represents a potential transition, it still documents an increased diversity of taxa and greater heterogeneity than glacial sites. This research further supports the idea that interglacial warming or transitional periods support a more heterogeneous environment, which allows increased diversity of dietary niches among resident fauna.

Technical Session XVIII (Saturday, October 20, 2:00 pm)

NEW DATA FOR EVALUATING FUNCTIONAL MORPHOLOGY IN PTILODONTIDAE (ALLOTHERIA, MULTITUBERCULATA) USING DIGITAL PREPARATION

YAPUNCICH, Gabriel S., CUNY Graduate Center/NYCEP, New York, NY, United States; BOYER, Doug M., Brooklyn College/NYCEP, New York, NY, United States; MAIORINO, Stephanie, Stony Brook University, Stony Brook, NY, United States; BOLORTSETSEG, Minjin, Institute for the Study of Mongolian Dinosaurs, Ulaanbaatar, Mongolia

Extinct Multituberculata was the longest surviving order of mammals. Given their near ubiquity in Mesozoic and Cenozoic communities, reconstructing their paleoecology is important for a balanced view of mammalian evolutionary history. The relative lack of multituberculate postcrania has hindered the study of their functional morphology and the implications for locomotor and positional behavior. Using microCT scanning and digital extraction of articulated bones, we re-examine the skeleton of *Ptilodus kummae* from the Paleocene of Saskatchewan, Canada. Previous work has suggested arboreal locomotion based on the presence of features that could meet the functional demands of this lifestyle. Alternatively, other features of *Ptilodus* have been argued to indicate a more terrestrial lifestyle, as inferred from Asian multituberculate skeletons. More detailed visualization and measurement of morphology provided by a digital approach facilitates testing these competing hypotheses. Compared to a large sample of extant therian taxa, elements of the manus, pes and caudal vertebral column in *Ptilodus* lack many features expected for an obligate arborealist. *Ptilodus* exhibits short, robust manual intermediate phalanges relative to its pedal intermediate phalanges, a pattern no extant arborealist exhibits. Rather, similar proportions characterize saltatorialists such as most macropodids, macroscelideans, and lagomorphs. As in cursorial and saltatorial animals, *Ptilodus* exhibits metapodials with cylindrical heads, which limit ab-adduction and promote flexion and extension at the metapodial-phalangeal joints. Additionally, the distal phalanges are mediolaterally broad and dorsoventrally shallow, resembling terrestrialists more than arborealists, as demonstrated by multivariate comparisons. Finally, arboreal taxa with prehensile tails are characterized by caudal vertebrae that are mediolaterally broad. In contrast, the caudal vertebrae of *Ptilodus* are dorsoventrally deep and mediolaterally narrow, a combination that does not enhance tight tail flexion and is not found within prehensile-tailed animals. The length of caudal chevrons is not significantly correlated with tail function in our sample, bringing the previously supposed significance of long chevrons in *Ptilodus* into question. These results suggest that arboreal activities did not dominate the lifestyle of *Ptilodus*, although some similarities to scansorialists such as scandentians and sciurids do not preclude facultative tree climbing. Instead, the examined morphology indicates that *Ptilodus* was most likely a terrestrial or scansorial mammal that progressed via saltation, potentially similar to Asian multituberculates.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RECONSTRUCTION OF INNER EAR SHAPE AND SIZE IN MOSASAURS (REPTILIA: SQUAMATA) REVEALS COMPLEX ADAPTATION STRATEGIES IN SECONDARY AQUATIC REPTILES

YI, Hongyu, American Museum of Natural History, New York, NY, United States; SAMPATH, Divya, Hunter College High School, New York, NY, United States; SCHOENFELD, Shoshana, Hunter College High School, New York, NY, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States

Mosasaurs were top predators in the Late Cretaceous oceans. They are a secondarily aquatic squamate clade, phylogenetically allied to varanid lizards. Morphologically, mosasaurs reach ten times the size of extant *Varanus*, and demonstrate distinct aquatic adaptations, including modified fin-like limbs and tails. Previous studies of postcrania suggest mosasaurs as agile swimmers, but discussions on their skull modifications in relation to aquatic lifestyles remain scarce. This study reconstructs the bony labyrinth in mosasaur braincases, especially the semicircular canals, to quantitatively evaluate their locomotory adaptations compared to their terrestrial sister group. Semicircular canals are vertebrate balance organs that are reduced in length and sensitivity in secondary aquatic mammals (cetaceans). This has been considered an adaptation for frequent rotation in the water. In this study, we digitally reconstructed and measured the bony labyrinth in one mosasaur genus (*Platecarpus*) and seven *Varanus* species, using high resolution X-Ray Computed Tomography scans. The results show that *Platecarpus* has a long conjoined path (crus commune) between the anterior and posterior semicircular canals, which resembles the diving marine iguanas more than *Varanus*. Quantitatively, lengths of the three semicircular canals in *Platecarpus* (scaled to skull length) was not significantly different from the lengths predicted by a linear regression model based on *Varanus* data, suggesting that sensitivity to rotation in *Platecarpus* was statistically the same as that in *Varanus*. The results further indicate that, compared to cetacean mammals, *Platecarpus* mosasaurs utilized a different strategy in their adaptations to balance in aquatic environments, and their semicircular canals are modified more in shape than size in response to an aquatic lifestyle.

Technical Session IX (Friday, October 19, 10:30 am)

CRANIODENTAL ANATOMY AND FEEDING MECHANICS OF *DAKOSAURUS MAXIMUS* AND *PLESIOSUCHUS MANSELII*, TWO CONTEMPORARY LARGE-BODIED, MACROPHAGOUS METRIORHYNCHID CROCODYLOMORPHS FROM THE LATE JURASSIC OF EUROPE

YOUNG, Mark, University of Edinburgh, Edinburgh, United Kingdom; BRUSATTE, Stephen L., Columbia University, New York, NY, United States; BEATTY, Brian L., New York College of Osteopathic Medicine, New York, NY, United States; DE ANDRADE, Marco B., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; DESOJO, Julia, Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia', Buenos Aires, Argentina

Metriorhynchidae was a peculiar but long-lived group of marine Mesozoic crocodylomorphs adapted to a pelagic lifestyle. Two contemporaneous species from the Late Jurassic of Europe, *Dakosaurus maximus* and *Plesiosuchus manselii*, were large-bodied (4.5-6.5 meters in total length) and macrophagous (fed on large-bodied prey). We redescribed the anatomy and reassessed the systematics of both species, which allows for a better understanding of their phylogeny and dietary ecology. Both taxa are diagnosed by several apomorphies. For *D. maximus* these include strongly ornamented maxillae, mesial/distal tooth wear and extensive crown breakage, and for *P. manselii* strongly convex palatines with a pronounced medial ridge and quadrate distal articular surfaces not separated into two condyles. Phylogenetic analysis places *D. maximus* as the sister taxon of the South American *D. andiniensis*, while *P. manselii* is placed in a polytomy at the base of the Geosaurini, the subclade of macrophagous metriorhynchids that includes *Dakosaurus*, *Geosaurus* and *Torvoneustes*. Craniodental morphology indicates that *D. maximus* and *P. manselii* were macrophagous, but may have fed in distinct ways. Uniquely, *D. maximus* had tightly fitting, vertical occlusion, as indicated by reception pits along the upper and lower tooth rows, vertically orientated crowns that were in close contact during occlusion, and vertical microwear striations extending along the mesial and distal margins of the teeth, obliterating the carinae and denticles due to shearing occlusion. Enamel thickness does not seem to be specialized in this group however, possibly reflecting tooth developmental constraints

recently suggested to be unique for archosaurs. Furthermore, *D. maximus* possesses craniomandibular features observed in extant suction-feeding odontocetes, most specifically the false killer whale, including: shortened tooth-row, amblygnathous ("bullet-shaped") rostrum and a very short mandibular symphysis. We hypothesize that the skull and dentition of *D. maximus* were optimized for cutting large and abrasive prey items into portions small enough to swallow. *Plesiosuchus manselii*, by contrast, possesses a non-amblygnathous rostrum, a longer mandibular symphysis and microziphodont serrations, and lacks spalled or broken tooth apices and mesial/distal wear facets. Lack of crown breakage and wear suggests this species fed on soft-bodied prey. The difference in optimum gape (gape at which multiple teeth come into contact with a prey item) between *P. manselii* and *D. maximus* is considerable. As *Plesiosuchus* had a large gape and non-worn teeth, the extant sperm whale may be a good analogue. Craniodental differentiation and niche partitioning enabled these two large-bodied species to coexist in the same ecosystem.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

INFERRING GROWTH IN GIANT PENGUINS FROM THE PALEOGENE OF ANTARCTICA AND THE NEOGENE OF SOUTH AMERICA

YURY-YÁÑEZ, Roberto E., Universidad de Chile, Santiago de Chile, Chile; OSSA, Luis, Universidad de Chile, Santiago de Chile, Chile; RUBILAR-ROGERS, David, Museo Nacional de Historia Natural, Santiago de Chile, Chile; SALLABERRY, Michel, Universidad de Chile, Santiago de Chile, Chile

Birds evolved high rates of growth, reaching full size within one year, which histologically results in the absent of LAGs (annual lines of arrested growth) that are usually developed by endotherms. With the exception of a very few cases such as the moa and the kiwi, birds lack LAGs. Today the Emperor penguin *Aptenodytes forsteri* , one of the largest extant penguins, is considered to be the faster vertebrate to reach full adult size. Fossil representatives of penguins are known to easily exceed the size of Emperor penguins, so their patterns of growth has remains obscured even with the large amount of research and interest in fossil penguins in the last decade. We studied thin sections of four representatives of extinct giant penguins: fossil bones referred to the genus *Palaeeudyptes* or *Anthropornis* from the Eocene of the La Meseta Formation, Seymour Island, Antarctica, the species *Pygoscelis grandis* and *Spheniscus urbinai*, from the late Miocene – Pliocene of the Bahía Inglesa Formation, northern Chile. We also included the Humboldt penguin *Spheniscus humboldti*, an extant species, and the genus *Palaeospheniscus* from the middle Miocene of Argentinian Patagonia, both medium size penguins. The Antarctic species belongs to the high diversity of basal penguins while the Chilean ones are extinct representatives of an extant genus in the crown group Spheniscidae. The Argentinian representative is an outgroup to the crown group. Histology shows that fast growth in penguins is common across the entire phylogenetic sample. As is common in other birds, fossil penguins do not developed LAGs. The largest representatives (Paleogene) are characterized by a big number of secondary osteons, while all studied giant penguins do not developed the outer circumferential layer that is negatively correlated with size. As the majority of neornithines, they reached full growth within one year. Fast growth, sometimes considered in penguins an adaptation to cold, is a plesiomorphic character to this order of birds.

Technical Session I (Wednesday, October 17, 8:00 am)

A NEW GIANT CARCHARODONTOSAURIAN ALLOSAUROID FROM THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION OF CENTRAL UTAH

ZANNO, Lindsay E., Nature Research Center, North Carolina Museum of Natural Sciences, Raleigh, NC, United States; MAKOVICKY, Peter J., Field Museum of Natural History, Chicago, IL, United States; GATES, Terry A., Ohio University, Athens, OH, United States

The terminal Early Cretaceous was a time of major faunal reorganization in western North America. Localized extinction of remnant Jurassic megafauna (e.g., sauropodomorphs and allosauroid theropods) co-occurred with establishment of neoceratopsians and advanced members of several coelurosaurian subclades, a transformation long attributed to faunal interchange with Asia. Here we report on a new theropod from the Lower Cretaceous Cedar Mountain Formation of Utah, representing the last surviving allosauroid species yet reported from the North American continent.

The new taxon is known from a partially preserved skeleton, including portions of the axial column, pelvis, and hind limb. Preliminary phylogenetic analysis substantiates referral to Carcharodontosauria based on extreme axial pneumaticity, including camellate vertebral structure, slit-like dorsal pluerocoels, and heavily pneumatized hypantra, as well as deep peg-and-socket iliac/ischial articulations. The new taxon exhibits shared morphology with neovenatorids including transversely compressed, cranialmost dorsal centra bearing a prominent ventral keel, as well as transversely inflated, quadrangular hypantra similar to the condition observed in *Aerosteon*. However, cranialmost dorsal centra are distinctly elongate, a feature not otherwise observed in the clade. More caudally positioned dorsal vertebrae exhibit weakly developed, flange-like lateral extensions of the postzygapophyses as in *Neovenator* and *Aerosteon*; a hypertrophied caudal centrodiapophyseal lamina; distinct, alariform, ventrolaterally trending hyposphenes unlike the sheet-like condition of carcharodontosaurids; and compact neural spines (in contrast with the approximately coeval North American carcharodontosaurid *Acrocanthosaurus*). The ilium possesses a hypertrophied acetabular shelf and autapomorphic morphology of the ventral postacetabular wing.

The new specimen derives from silty mudstone of the uppermost Mussentuchit Member, 8-9 meters above a smectitic ash horizon previously dated to 98.39 +/- 0.07 Ma and 6-7 meters below the contact with the Upper Cretaceous Dakota Formation. The presence of a new taxon refutes prior hypotheses of homogeneity in the allosauroid fauna of the continent during this interval. The new taxon also confirms both an extended temporal overlap and marked body mass discrepancy between carcharodontosaurians and advanced tyrannosauroids in the Early Cretaceous of western North America. The extinction of allosauroids as apex predators in late Mesozoic terrestrial ecosystems of western North America may have allowed opportunistic invasion of this niche by tyrannosauroids, which proceeded to dominate terrestrial ecosystems in this region until the terminal Cretaceous extinction event.

Technical Session III (Wednesday, October 17, 2:45 pm)

THE WESTERNMOST TARSIER: A NEW GENUS AND SPECIES FROM THE MIOCENE OF PAKISTAN

ZIJLSTRA, Jelle S., Harvard College, Cambridge, MA, United States; FLYNN, Lawrence J., Peabody Museum, Harvard University, Cambridge, MA, United States; WESSELS, Wilma, Institute for Earth Sciences, University of Utrecht, Utrecht, Netherlands

As the closest living sister group of anthropoids, tarsiers (family Tarsiidae) are an important group in primate evolution. However, their fossil record is poor: only four species have been described, two from the Eocene of China and two from the Miocene of Thailand. All are from outside the range of the living species, which occur only on the islands of Southeast Asia.

Here, I describe the first fossil tarsier from Pakistan, a significant range extension. This record consists of two lower molars, an upper molar, and three fragmentary upper anterior teeth found in the Miocene Manchar Formation of Sindh Province, southern Pakistan. The lower molars are recognizable as tarsiers by their high crown, prominent paraconid, and distinct cingulum. However, they are characterized by a relatively narrow shape and the possession of an anterolabial cingulum. The single upper molar is identified as an M3. It is distinct in showing a broad buccal shelf, with the paracone and metacone relatively lingual in position. In addition, the lingual cingulum is weak.

The Pakistani tarsier is morphologically distinct from all living and fossil tarsiers, but most similar to the Middle Miocene Thai species *Tarsius thailandicus*. Though living tarsiers have traditionally been classified in a single genus, a recent revision proposed a division into three genera. The differences that separate the Pakistani tarsier from other known species are of the same order of magnitude as those between the living genera, and we have found no evidence to support a close relationship between the Pakistani tarsier and any one of the extant genera. However, the Pakistani tarsier appears to be similar to *Tarsius thailandicus*, for which the upper molars are unknown. Thus, we propose that the Pakistani tarsier and *T. thailandicus* should be placed in a new tarsiid genus.

This discovery broadens our understanding of the geographic range and morphological diversity of Miocene tarsiers and helps put the living tarsiers into their evolutionary context.

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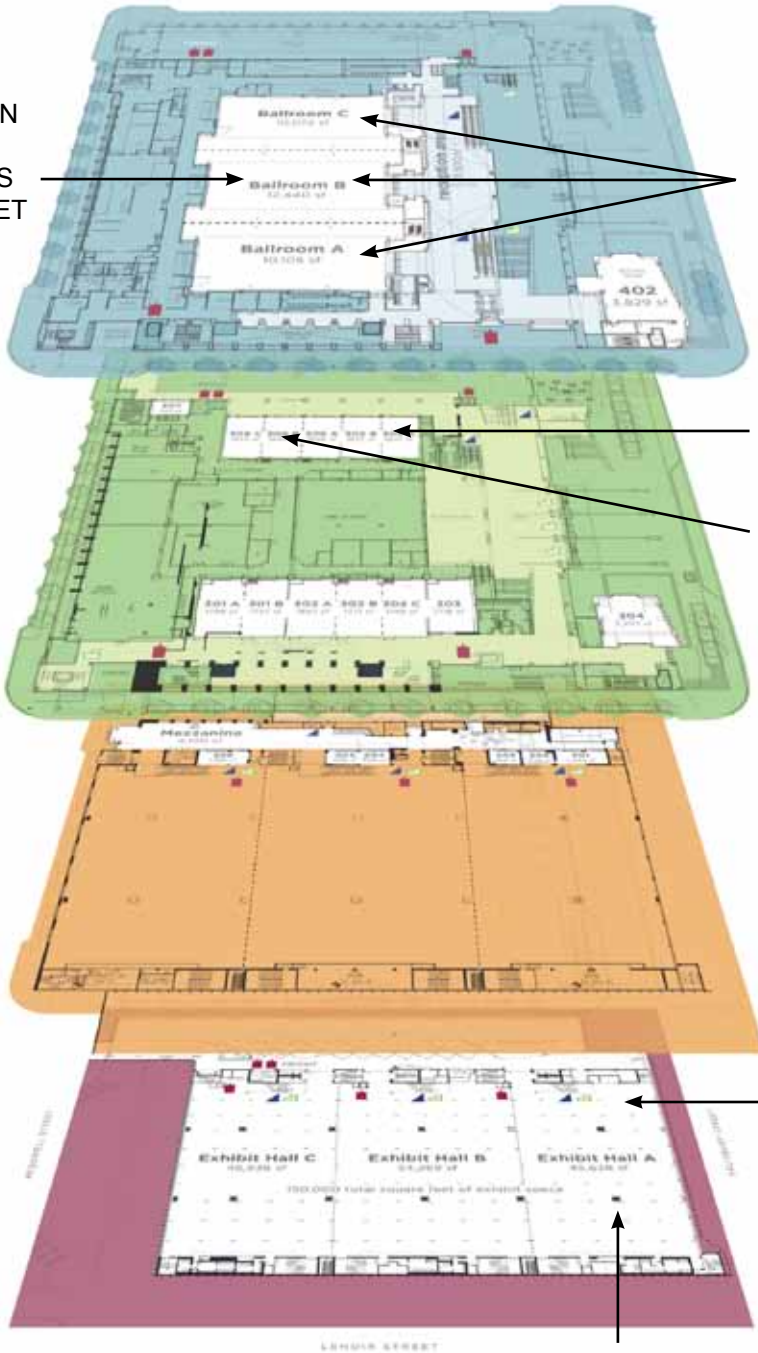

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306 A-C CONCURRENT SESSIONS
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