SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

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Program and Abstracts

71st Annual Meeting
Society of Vertebrate Paleontology

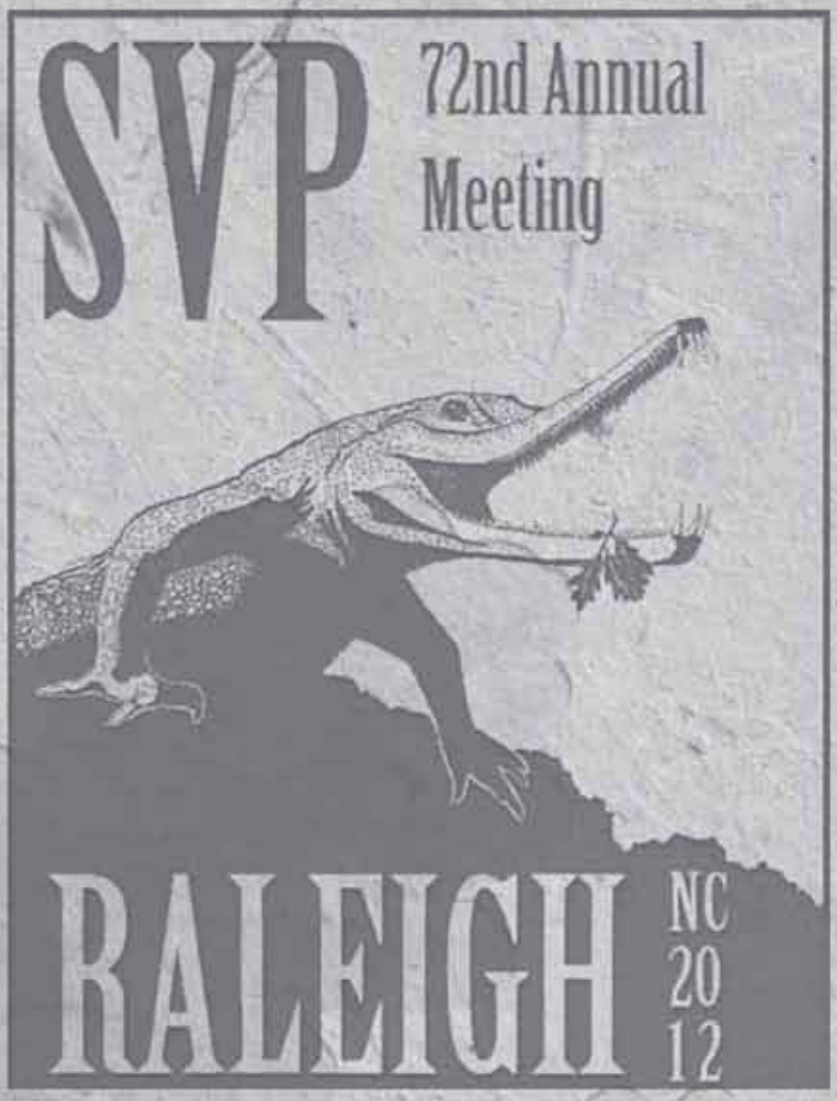
Paris Las Vegas
Las Vegas, Nevada, USA
November 2 – 5, 2011

Society of Vertebrate Paleontology

ISSN 1937-2809

SOCIETY OF VERTEBRATE PALEONTOLOGY
ABSTRACTS OF PAPERS
SEVENTY-FIRST ANNUAL MEETING

PARIS LAS VEGAS HOTEL
LAS VEGAS, NV, USA
NOVEMBER 2–5, 2011



SAVE THE DATE!

SVP 72ND ANNUAL MEETING

OCTOBER 17 – 20, 2012

RALEIGH CONVENTION CENTER
RALEIGH, NC USA

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SOCIETY OF VERTEBRATE PALEONTOLOGY

Members and Friends of the Society of Vertebrate Paleontology,

The Host Committee cordially welcomes you to the 71st Annual Meeting of the Society of Vertebrate Paleontology in Las Vegas. We have planned an exciting scientific program, as well as an engaging selection of pre-meeting and post-meeting field trips and a diverse menu of trips for accompanying guests. If your impression of Las Vegas is simply glitz and gambling, you're in for a surprise. Beyond the Las Vegas Strip (which itself is packed with wonderful, non-gambling distractions), consider taking a hike in nearby Red Rock Canyon National Conservation Area (which has a new visitor center), visiting the spectacular new Nevada State Museum at the Springs Preserve, checking out the Las Vegas Natural History Museum, or investigating the amazing, new, Frank Gehry-designed Lou Ruvo Center for Brain Health.

Early November is a perfect time to visit Las Vegas. We look forward to a scientifically exciting and culturally memorable SVP meeting.

2011 SVP 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 and other intent to communicate or disseminate results or discussion presented at the SVP Annual Meeting. Content that may be pre-published online in advance of print publication is also subject to the SVP embargo policy.

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.

2011 SVP SCHEDULE OF EVENTS (subject to change)

All events are held at the Paris Las Vegas Hotel unless otherwise noted with an **

Event/Function	Tuesday, November 1	Wednesday, November 2	Thursday, November 3	Friday, November 4	Saturday, November 5
Registration Desk	1 pm – 6 pm *RIVOLI A*	7 am – 5 pm *RIVOLI A*	7 am – 5 pm *RIVOLI A*	7:30 am – 5 pm *RIVOLI A*	8:00 am – 5 pm *RIVOLI A*
Plenary Session/Welcome		7:45 am – 8 am *CONCORDE A/B*			
Symposium		8 am – 12:15 pm **Symposium 1 - To Fins, Limbs, Wings and Back Again** *CONCORDE A/B*	8 am – 12:15 pm **Symposium 3 – The Evolution and Ecology of Terrestrial Ecosystems of Campanian Laramidia (Western North America)** *VENDOME A*	8 am – 12:15 pm **Symposium 4 – Vertebrate Diversity Patterns and Sampling Bias** *CONCORDE A/B*	
Symposium		8 am – 12:15 pm **Symposium 2 – Climate Change and Vertebrate Response in the Evolving Arid West of Plio-Pleistocene North America** *VENDOME B*			
Technical Session Romer Session		8 am – 12:15 pm **Technical Session I** *VENDOME A*	8 am – 12:15 pm **Romer Session/Technical Session V** *CONCORDE A/B*	8 am – 12:15 pm **Technical Session IX** *VENDOME A*	8 am – 12:15 pm **Technical Session XIV** *CONCORDE A/B*
Technical Session Preparators' Session			8 am – 12:15 pm **Preparators' Session** *VENDOME B*	8 am – 12:15 pm **Technical Session X** *VENDOME B*	8 am – 12:15 pm **Technical Session XV** *VENDOME A*
Technical Session					8 am– 12:15 pm **Technical Session XVI** *VENDOME B*
Technical Session		1:45 pm – 4:15 pm **Technical Session II** *CONCORDE A/B*	1:45 pm – 4:15 pm **Technical Session VI** *CONCORDE A/B*	1:45 pm – 4:15 pm **Technical Session XI** *CONCORDE A/B*	1:45 pm – 4:15 pm **Technical Session XVII** *CONCORDE A/B*
Technical Session		1:45 pm – 4:15 pm **Technical Session III** *VENDOME A*	1:45 pm – 4:15 pm **Technical Session VII** *VENDOME A*	1:45 pm – 4:15 pm **Technical Session XII** *VENDOME A*	1:45 pm – 4:15 pm **Technical Session XVIII** *VENDOME A*
Technical Session		1:45 pm – 4:15 pm **Technical Session IV** *VENDOME B*	1:45 pm – 4:15 pm **Technical Session VIII** *VENDOME B*	1:45 pm – 4:15 pm **Technical Session XIII** *VENDOME B*	1:45 pm – 4:15 pm **Technical Session XIX** *VENDOME B*
Workshops/Educational Events	9 am – 4 pm **Phylogenetic Comparative Methods Workshop** *For Pre-Registered Attendees* *VERSAILLES BALLROOM 1*				12:30 pm – 1:30 pm **Town Hall Meeting on Evolution IX** *CONCORDE A/B*
	9 am – 4 pm **Travel and Expedition Medicine Workshop** *For Pre-Registered Attendees* ***UNLV LILLY FONG GEOSCIENCES BUILDING ROOM: 201A*				
	2 pm – 5 pm **Protection of Vertebrate Fossil Resources, Including the Paleo Park Initiative Workshop** *For Pre-Registered Attendees* *VERSAILLES BALLROOM 4*	12:30 pm – 1:30 pm **Women in Paleontology Event How to Land a Faculty Position: An Interactive Workshop Featuring Recent Hires** *CHAMPAGNE BALLROOM 1*			
	2 pm – 5 -pm **Effective Poster Design Workshop** *For Pre-Registered Attendees* *VENDOME C*				

2011 SVP SCHEDULE OF EVENTS (subject to change)

All events are held at the Paris Las Vegas Hotel unless otherwise noted with an **

Event/Function	Tuesday, November 1	Wednesday, November 2	Thursday, November 3	Friday, November 4	Saturday, November 5
Special Event	7:30 pm **A Special Presentation by Dr. "Jack" Horner: Dinosaurs and the Proofs of Evolution** *CONCORDE A/B*	12:30 pm – 1:30 pm **Special Address: Brett Riddle: The History of Biotic Diversification in North American Deserts** *CONCORDE A/B*			
Poster Sessions Setup: 7:30 am – 9:30 am		**Poster Session I:** 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm *RIVOLI B*	**Poster Session II:** 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm *RIVOLI B*	**Poster Session III:** 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm *RIVOLI B*	**Poster Session IV:** 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm *RIVOLI B*
Exhibit Viewing		9:30 am – 6:15 pm *RIVOLI B*	9:30 am – 6:15 pm *RIVOLI B*	9:30 am – 6:15 pm *RIVOLI B*	9:30 am – 6:15 pm *RIVOLI B*
Annual Business Meeting/ Open Executive Committee Meeting			12:30 pm – 1:30 pm **Annual Business Meeting** *CONCORDE A/B*	12:30 pm – 1:30 pm **Open Executive Committee Meeting** *CONCORDE A/B*	
Press Event			4:15 pm – 5:45 pm *CHAMPAGNE BALLROOM 1*		
Social Events		7 pm – 10 pm **Welcome Reception** *PARIS LAS VEGAS POOLSIDE THIRD FLOOR*	8 pm – 10 pm **Student Roundtable Forum & Reprint Exchange** *CHAMPAGNE BALLROOM 2*	6:30 pm – 10:30 pm **Auction/Reception** *CHAMPAGNE BALLROOM*	**Awards Banquet Dinner** *(Ticketed Event)* 7 pm – 8:30 pm **Awards Ceremony** *(All Invited to Attend)* 8:30 pm – 10 pm *CONCORDE A/B* 10 pm – 2 am **After Hours Party** *CHAMPAGNE BALLROOM AND PARIS FOYER*
Beverage Service		7 am – 8 am *PARIS FOYER* 10 am – 10:15 am *RIVOLI B/C*	7 am – 8 am *PARIS FOYER* 10 am – 10:15 am *RIVOLI B/C*	7 am – 8 am *PARIS FOYER* 10 am – 10:15 am *RIVOLI B/C*	7 am – 8 am *PARIS FOYER* 10 am – 10:15 am *RIVOLI B/C*
Speaker Ready Room	1 pm – 6 pm *BURGUNDY ROOM*	7 am – 5 pm *BURGUNDY ROOM*	7 am – 5 pm *BURGUNDY ROOM*	7 am – 5 pm *BURGUNDY ROOM*	7 am – 4 pm *BURGUNDY ROOM*
Meeting Rooms	8 am – 7 pm *CONCORDE C* *VERSAILLES BALLROOM 1* *VERSAILLES BALLROOM 4* *BORDEAUX*	7 am – 7 pm *CONCORDE C* *VERSAILLES BALLROOM 1* *VERSAILLES BALLROOM 4* *BORDEAUX*	7 am – 7 pm *CONCORDE C* *VERSAILLES BALLROOM 1* *VERSAILLES BALLROOM 4* *BORDEAUX*	7 am – 7 pm *CONCORDE C* *VERSAILLES BALLROOM 1* *VERSAILLES BALLROOM 4* *BORDEAUX*	7 am – 7 pm *CONCORDE C* *VERSAILLES BALLROOM 1* *VERSAILLES BALLROOM 4* *BORDEAUX*

PROGRAM AT A GLANCE

	Concorde A/B	Vendome A	Vendome B	Concorde A/B	Vendome A	Vendome B
	SYMPOSIUM 1 To Fins, Limbs, Wings and Back Again	Tech I	SYMPOSIUM 2 Climate Change and Vertebrate Response in the Evolving Arid West of Plio-Pleistocene North America	Romer Prize Session/ Tech V	SYMPOSIUM 3 The Evolution and Ecology of Terrestrial Ecosystems of Campanian Laramidia (Western North America)	Preparators' Session
	WEDNESDAY	**WEDNESDAY**	**WEDNESDAY**	**THURSDAY**	**THURSDAY**	**THURSDAY**
8:00 am	Wilson	Wings	Bell	Dutchak	Fiorillo	Esker
8:15 am	Shubin	Porter	McCord	Knell	Schmitt	Breithaupt
8:30 am	Schneider	Werning	Steadman	Orcutt	Roberts	Matthews
8:45 am	Johanson	Barrett	Mead	van Heteren	Miller	Henrici
9:00 am	Pierce	Mounce	McDonald	Varriale	Brinkman	Getty
9:15 am	Gatesy	Salzberg	McGuire	Woodward	Eaton	Wilkins
9:30 am	Fröbisch	Varricchio	Meyers	Hulbert, Jr.	Konishi	Lucking
9:45 am	Caldwell	Venditti	Jass	Wang	Nydam	Cavigelli
10:00 am	COFFEE					
10:15 am	Fowler	Mallison	Springer	Johnson	Irmis	Roach
10:30 am	Maxwell	VanBuren	Sagebiel	Fisher	Drumheller	Balcarcel
10:45 am	Larsson	Maidment	Harris	Mothé	Loewen	Schulp
11:00 am	Dececchi	Ridgwell	Arroyo-Cabrales	MacPhee	Farke	Brown
11:15 am	Sánchez	Nabavizadeh	Blois	Graham	Brown	Bader
11:30 am	Cooper	Morhardt	Polly	Miller	Evans	Smith
11:45 am	Sears	Han	Atwater	Feranec	Gates	Davies
12:00 pm	Weisbecker	Zhao	Scott	Schikora	Sampson	Fitzgerald
12:15 pm	LUNCH					
1:30 pm						
	Tech II	Tech III	Tech IV	Tech VI	Tech VII	Tech VIII
1:45 pm	Tsuji	Samuels	Anderson	Carney	Anemone	Ahlberg
2:00 pm	Cisneros	Bjornsson	Sallam	Barden	Hunter	Molnar
2:15 pm	Modesto	Meachen-Samuels	Schwarz	Wang	Wilson	Kavanagh
2:30 pm	Gardner	Sakamoto	Higgins	Li	Calede	Chen
2:45 pm	Yi	Goswami	Hopkins	Dyke	Wang	Pardo
3:00 pm	Wu	Borths	Mōrs	Huynh	Eberle	Huttenlocker
3:15 pm	Botha-Brink	Smits	Rinaldi	Heers	Missiaen	Anderson
3:30 pm	Sidor	Shabel	Perez	English	Orliac	Reisz
3:45 pm	Nesbitt	Churchill	Bertrand	Andres	Beard	Marsicano
4:00 pm	Bhullar	Bloch	Gaudin	Rodrigues	Kohn	Fujiwara
4:15 pm	*Poster Session I/Reception* *RIVOLI B*			*Poster Session II/Reception* *RIVOLI B*		
6:00 pm						

PROGRAM AT A GLANCE

	Concorde A/B	Vendome A	Vendome B	Concorde A/B	Vendome A	Vendome B
	SYMPOSIUM 4 Vertebrate Diversity Patterns and Sampling Bias	Tech IX	Tech X	Tech XIV	Tech XV	Tech XVI
	FRIDAY	**FRIDAY**	**FRIDAY**	**SATURDAY**	**SATURDAY**	**SATURDAY**
8:00 am	Lloyd	Druckenmiller	Habersetzer	Langer	Hawthorn	Gai
8:15 am	Brusatte	Beardmore	Padian	Cutler	Brink	Scott
8:30 am	Benson	Jiang	Manz	Souter	Sigurdsen	Zhu
8:45 am	Benton	Neenan	Yapuncich	Du	Angielczyk	Brazeau
9:00 am	Fröbisch	O'Keefe	Chester	Zelenitsky	Camp	Anderson
9:15 am	Whiteside	Conrad	Secord	Bourke	Smith	Boisvert
9:30 am	Butler	Hipsley	Jones	Lee	Kammerer	Finarelli
9:45 am	Upchurch	Stocker	Maiolino	Zanno	Rubidge	Choo
10:00 am	COFFEE					
10:15 am	Carrano	Jones	Pérez de los Ríos	Miyashita	Jasinoski	Sallan
10:30 am	Vavrek	Curtis	Matson	Carr	Luo	Khalloufi
10:45 am	Campione	Evans	Alba	Goodwin	Rowe	Kriwet
11:00 am	Mannion	Edwards	Cooke	Allain	Martin	Dutel
11:15 am	Chew	Head	Kay	Choiniere	Rougier	Criswell
11:30 am	Carrasco	Williams	Crowley	Xu	Corfe	Qiao
11:45 am	Stegner	Danilov	Musiba	Lamanna	Evans	Lemberg
12:00 pm	Rook	Ehret	Bates	Müeller	Buchholtz	Liu
12:15 pm	LUNCH					
1:30 pm						
	Tech XI	Tech XII	Tech XIII	Tech XVII	Tech XVIII	Tech XIX
1:45 pm	Falkingham	Dial	Simpler	Ross	Pol	Uhen
2:00 pm	Sereno	Atterholt	Schultz	Bormet	Holliday	Fordyce
2:15 pm	Dumont	Smith	Fraser	Levering	Sertich	Graf
2:30 pm	Waskow	Bourdon	Gailer	Rossner	Hastings	Aguirre-Fernandez
2:45 pm	Sander	Ando	Nieberg	Souron	Brochu	Martin
3:00 pm	Boehmer	Habib	Calandra	Louys	Wilberg	Geisler
3:15 pm	Gee	Ksepka	Mihlbachler	Wood	Montefeltro	Govender
3:30 pm	D'Emic	Meijer	Hoffman	Mkrtchyan	Schachner	Hayashi
3:45 pm	Sues	Prassack	Boardman	Kapner	Owerkowicz	Clementz
4:00 pm	Wilson	Hargrave	Beatty	Matzke	Tsai	Motani
4:15 pm	*Poster Session III/Reception RIVOLI B*			*Poster Session IV/Reception RIVOLI B*		
6:00 pm						

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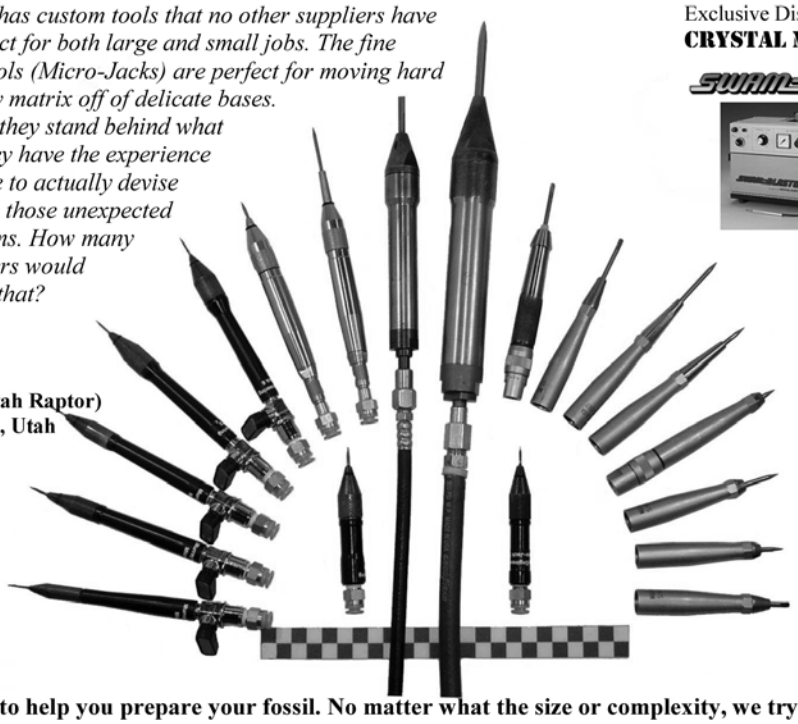

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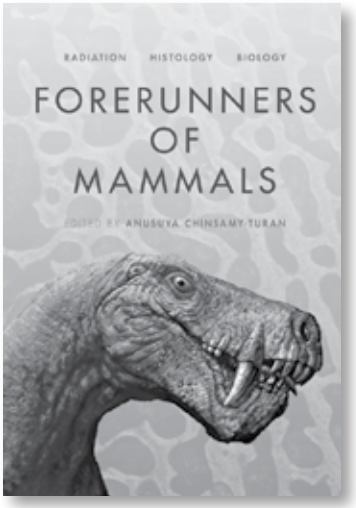

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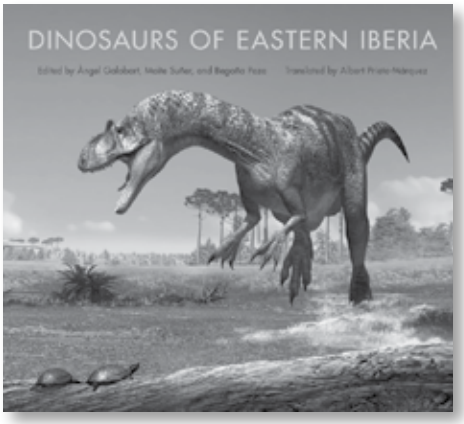

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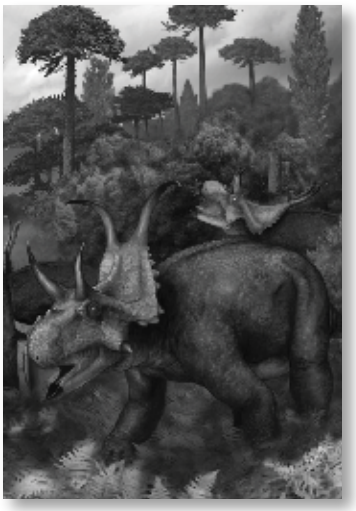

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SVP 2011 EDUCATION AND OUTREACH POSTER SESSION: TITLES AND AUTHORS
Novel Approaches to Informal Educational Outreach
Location: Paris Las Vegas/Registration Area Rivoli A
Dates: Wednesday, November 2 through Saturday, November 5

AUTHORS WILL BE PRESENT AT THEIR POSTERS: Wednesday, November 2, 4:15-5:15 p.m.

1 **MacFadden, B., Pimiento, C.** INNOVATION IN GRADUATE EDUCATION: THE NON-TRADITIONAL MASTERS AND E-PH.D. DEGREES IN STEM DISCIPLINES SUCH AS VERTEBRATE PALEONTOLOGY

2 **Oviedo, L., Seymour, G., McFadden, B.** FOSSIL HORSES, ORTHOGENESIS, AND PUBLIC UNDERSTANDING OF EVOLUTION

3 **Smith, K., Weil, A., Czaplewski, N., Whitten, R., Hargrave, J.** NATIVE EXPLORERS: INCREASING MINORITY PARTICIPATION AND OPPORTUNITES IN MEDICINE AND THE NATURAL SCIENCES

4 **Drewniak, P., Semprebon, G.** A LIVING LABORATORY APPROACH TO TEACHING STUDENTS ABOUT THE SCIENTIFIC METHOD AND EVOLUTION: CRAFTING A CURRICULUM THAT ALLOWS STUDENTS TO GENERATE THEIR OWN EVIDENCE AND FORMULATE THEIR OWN CONCLUSIONS ABOUT EVOLUTIONARY PROCESSES

5 **ElShafie, S., Thompson, K.** A PARADIGM SHIFT IN SCIENCE OUTREACH: NEW STUDENT-DEVELOPED PROGRAM FACILITATES AND REINFORCES ACTIVE LEARNING IN PALEONTOLOGY THROUGH PERSONALIZED MENTORING AND DEVELOPMENT OF LEARNING TOOLS

6 **Dewar, E., Maceli, A., Pietrantonio, H.** VERTEBRATE PALEONTOLOGY AS THE CORNERSTONE OF A FIRST-YEAR COLLEGE SEMINAR

7 **Gant, C., Skiljan, R., Tsai, H., Folk, W., Holliday, C.** ALLIGATORS NEAR AND FAR: USING THE MAPS IN MEDICINE: INSIDE ALLIGATORS HIGH SCHOOL WORKSHOP AND 3D ALLIGATOR WEBSITE AS EDUCATIONAL TOOLS IN ANATOMY AND EVOLUTION

8 **Moots, H., Bucklin, S., Caughron, S.** DEVELOPING ADULT EDUCATIONAL PROGRAMS: BEER & BONES, A COCKTAIL PARTY APPROACH TO PUBLIC OUTREACH

9 **Weiler, M., Schumaker, K.** DEVELOPMENT AND BENEFITS OF STUDENT ORGANIZATION LED OUTREACH PROGRAMS: TWO CASE STUDIES FROM THE UNIVERSITY OF NORTH DAKOTA AND SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

10 **Schenck, R.** QUALITATIVE CLASSROOM DATA ON THE DEVELOPMENT OF STUDENTS' UNDERSTANDING OF COMPLEX SYSTEMS IN VERTEBRATE PALEONTOLOGY AT A 2-YEAR COMMUNITY COLLEGE

11 **Tembe, G., Siddiqui, S.** APPLICATIONS OF COMPUTED TOMOGRAPHY TO MUSEUM CONSERVATION AND EXHIBITS

WEDNESDAY MORNING, NOVEMBER 2, 2011
SYMPOSIUM 1: TO FINS, LIMBS, WINGS AND BACK AGAIN
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: Nadia Fröbisch, Hans C. E. Larsson

8:00 **Wilson, M.** COMPARATIVE MORPHOLOGY AND SUGGESTED HOMOLOGIES OF PAIRED FINS IN JAWLESS AND EARLY JAWED VERTEBRATES

8:15 **Shubin, N., Schneider, I.** FOSSILS, GENES AND THE SEARCH FOR ANTECEDENTS OF THE TETRAPOD LIMB

8:30 **Schneider, I., Aneas, I., Nobrega, M., Shubin, N.** AUTOPODIAL EXPRESSION IN MOUSE LIMBS DRIVEN BY A HOXD ENHANCER OF FINNED VERTEBRATES

8:45 **Johanson, Z.** EVOLUTION OF PAIRED FINS AND THE LATERAL SOMITIC FRONTIER

9:00 **Pierce, S., Clack, J., Hutchinson, J.** COMPARATIVE LIMB RANGE OF MOVEMENT IN THE DEVONIAN TETRAPOD *ICHTHYOSTEGA* AND THE EVOLUTION OF TERRESTRIAL LOCOMOTION

9:15 **Gatesy, S., Pollard, N.** LIMB DISPARITY, COORDINATION, AND THE EVOLUTION OF TERRESTRIAL LOCOMOTION

9:30 **Fröbisch, N., Shubin, N., Schneider, I.** DEVELOPMENT AND EVOLUTION OF THE URODELE LIMB — INTEGRATING MORPHOLOGY, GENES, AND THE FOSSIL RECORD

9:45 **Caldwell, M.** 380 MILLION YEARS OF TETRAPOD EVOLUTIONARY TRANSFORMATIONS: CONVERGENT EVOLUTION AND THE COUPLING OF AXIAL ELONGATION WITH LIMB AND GIRDLE REDUCTION AND LOSS

10:15 **Fowler, D., de Bakker, M., Richardson, M.** HOX GENE EXPRESSION AND ANATOMICAL DIFFERENCES IN ARCHOSAURIA

10:30 **Maxwell, E.** INTRASPECIFIC VARIATION IN THE LIMB STRUCTURE OF THE LOWER JURASSIC ICHTHYOSAUR *STENOPTERYGIUS*

10:45 **Larsson, H., Dececchi, T., Harrison, L.** INTEGRATING THE GENOTYPE—PHENOTYPE MAP ACROSS THE ORIGIN OF BIRD WINGS

11:00 **Dececchi, A., Larsson, H.** THE ORIGIN OF WINGS

11:15 **Sánchez, M., Mitgutsch, C., Jiménez, R., Richardson, M.** CIRCUMVENTING CONSTRAINTS IN LIMB EVOLUTION: THE MOLE'S "THUMB" AND LATE GROWTH IN LIVING AND FOSSIL FORMS

11:30 **Cooper, L., Jast, J., Cretekos, C., Rasweiler IV, J., Sears, K.** CELLULAR PATTERNS OF BAT (*CAROLLIA*) FORELIMB SKELETOGENESIS AND THEIR BIOMECHANICAL CONSEQUENCES

11:45 **Sears, K., Hübler, M., Ross, D., Beck, A.** EVOLUTION OF THE “OTHER” PART OF THE LIMB: FOSSIL AND DEVELOPMENTAL PERSPECTIVES ON MAMMALIAN SHOULDER GIRDLE EVOLUTION

12:00 **Weisbecker, V.** UNDERSTANDING THE IMPLICATIONS OF LATE-STAGE LIMB AND GIRDLE DEVELOPMENT ON MAMMALIAN LIMB/GIRDLE EVOLUTION—ADDING A FEW MONOTREMES REALLY HELPS

WEDNESDAY MORNING, NOVEMBER 2, 2011
TECHNICAL SESSION I
PARIS LAS VEGAS, VENDOME A
MODERATORS: Sarah Werning, David Varricchio

8:00 **Wings, O.** BEYOND *EUROPASAURUS*: THE LATE JURASSIC VERTEBRATE ASSEMBLAGE OF THE LANGENBERG QUARRY IN OKER/GERMANY

8:15 **Porter, W., Witmer, L.** VASCULAR ANATOMY AND ITS PHYSIOLOGICAL IMPLICATIONS IN EXTANT AND EXTINCT DINOSAURS AND OTHER DIAPSIDS

WEDNESDAY MORNING, NOVEMBER 2, 2011
TECHNICAL SESSION I (continued)

8:30 **Werning, S., Irmis, R., Smith, N., Turner, A., Padian, K.** ARCHOSAUROMORPH BONE HISTOLOGY REVEALS EARLY EVOLUTION OF ELEVATED GROWTH AND METABOLIC RATES

8:45 **Barrett, P., Butler, R., Gower, D., Abel, R.** POSTCRANIAL SKELETAL PNEUMATICITY AND THE EVOLUTION OF ARCHOSAUR RESPIRATORY SYSTEMS

9:00 **Mounce, R., Wills, M.** PHYLOGENETIC CONGRUENCE BETWEEN CRANIAL AND POSTCRANIAL CHARACTERS IN ARCHOSAUR SYSTEMATICS

9:15 **Salzberg, S., Novak, B., Poinar, H., Kaye, T., MacCoss, M.** DNA, DINOSAURS, AND METAGENOMICS: A NEW TOOL FOR MASS IDENTIFICATION OF DNA FROM FOSSIL BONE

9:30 **Varricchio, D., Simon, D., Oser, S., Lawver, D., Jackson, F.** DINOSAUR EGGS IN SPACE AND TIME

9:45 **Venditti, C., Benton, M., Organ, C., Meade, A., Pagel, M.** THE EVOLUTIONARY SOURCES OF MORPHOLOGICAL DIVERSITY IN DINOSAURS

10:15 **Mallison, H.** FAST MOVING DINOSAURS: WHY OUR BASIC TENET IS WRONG

10:30 **VanBuren, C., Bonnan, M.** QUANTIFYING THE POSTURE OF QUADRUPEDAL DINOSAURS: A MORPHOMETRIC APPROACH

10:45 **Maidment, S., Bates, K., Allen, V., Barrett, P.** 3D COMPUTATIONAL MODELLING OF LOCOMOTOR MUSCLE MOMENT ARMS IN *LESOTHOSAURUS DIAGNOSTICUS*: IMPLICATIONS FOR BASAL DINOSAUR LOCOMOTION

11:00 **Ridgwell, N.** A BASAL THYREOPHORAN (DINOSAURIA, ORNITHISCHIA) FROM AFRICA CLARIFIES THE EARLY EVOLUTION OF ARMORED DINOSAURS

11:15 **Nabavizadeh, A.** THYREOPHORAN JAW MECHANICS AND THE FUNCTIONAL SIGNIFICANCE OF THE PREDENTARY BONE

11:30 **Morhardt, A., Ridgely, R., Witmer, L.** NEW STUDIES OF BRAIN AND INNER EAR STRUCTURE IN *STEGOSAURUS* (DINOSAURIA: ORNITHISCHIA) BASED ON CT SCANNING AND 3D VISUALIZATION

11:45 **Han, F., Xu, X., Paul, B.** ANATOMY OF *JEHOLOSAURUS SHANGYUANENSIS* AND A PHYLOGENETIC ANALYSIS OF BASAL ORNITHISCHIANS

12:00 **Zhao, Q., Benton, M., Hayashi, S., Sander, M., Xu, X.** LONG BONE HISTOLOGY AND GROWTH PATTERNS OF *PSITTACOSAURUS LUJIATUNENSIS* (CERATOPSIA: PSITTACOSAURIDAE)

WEDNESDAY MORNING, NOVEMBER 2, 2011
SYMPOSIUM 2: CLIMATE CHANGE AND VERTEBRATE RESPONSE IN THE EVOLVING ARID WEST OF PLIO-PLEISTOCENE NORTH AMERICA
PARIS LAS VEGAS, VENDOME B
MODERATORS: Eric D. Scott, Kathleen Springer, Jim I. Mead

8:00 **Bell, C.** TAXON-BASED PALEOECOLOGICAL RECONSTRUCTIONS: CAUTIONARY NOTES ON THE PULL OF THE RECENT

8:15 **McCord, R.** TORTOISES AS TEMPERATURE PROXIES: A PHYLOGENETIC REAPPRAISAL

8:30 **Steadman, D.** CHANGING LATE NEOGENE BIRD COMMUNITIES IN NORTHWESTERN MEXICO AND THE SOUTHWESTERN UNITED STATES

8:45 **Mead, J., Shaw, C.** THE ENVIRONMENTAL RECONSTRUCTION OF EL GOLFO, SONORA, AND THE USE OF *HELODERMA*

9:00 **McDonald, H.** *NOTHROTHERIOPS SHASTENSIS*: THE DESERT-ADAPTED GROUND SLOTH

9:15 **McGuire, J.** HOW QUATERNARY CLIMATE CHANGE PATTERNED MORPHOLOGICAL VARIATION IN *MICROTUS CALIFORNICUS*

WEDNESDAY MORNING, NOVEMBER 2, 2011
SYMPOSIUM 2: CLIMATE CHANGE AND VERTEBRATE RESPONSE IN THE EVOLVING ARID WEST OF PLIO-PLEISTOCENE NORTH AMERICA (continued)

9:30 **Meyers, V., Rowland, S.** PALEOECOLOGY OF TWO PLIOCENE VERTEBRATE FOSSIL ASSEMBLAGES IN WESTERN NORTH AMERICA: THE PANACA FAUNA OF LINCOLN COUNTY, NEVADA AND THE HAGERMAN FAUNA OF TWIN FALLS COUNTY, IDAHO

9:45 **Jass, C.** INSIGHT INTO THE "BIG BLACK HOLE": VERTEBRATE REMAINS FROM ROOM 2, CATHEDRAL CAVE, NEVADA

10:15 **Springer, K., Manker, C., Scott, E., Pigati, J., Mahan, S.** GEOCHRONOLOGIC AND PALEOENVIRONMENTAL FRAMEWORK OF THE LATE PLEISTOCENE TULE SPRINGS LOCAL FAUNA

10:30 **Sagebiel, J., Springer, K., Manker, C., Scott, E.** MICROVERTEBRATE FAUNA AND PALEOECOLOGY OF THE TULE SPRINGS LOCAL FAUNA, CLARK COUNTY, NEVADA

10:45 **Harris, J., Farrell, A., Howard, C., Scott, K., Shaw, C.** CONTRIBUTIONS FROM PROJECT 23 TO OUR UNDERSTANDING OF THE RANCHO LA BREA BIOTA

11:00 **Arroyo-Cabrales, J., Lopez-Jimenez, A., Sanchez-Miranda, G., Gaines, E., Holliday, V.** FAUNAL REMAINS FROM *EL FIN DEL MUNDO* ARCHAEOLOGICAL SITE, SONORA, MEXICO

11:15 **Blois, J., Graham, R., Badgley, C., Williams, J.** BIOME SHIFTS WITH PALEOCLIMATE CHANGE: RECONSTRUCTING PAST BIOMES USING MAMMALS

11:30 **Polly, P., Dundas, R., Lawing, A.** STANDING UP TO CLIMATE CHANGE: COMMUNITY LOCOMOTOR ECOMORPHOLOGY AND PALEOENVIRONMENT IN THE PLIO-PLEISTOCENE

11:45 **Atwater, A., Davis, E.** TOPOGRAPHIC AND CLIMATE CHANGE DIFFERENTIALLY DRIVE PLIOCENE AND PLEISTOCENE MAMMALIAN BETA DIVERSITY OF THE GREAT BASIN AND GREAT PLAINS PROVINCES OF NORTH AMERICA

12:00 **Scott, E.** PLIO-PLEISTOCENE *EQUUS* IN WESTERN NORTH AMERICA: MORPHOLOGY, MOLECULES, AND CHANGES IN DIVERSITY THROUGH TIME AND SPACE

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
TECHNICAL SESSION II
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: Nicholas Gardner, Sterling Nesbitt

1:45 **Tsuji, L., Smith, R., Sidor, C.** WHAT, IF ANYTHING, IS A 'DWARF' PAREIASAUR? NEW INFORMATION ON *PUMILIOPAREIA PRICEI*

2:00 **Cisneros, J., Hamley, T., Damiani, R.** A PROCOLOPHONID PARAREPTILE FROM THE TRIASSIC OF AUSTRALIA

2:15 **Modesto, S., Reisz, R., Scott, D.** A NEODIAPSID REPTILE FROM THE LOWER PERMIAN OF OKLAHOMA

2:30 **Gardner, N., Bhullar, B., Holliday, C., O'Keefe, R.** CRANIAL ANATOMY IN THE BASAL DIAPSID *YOUNGINA CAPENSIS* AND ITS RELEVANCE TO HIGHER RADIATIONS OF PERMO-TRIASSIC NEODIAPSIDA

2:45 **Yi, H.** FUNCTIONAL MORPHOLOGY OF THE LOWER JAW IN THE CHORISTODERA (REPTILIA: DIAPSIDA) INDICATES DIET DIVERGENCE BETWEEN ECOMORPHS

3:00 **Wu, X., Li, C., Zhao, L., Sato, T., Wang, L.** A NEW ARCHOSAUR (DIAPSIDA: ARCHOSAURIFORMES) FROM THE MARINE TRIASSIC OF CHINA

3:15 **Botha-Brink, J., Smith, R.** OSTEOHISTOLOGY OF TRIASSIC ARCHOSAUROMORPHS FROM THE KAROO BASIN OF SOUTH AFRICA

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
TECHNICAL SESSION II (continued)

3:30 **Sidor, C., Smith, R., Huttenlocker, A., Peecook, B., Hammer, W.** NEW INFORMATION ON THE TRIASSIC VERTEBRATE FAUNAS OF ANTARCTICA

3:45 **Nesbitt, S., Sidor, C., Angielczyk, K., Smith, R., Tsuji, L.** AN ENIGMATIC ARCHOSAURIFORM FROM THE MANDA BEDS (MIDDLE TRIASSIC) OF SOUTHWESTERN TANZANIA: CHARACTER CONFLICT AT THE BASE OF PSEUDOSUCHIA

4:00 **Bhullar, B., Bever, G., Merck, J., Lyson, T., Gauthier, J.** UNITING MICROEVOLUTION AND MACROEVOLUTION IN DEEP TIME: THE ZONE OF VARIABILITY IN ARCHOSAUROMORPHA

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
TECHNICAL SESSION III
PARIS LAS VEGAS, VENDOME A
MODERATORS: Julia Meachen-Samuels, Joshua Samuels

1:45 **Samuels, J., Van Valkenburgh, B.** CARNIVORE DIVERSITY THROUGH THE CENOZOIC OF OREGON

2:00 **Bjornsson, C., Feranec, R., Tseng, Z.** DETERMINING THE ERUPTION RATE AND DEVELOPMENTAL TIME FOR ADULT CANINES IN THE SABER-TOOTH CAT, *SMILODON FATALIS*, USING MICROCT AND STABLE ISOTOPES

2:15 **Meachen-Samuels, J., Werdelin, L.** CARNIVORE POSTCRANIAL DISPARITY: ADAPTATION TO CLIMATE AND HABITAT

2:30 **Sakamoto, M., Ruta, M.** MORPHOLOGICAL DISPARITY, ALLOMETRY AND PHYLOGENETIC SIGNALS IN THE SKULLS OF EXTANT AND FOSSIL CATS (FELIDAE, CARNIVORA)

2:45 **Goswami, A., Martin, J., Foley, L.** THE RATE AND CESSATION OF FACIAL GROWTH IN CARNIVORANS

3:00 **Borths, M., Goswami, A., Milne, N., Wroe, S.** CRANIAL VARIATION IN "CREODONTA" AND IMPLICATIONS FOR CONVERGENCE IN PLACENTAL AND MARSUPIAL CARNIVORES

3:15 **Smits, P., Evans, A.** CONSTRAINTS ON TOOTH SHAPE AND JAW MOTION IN CARNIVOROUS MAMMALS

3:30 **Shabel, A.** THE CLAWLESS OTTERS OF AFRICA (*AONYX*): MORPHOLOGY, ECOLOGY, AND FOSSIL RECORD

3:45 **Churchill, M., Boessenecker, R., Clementz, M.** BIOGEOGRAPHIC IMPLICATIONS OF OTARIIDAE (MAMMALIA: CARNIVORA) SYSTEMATICS

4:00 **Bloch, J., Hunt, R., Rincon, A., MacFadden, B.** FIRST RECORD OF A LARGE IMMIGRANT BEARDOG (MAMMALIA, AMPHICYONIDAE) FROM THE EARLY MIOCENE OF PANAMA

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
TECHNICAL SESSION IV
PARIS LAS VEGAS, VENDOME B
MODERATORS: Samantha Hopkins, Pennilyn Higgins

1:45 **Anderson, D., Casey, K., Erdman, A.** DIVERSITY OF SCIURAVIDAE (MAMMALIA: RODENTIA) INCLUDING A NEW SPECIES FROM THE MIDDLE EOCENE OF WYOMING

2:00 **Sallam, H., Seiffert, E., Simons, E.** NEW GENERA OF HYSTRICOGNATHI (RODENTIA, MAMMALIA) FROM THE LATE EOCENE OF THE FAYUM DEPRESSION, NORTHERN EGYPT

2:15 **Schwarz, C., Ruf, I., Martin, T.** SHOW ME YOUR EAR: LOCOMOTORY ADAPTATIONS IN THE INNER EAR OF SCIUROMORPHA (RODENTIA, MAMMALIA)

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
TECHNICAL SESSION IV (continued)

2:30 **Higgins, P., Croft, D., Bostelmann, E., Rinderknecht, A., Ubilla, M.** PALEODIET AND PALEOENVIRONMENT OF FOSSIL GIANT RODENTS FROM URUGUAY

2:45 **Hopkins, S.** ROLE OF VOLCANIC ACTIVITY IN THE EVOLUTION OF HYPSELODONTY IN APLODONTID RODENTS

3:00 **Mōrs, T., Ruf, I., Tomida, Y.** MIOCENE BEAVERS (CASTORIDAE, RODENTIA) FROM JAPAN

3:15 **Rinaldi, C., Martin, L., Timm, R., Cole III, T., Kumar, V.** INTERNAL AIRWAY MORPHOLOGY AND SOUND PRODUCTION IN PLEISTOCENE GIANT BEAVERS

3:30 **Perez, M., Pol, D.** DIVERSIFICATION PATTERNS AND THE ORIGIN OF CAVIOIDEA SENSU STRICTO: FOSSILS, GHOST LINEAGES, AND MOLECULAR CLOCK ESTIMATES

3:45 **Bertrand, O., Flynn, J., Croft, D., Wyss, A.** HIGHER-LEVEL OF EARLY CAVIOMORPHA (RODENTIA: HYSTRICOGNATHI), PALEOGEOGRAPHY, AND EVOLUTION OF HYPSONDONTY

4:00 **Gaudin, T., McDonald, H., Rincó A.** PHYLOGENETIC ANALYSIS OF THE SLOTH FAMILY MEGALONYCHIDAE (MAMMALIA, XENARTHRA, FOLIVORA) BASED ON CRANIAL DATA

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
POSTER SESSION I
PARIS LAS VEGAS, RIVOLI B
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Berg, L.** MAMMALIAN FEMORA FROM THE CRETACEOUS-PALEOGENE BOUNDARY OF NORTHEASTERN MONTANA

2 **Bykowski, R.** BITING OFF MORE THAN THEY COULD CHEW: A GEOMETRIC MORPHOMETRIC APPROACH TO THEROPOD FEEDING ECOLOGY

3 **Campbell, T.** PLIO-PLEISTOCENE PALEOENVIRONMENTAL CHANGE IN THE CRADLE OF HUMANKIND, SOUTH AFRICA: AN APPLICATION OF MODERN RODENT NICHE MODELS TO FOSSIL BEARING LOCALITIES

4 **Cleland, T.** CHEMICAL AND MORPHOLOGICAL REINVESTIGATION OF THE DINOSAUR HEART

5 **Garcia, B.** SKELETOCHRONOLOGY OF THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*): THE UTILITY OF VARIOUS ELEMENTS FOR DETERMINING GROWTH PATTERNS AND LONGEVITY

6 **Harper, T.** THREE DIMENSIONAL DENTAL WEAR ANALYSIS OF THE BISSETKY FAUNA EUTHERIANS, DZARAKUDUK REGION, UZBEKISTAN

7 **Kemp, M.** HOLOCENE LOSS OF LAGOMORPH SPECIES RICHNESS IN THE GREAT BASIN OF NORTH AMERICA

8 **Kim, S.** ECOLOGY AND EVOLUTION OF COSMOPOLITODUS HASTALIS AND CARCHARODON CARCHARIAS

9 **Liu, J.** BIODIVERSITY OF MARINE REPTILES FROM THE MIDDLE TRIASSIC LUOPING BIOTA, YUNNAN, CHINA

10 **Mallon, J., Anderson, J.** BIOSTRATIGRAPHY OF THE MEGAHERBIVOROUS DINOSAURS FROM THE DINOSAUR PARK FORMATION (UPPER CAMPANIAN) OF ALBERTA

11 **Matsumoto, R.** FRESHWATER NICHE COMPETITION BETWEEN CHORISTODERES AND CROCODILES IN THE MESOZOIC AND PALEOGENE

12 **McGarrity, C.** CRANIAL MORPHOLOGY AND VARIATION IN *PROSAUROLOPHUS MAXIMUS* WITH IMPLICATIONS FOR HADROSAURID DIVERSITY AND EVOLUTION

13 **Nakajima, Y.** OSTEOSCLEROSIS IN THE LIMB BONES OF TERRESTRIAL AND AQUATIC TURTLES

14 **Norton, L.** MORPHOLOGICAL VARIATION IN THE SKULL OF *AELUROGNATHUS* (THERAPSIDA, GORGONOPSIA) AND ITS REPERCUSSION ON THE TAXONOMY OF THE GENUS

15 **Pilbro, C.** ECOLOGY OF EARLY EOCENE SAN JUAN BASIN, NM *PHENACOLEMUR JEPSENI* WITH *PHENACOLEMUR CITATUS* AND *PHENACOLEMUR PRAECOX* FROM BIGHORN BASIN, WY - A STUDY OF MICROWEAR AND DENTAL VARIATION

16 **Pineda Muñoz, S., Casanovas Vilar, I., De Miguel, D., Karme, A., Fortelius, M.** EVOLUTION OF HYPSODONTY IN A CRICETID (RODENTIA) LINEAGE: PRELIMINARY RESULTS USING PATCH ANALYSIS

17 **Sarringhaus, L.** CHANGES IN METACARPAL CURVATURE DURING WILD CHIMPANZEE DEVELOPMENT

18 **Scott, J.** DENTAL MICROWEAR TEXTURE ANALYSIS OF EXTANT AFRICAN BOVIDAE

19 **Shi, Q.** A NEW SPECIES OF *TSAIDAMOTHERIUM* (BOVIDAE, MAMMALIAN): SECOND DISCOVERY OF THE UNICORNOUS ANTELOPE RESTRICTED TO CHINA IN THE LATE MIOCENE

20 **Stein, K., Sander, M.** OSTEOCYTE LACUNA DENSITY IN SAURISCHIAN DINOSAURS AND THE CONVERGENCE OF FIBROLAMELLAR BONE IN MAMMALS AND DINOSAURS: DIFFERENT STRATEGIES TO GROW FAST

21 **Thomson, T.** AQUATIC BEHAVIOR AND LOCOMOTION OF ARCHOSAURIFORM REPTILES INTERPRETED FROM EARLY-MIDDLE TRIASSIC SWIM TRACKS OF THE WESTERN UNITED STATES

22 **Watanabe, A.** BONE HISTOLOGY OF AN ALASKAN ORNITHOMIMOSAUR: IMPLICATIONS FOR POLAR DINOSAURIAN PHYSIOLOGY

23 **Wilson, L.** THE FEEDING ECOLOGY OF CRETACEOUS AND MODERN PURSUIT DIVING BIRDS

24 **Yamada, E., Nakaya, H.** MESOWEAR ANALYSIS OF EXTANT JAPANESE SIKA DEER (*CERVUS NIPPON*) IN DIFFERENT HABITATS AND SEXES

25 **Zhang, Y.** MASTICATORY PATTERN RECONSTRUCTION OF *MESODMA* (NEOPLAGIAULACIDAE, MULTITUBERCULATA, MAMMALIA) BASED ON TOOTH WEAR STUDY

26 **Anné J.** CHANGING OLD VIEWS WITH NEW TECHNOLOGY: USING XRF TO COMPARE BONE CHEMISTRY OF BIRDS WITH OTHER VERTEBRATES

27 **Balanoff, A., Ksepka, D.** ENDOCRANIAL MORPHOLOGY OF LIVING AND EXTINCT PENGUINS: TRANSITIONS ASSOCIATED WITH THE EVOLUTION OF UNDERWATER "FLIGHT"

28 **Bradford, K., Clarke, J., Middleton, K.** ESTIMATING BENDING MECHANICS OF EXTANT AND FOSSIL PENGUIN? CONTOUR FEATHERS

29 **Stidham, T.** PHYLOGENETIC INFORMATION FROM THE QUADRATE OF *DIATRYMA* (NEORNITHES)

30 **Wang, M., Mayr, G., Zhang, J., Zhou, Z.** A NEW WATER BIRD FROM THE EOCENE OF GUANGDONG, CHINA

31 **Torres, C., Clarke, J.** FEATHERING AND ESTIMATING WING LOADING FOR LITHORNITHID BIRDS FROM THE EARLY EOCENE GREEN RIVER FORMATION

32 **Rubilar-Rogers, D., Yury-Yáñez, R., Mayr, G., Gutstein, C., Otero, R.** A HUMERUS OF A GIANT LATE EOCENE PSEUDO-TOOTHED BIRD FROM ANTARCTICA

33 **Ohashi, T., Hasegawa, Y., Kawabe, S., Okazaki, Y.** NEW INFORMATION ON THE PLOTOPTERIDAE SKULLS FROM THE OLIGOCENE KISHIMA GROUP AND ASHIYA GROUP OF NORTHERN KYUSHU, JAPAN

34 **Ngo, M., Canchola, J., Dundas, R.** AVIFAUNAS OF THE MIDDLE PLEISTOCENE IRVINGTON AND FAIRMEAD LANDFILL LOCALITIES IN CALIFORNIA

35 **Fragomeni, A., Prothero, D.** STASIS IN LATE QUATERNARY BIRDS FROM THE LA BREA TAR PITS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

36 **Watanabe, J.** ONTOGENETIC CHANGES OF MORPHOLOGY AND SURFACE TEXTURE OF LONG BONES IN THE EXTANT GRAY HERON, *ARDEA CINEREA* (AVES, ARDEIDAE)—A FUNDAMENTAL STUDY FOR ONTOGENETIC AGEING

37 **Hanson, B., Bell, A., Cipriani, M., Schachner, E., Farmer, C.** ENVIRONMENTALLY INDUCED PHENOTYPIC PLASTICITY IN THE JAPANESE QUAIL (*COTURNIX CORTURNIX JAPONICA*) AND ITS IMPACT ON AVIAN EVOLUTION

38 **Botelho, J., Palma, V., Soto, S., Vargas, A.** DISTAL FIBULAR REDUCTION AND ITS REVERSION IN EVOLUTION AND DEVELOPMENT

39 **Salinas-Saavedra, M., Soto-Acuña, S., Nuñez-Leon, D., Ossa-Fuentes, L., Vargas, A.** THE DEVELOPMENT OF CARPAL ELEMENTS IN CHILEAN TINAMOU AND CHICKEN CLARIFIES CONTROVERSIES ABOUT THE PRESENCE OF THE ULNARE IN THE WRIST OF MODERN BIRDS

40 **Cuff, A., Rayfield, E.** VALIDATION OF THE FINITE ELEMENT METHOD ON AN AVIAN SKULL AND IMPLICATIONS FOR DINOSAURIAN MODELING

41 **Kambic, R., Gatesy, S.** MODELING THEROPOD JOINT STABILITY

42 **Dalman, S., Gishlick, A.** THEROPOD MATERIAL FROM LAMETA, INDIA, IN THE COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY AND ITS BEARING ON THE DIAGNOSIS AND PHYLOGENETIC AND TAXONOMIC STATUS OF *INDOSUCHUS RAPTORIUS*

43 **Main, D., Noto, C., Scotese, C.** NEW THEROPOD MATERIAL FROM THE CRETACEOUS (CENOMANIAN) WOODBINE FORMATION OF NORTH CENTRAL TEXAS: PALEOBIOGEOGRAPHIC AND PALEOECOLOGICAL IMPLICATIONS

44 **Sayão, J., Saraiva, A., Silva, H., Kellner, A.** A NEW THEROPOD DINOSAUR FROM THE ROMUALDO *LAGERSTÄTTE* (APTIAN-ALBIAN), ARARIPE BASIN, BRAZIL

45 **Kirkland, J., Loewen, M., DeBlieux, D., Madsen, S., Choiniere, J.** NEW THEROPOD CRANIAL MATERIAL FROM THE YELLOW CAT MEMBER, CEDAR MOUNTAIN FORMATION (BARREMIAN-BASAL APTIAN, CRETACEOUS), STIKES QUARRY, NORTH OF ARCHES NATIONAL PARK, EAST-CENTRAL UTAH

46 **Selles, A., Santos-Cubedo, A., Poza, B.** INJURY IN A THEROPOD DINOSAUR FROM THE EARLY CRETACEOUS OF SPAIN

47 **Fanti, F., Contessi, M., Nigarov, A.** NEW DATA ON TWO LARGE DINOSAUR TRACKSITES FROM THE MIDDLE JURASSIC OF EASTERN TURKMENISTAN, CENTRAL ASIA

48 **Claessens, L., Loewen, M., Lavender, Z.** A REEVALUATION OF THE GENUS *ORNITHOMIMUS* BASED ON NEW PREPARATION OF THE HOLOTYPE OF *O. VELOX* AND NEW FOSSIL DISCOVERIES

49 **Lee, H., Lee, Y., Adams, T., Kobayashi, Y., Jacobs, L.** THEROPOD TRACKWAYS ASSOCIATED WITH ORNITHOMIMID SKELETONS FROM THE NEMEGT FORMATION (MAASTRICHIAN) AT BUGIN TSAV, MONGOLIA

50 **Persons, W., Currie, P., Norell, M.** SHAKE YOUR TAIL FEATHERS: THE FLAMBOYANT, ATHLETIC, AND POSSIBLY FLIRTATIOUS CAUDAL MORPHOLOGY OF OVIRAPTOROSAURS

51 **Lautenschlager, S., Rayfield, E., Witmer, L., Altangerel, P.** THE ENDOCRANIAL ANATOMY OF THE MONGOLIAN THERIZINOSAUROID DINOSAUR *ERLIKOSAURUS ANDREWSI* AS REVEALED BY 3D VISUALIZATION

52 **Pei, R., Norell, M.** A NEW TROODONTID (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS DJADOKHTA FORMATION OF MONGOLIA

53 **O'Connor, J., Zhou, Z., Xu, X.** SMALL THEROPOD WITH BIRD IN STOMACH INDICATES BOTH LIVED IN TREES

54 **Chapman, R., Andersen, A., Makovicky, P., Deck, L., Simpson, W.** THE VIRTUALIZATION OF A LARGE *TYRANNOSAURUS REX* SPECIMEN (SUE) FROM SOUTH DAKOTA

55 **Melstrom, K., D'Emic, M.** *ACROCANTHOSAURUS ATOKENSIS* (DINOSAURIA: THEROPODA) FROM THE CLOVERLY FORMATION OF WYOMING: IMPLICATIONS FOR EARLY CRETACEOUS NORTH AMERICAN ECOSYSTEMS

56 **Testin, J., Tucker, R., Miyashita, T., Holtz, Jr., T.** DENTAL MORPHOLOGY OF *ALLOSAURUS FRAGILIS* (DINOSAURIA: THEROPODA) FROM THE UPPER JURASSIC MORRISON FORMATION OF WESTERN NORTH AMERICA: IS DENTITION MORE INDICATIVE OF TAXONOMY OR FEEDING NICHE?

57 **Birkemeier, T.** NEUROCENTRAL SUTURE CLOSURE IN *ALLOSAURUS* (SAURISCHIA : THEROPODA): SEQUENCE AND TIMING

58 **Ibrahim, N., Sereno, P.** NEW DATA ON SPINOSAURIDS (DINOSAURIA: THEROPODA) FROM AFRICA

59 **McFeeters, B., Ryan, M., Schroder-Adams, C., Hinic-Frlog, S.** REDIAGNOSIS AND PHYLOGENETIC RELATIONSHIPS OF *SIGILMASSASAURUS*, A PROBLEMATIC THEROPOD FROM THE MID-CRETACEOUS OF MOROCCO

60 **Machado, E., Campos, D., Kellner, A.** A NEW ABELISAURID TIBIA FROM THE LATE CRETACEOUS OF BRAZIL

61 **Thompson, K.** COMPARATIVE ANALYSIS OF ABELISAURID SKULLS INDICATES DIETARY SPECIALIZATION

62 **Britt, B., Chambers, M., Engelmann, G., Chure, D., Scheetz, R.** TAPHONOMY OF COELOPHYSOID THEROPOD BONEBEDS PRESERVED ALONG THE SHORELINE OF AN EARLY JURASSIC LAKE IN THE NUGGET SANDSTONE OF NE UTAH

63 **Ji, C., Jiang, D., Motani, R., Hao, W., Sun, Z.** PRELIMINARY RESULTS OF PHYLOGENETIC ANALYSIS OF TRIASSIC ICHTHYOSAURS

64 **Shang, Q., Li, C., Liu, J.** THE SEXUAL DIMORPHISM OF *SHASTASAURUS TANGAE* (REPTILIA: ICHTHYOSAURIA) FROM GUANLING BIOTA, CHINA

65 **Cuthbertson, R., Russell, A., Anderson, J.** RE-EXAMINATION OF THE CRANIAL MORPHOLOGY OF *UTATSUSAURUS HATAII* FROM THE OSAWA FORMATION (LOWER TRIASSIC) OF MIYAGI, JAPAN

66 **Fischer, V.** NEW OPHTHALMOSAURIDS FROM EUROPE AND RUSSIA BROADEN THE BIODIVERSITY OF EARLY CRETACEOUS ICHTHYOSAURS

67 **Pardo Pérez, J., Frey, P., Stinnesbeck, P., Rivas, L.** EARLY CRETACEOUS ICHTHYOSAURS FROM THE TYNDALL GLACIER IN TORRES DEL PAINE NATIONAL PARK, SOUTHERNMOST CHILE

68 **Wahl, W.** HYOID STRUCTURE AND BREATHING IN ICHTHYOSAURS

69 **Arajo, R., Louis, J., Polcyn, M., Mateus, O., Schulp, A.** PLESIOSAUR STRUCTURAL EXTREME FROM THE MAASTRICHTIAN OF ANGOLA

70 **Richards, C., O'Keefe, F., Henderson, D.** PLESIOSAUR BODY SHAPE AND ITS IMPACT ON STABILITY

71 **Schwermann, L., Sander, P.** A NEW PLESIOSAURIDAE FROM THE PLIENSBACHIAN OF GERMANY AND ITS EVOLUTIONARY IMPLICATIONS

72 **Long, C., Xiaohong, C., Jun, L., Xiongwei, Z.** A NEW SPECIES OF *PARAPLACODUS* (SAUROPTERYGIA: PLACODONTOIDEA) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

73 **Jiang, D., Rieppel, O., Motani, R., Hao, W., Tintori, A.** THE MARINE REPTILE *SAUROSPHARGIS* FROM ANISIAN (MIDDLE TRIASSIC) OF PANXIAN, GUIZHOU, SOUTHWESTERN CHINA

74 **Kuykendall, S., Robbins, J.** DISTINGUISHING FORAGING RANGE AND DIVING HABITS AMONG MARINE VERTEBRATES USING CARBON ISOTOPES AND WT. % CARBONATE

75 **Shelton, C., Sander, M.** VALIDATING *DIMETRODON* SPECIES FROM THE BRIAR CREEK BONE BED (LOWER PERMIAN, ARCHER COUNTY, TEXAS) USING BONE HISTOLOGY AND MORPHOMETRICS OF FEMORA AND HUMERI

76 **Liu, J., Li, J.** OSTEOLOGY AND PHYLOGENETIC POSITION OF *SINOPHEONEUS YUMENENSIS* (THERAPSIDA, DINOCEPHALIA) FROM THE DASHANKOU FAUNA (MIDDLE PERMIAN)

77 **Engelmann, G., Chure, D.** UP, DOWN, AND SIDEWAYS: ABUNDANT THERAPSID TRACKS ON A DUNE SLIPFACE IN THE NUGGET SANDSTONE (EARLY JURASSIC) FROM NEAR HEBER, UTAH

78 **Green, J.** DECIPHERING THE PERIODICITY OF GROWTH INCREMENTS IN THE TUSKS OF LATE TRIASSIC DICYNODONTS (THERAPSIDA: ANOMODONTIA)

79 **Davis, B.** MICRO-COMPUTED TOMOGRAPHY REVEALS A DIVERSITY OF PERAMURAN MAMMALS FROM THE PURBECK GROUP (BERRIASIAN) OF ENGLAND

80 **Cifelli, R., Gordon, C.** NEW INFORMATION ON TRIBOSPHENIC MAMMALS FROM THE CLOVERLY FORMATION, MONTANA AND WYOMING

81 **Fabre, A., Cornette, R., Prasad, G., Boyer, D., Goswami, A.** A 3D MORPHOMETRIC ANALYSIS OF THE LOCOMOTORY ECOLOGY OF *DECCANOLESTES*, A EUTHERIAN MAMMAL FROM THE LATE CRETACEOUS OF INDIA

82 **Martin, A., Noto, C., Chiappe, L.** A BURROW RUNS THROUGH IT: UNUSUAL CO-OCCURRENCE OF A LARGE MAMMAL BURROW SYSTEM AND DINOSAUR SKELETON IN THE MORRISON FORMATION OF UTAH

83 **Bickelmann, C., Müller, J., Du, J., Chang, B.** *IN VITRO* SYNTHESIS OF ANCESTRAL VISUAL PIGMENTS AND ITS IMPLICATION FOR NOCTURNALITY IN EARLY MAMMALS

84 **Muldoon, K., Gerber, B., Karpanty, S.** TAPHONOMIC ANALYSIS OF SMALL MAMMAL PREY ASSEMBLAGES DERIVED FROM THREE RAPTORS (ACCIPITRIDAE) IN SOUTHEASTERN MADAGASCAR

85 **WITHDRAWN**

86 **Bunn, J., Zohdy, S., King, S., Wright, P., Jernvall, J.** TESTING FOR TOOTH WEAR RESISTANT MEASURES OF DIET IN PRIMATES

87 **Allen, K., Gonzales, L., Cooke, S., Kay, R.** EVALUATION OF UPPER MOLAR OCCLUSAL MORPHOLOGY FOR DIETARY INFERENCE IN MID- TO LARGE-BODIED PLATYRRHINI (PRIMATES)

88 **Claxton, A., Langdon, J.** THE RELATIONSHIP BETWEEN MANUAL PHALANGEAL CURVATURE AND LOCOMOTOR BEHAVIOR IN ANTHROPOID PRIMATES

89 **Parks, H., White, J., Bonnan, M.** HOW THE ANATOMY OF THE FIRST CERVICAL VERTEBRA INFORMS US ABOUT THE LOCOMOTION AND POSTURE OF A FOSSIL PRIMATE

90 **Pina, M., Moyà-Solà, S., Fortuny, J.** INFERRING LOCOMOTION IN MIOCENE APES: THE FEMUR OF *HISPANOPITHECUS LAIETANUS*

91 **Almécija, S., Tallman, M., Alba, D., Pina, M., Moyà-Solà, S.** PROXIMAL FEMORAL AFFINITIES OF MIOCENE APES AND EARLY HOMININS ON THE BASIS OF 3D GEOMETRIC MORPHOMETRICS ANALYSES

92 **Susanna, I., Alba, D., Almécija, S., Moyà-Solà, S.** VERTEBRAL REMAINS OF THE LATE MIOCENE APE *HISPANOPITHECUS LAIETANUS* (PRIMATES: HOMINIDAE): FUNCTIONAL MORPHOLOGY AND PALEOBIOLOGICAL INFERENCES

93 **Karme, A., Evans, A., Fortelius, M.** GISWEAR: 3D AND GIS DIET ANALYSIS METHOD FOR BUNODONT OMNIVORE GROUPS SUINA AND HOMINIDAE

94 **DeMiguel, D., Alba, D., Moyà-Solà, S.** DIETARY RECONSTRUCTION OF MIOCENE APES (PRIMATES: HOMINIDAE) FROM CATALONIA (NE SPAIN) BASED ON DENTAL MICROWEAR

95 **Kingston, J., MacLatchy, L., Cote, S., Kityo, R., Sanders, W.** ISOTOPIC EVIDENCE OF PALEOENVIRONMENTS AND NICHE PARTITIONING OF EARLY MIOCENE FOSSIL FAUNA FROM NAPAK AND MOROTO, UGANDA

96 **Thomas, D., Brink, J., Chinsamy, A.** CHEMICAL EVIDENCE DEMONSTRATES A THERMAL SPRING DEPOSITIONAL ENVIRONMENT FOR THE FLORISBAD HOMININE SKULL

97 **Arbor, T.** A MORPHOMETRIC ANALYSIS OF THE MANDIBULAR PREMOLARS AND MOLARS OF SOUTH AFRICAN *AUSTRALOPITHECUS*

98 **Dunsworth, H., Warrener, A., Pontzer, H.** LIFE HISTORY JUST ISN'T HIP: HUMAN EVOLUTION WITHOUT AN 'OBSTETRIC DILEMMA'

99 **Samonds, K., Conway, S.** LARGE SUBFOSSIL FROG FROM NORTHWESTERN MADAGASCAR

100 **Báez A., Gómez, R., Taglioretti, M.** NEW FIND OF ENIGMATIC PIPID FROGS IN THE UPPER PLEISTOCENE OF THE SOUTH AMERICAN PAMPAS

101 **Folie, A., Rana, R., Rose, K., Kumar, K., Smith, T.** A NEW BOMBINATORID FROG FROM THE EARLY EOCENE OF VASTAN, GUJARAT, INDIA

102 **Bonde, J., Shirk, A., Druschke, P., Hilton, R.** FROG TAPHONOMY IN A HIGH ELEVATION LAKE BASIN ON THE NEVADAPLANO, LATE CRETACEOUS TO EOCENE, SHEEP PASS FORMATION, EAST-CENTRAL NEVADA

103 **DeMar, Jr., D.** NEW TAXONOMIC, PALEOBIOGEOGRAPHIC, AND BIOSTRATIGRAPHIC RECORDS OF FOSSIL SALAMANDERS (CAUDATA) FROM THE HELL CREEK AND TULLOCK FORMATIONS OF GARFIELD COUNTY, MONTANA

104 **Grieco, T.** TOOTH INITIATION FOLLOWS AN ALTERNATE ONTOGENETIC CLOCK IN PROMETAMORPHIC PIPID TADPOLES

105 **Dong, L., Huang, D., Wang, Y.** FOOD SELECTION IN JURASSIC SALAMANDERS FROM INNER MONGOLIA, CHINA

106 **Steyer, J., Mateus, O., Butler, R., Brusatte, S., Whiteside, J.** A NEW METOPOSAURID (TEMNOSPONDYL) BONEBED FROM THE LATE TRIASSIC OF PORTUGAL

107 **McHugh, J.** ASSESSING RATE AND SCALE IN TEMNOSPONDYL EVOLUTION

108 **Vargas, A., Soto-Acuña, S., Weiss, C., Ossa, L.** THE STATUS OF MORPHOLOGICAL AND DEVELOPMENTAL EVIDENCE ON DIGIT IDENTITY IN THE HAND OF ANURA

109 **Klembara, J., Clack, J., Milner, A., Ruta, M.** THE LATE CARBONIFEROUS TETRAPOD *GEPHYROSTEGUS BOHEMICUS*: THE ANATOMY OF THE SKULL AND RELATIONSHIPS

110 **Germain, D.** ALONE ON GONDWANA: THE STORY OF THE MOROCCAN DIPLOCAULID

111 **Berman, D., Henrici, A., Martens, T., Sumida, S., Anderson, J.** A SECOND, NEW SPECIES OF TREMATOPID AMPHIBIAN FROM THE LOWER PERMIAN BROMACKER LOCALITY OF CENTRAL GERMANY

112 **Olori, J.** CRANIAL GROWTH AND DEVELOPMENT IN *PANTYLUS CORDATUS* (LEPOSPONDYLI: TETRAPODA)

113 **Zigaite, Z., Karatajute-Talimaa, V.** ASPIDIN OR GALEASPEDIN: NEW EARLY VERTEBRATE HISTOLOGY FROM THE LOWER SILURIAN OF SOUTHERN SIBERIA

WEDNESDAY AFTERNOON, NOVEMBER 2, 2011
POSTER SESSION I (continued)

114 **Blais, S., Hermus, C., Wilson, M.** NEW SPECIES OF EARLY DEVONIAN ISCHNACANTHID ACANTHODIANS FROM THE MOTH LOCALITY OF NORTHERN CANADA

115 **Boyle, J., Ryan, M.** A REVISED DIAGNOSIS OF *TITANICHTHYS* (PLACODERMI: ARTHRODIRA) FROM THE CLEVELAND SHALE (FAMENNIAN) OF OHIO, USA, WITH IMPLICATIONS FOR ASPINOTHORACID PHYLOGENY

116 **Richter, M., Daeschler, T., Samson, I., Shubin, N.** THE DERMAL SCALES OF *TIKTAALIK ROSEAE*

117 **Mellbin, B.** A DIPNOAN PTERYGOID FROM BERGISCH GLADBACH, GERMANY

118 **Cloutier, R., Béchard, I.** DEVELOPMENTAL CONSERVATISM IN THE DENTAL SYSTEM OF THE LATE DEVONIAN DIPNOAN, *SCAUMENACIA CURTA* (SARCOPTERYGII)

119 **Gottfried, M., Suarez, M.** FIRST FOSSIL RECORD OF A SERRASALMINE TELEOST (PACUS AND PIRANHAS) ON THE WESTERN SIDE OF THE ANDES, FROM THE LATE MIOCENE OF CHILE

120 **Claeson, K., Eastman, J., MacPhee, R.** WHAT THE HAKE? NEW SPECIMEN OF AN EXTINCT GADIFORM FROM THE EOCENE OF SEYMOUR ISLAND, ANTARCTICA

121 **ORAL PRESENTATION, November 5, 10:30 a.m.**

122 **Ostrowski, S.** REGIONAL VERSUS TAXONOMIC VARIATION IN VERTEBRAE OF ALBULOID (TELEOSTEI, ELOPOMORPHA) FISHES

123 **Galluzzi, C., Shimada, K.** A NEW SKELETON OF THE LATE CRETACEOUS BONY FISH, *MICROPYCNODON KANSASENSIS*, FROM THE NIOBRARA CHALK OF KANSAS, USA

124 **MartAbad, H., Poyato-Ariza, F.** A NEW HALECOMORPH FISH FROM THE EARLY CRETACEOUS WETLAND OF LAS HOYAS

125 **WITHDRAWN**

THURSDAY MORNING, NOVEMBER 3, 2011
ROMER PRIZE SESSION
PARIS LAS VEGAS, CONCORDE A/B
MODERATOR: David Fox

8:00 **Dutchak, A.** MAMMALIAN FAUNAL CHANGE AT RAVEN RIDGE, NORTHEASTERN UINTA BASIN, COLORADO-UTAH, DURING THE EARLY EOCENE CLIMATIC OPTIMUM

8:15 **Knell, M.** THE BIOSTRATINOMY OF FOSSIL FRESHWATER TURTLE SHELLS IN FLUVIAL DEPOSITS INTEGRATING ACTUALISTIC EXPERIMENTATION

8:30 **Orcutt, J.** THE PRESENT IS NOT ALWAYS THE KEY TO THE PAST: MAMMAL BODY SIZE AND CLIMATE IN NEOGENE NORTH AMERICA

8:45 **van Heteren, A.** THREE-DIMENSIONAL GEOMETRIC MORPHOMETRICAL ANALYSES OF THE FUNCTIONAL MORPHOLOGY OF THE *URSUS SPELAEUS* MANDIBLE

9:00 **Varriale, F.** DENTAL MICROWEAR AND THE EVOLUTION OF CHEWING IN CERATOPSIAN DINOSAURS

9:15 **Woodward, H.** AN INTRA-SKELETAL BONE MICROANALYSIS OF *ALLIGATOR MISSISSIPPIENSIS* AND ITS APPLICATION TO NON-AVIAN DINOSAUR OSTEOHISTOLOGY

THURSDAY MORNING, NOVEMBER 3, 2011
TECHNICAL SESSION V

PARIS LAS VEGAS, CONCORDE A/B

MODERATOR: Ross MacPhee, Joshua Miller

9:30 **Hulbert Jr, R., Bourque, J., Meylan, P., Poyer, A.** MILLENNIUM PARK, A NEW RANCHOLABREAN SITE FROM CENTRAL FLORIDA: EVIDENCE OF THE ELUSIVE SOUTHEASTERN PLEISTOCENE PRAIRIE FAUNA

9:45 **Wang, X., Li, Q., Tseng, Z., Takeuchi, G., Deng, T.** DID THE MEGAFAUNA ORIGINATE FROM TIBET? COLD-ADAPTED PLIOCENE FAUNA FROM ZANDA BASIN SUGGESTS ORIGIN OF ICE AGE MEGAHERBIVORES IN HIGH PLATEAU

10:15 **Johnson, K., Miller, I., Stucky, R., Pigati, J., Holen, S.** ZIEGLER RESERVOIR AND THE SNOWMASTODON PROJECT: OVERVIEW AND GEOLOGIC SETTING OF A RECENTLY DISCOVERED SERIES OF HIGH-ELEVATION PLEISTOCENE (SANGAMONIAN) ECOSYSTEMS NEAR SNOWMASS VILLAGE, COLORADO

10:30 **Fisher, D., Rountrey, A.** SNOWMASS: PROBOSCIDEAN PALEOBIOLOGY BEFORE THE BEGINNING OF THE END

10:45 **Mothé, D., Avilla, L., Cozzuol, M.** THE SOUTH AMERICAN LOWLAND GOMPHOTHERE (MAMMALIA, PROBOSCIDEA, GOMPHOTHERIIDAE): TAXONOMY, PHYLOGENY AND BIOGEOGRAPHY

11:00 **MacPhee, R., Enk, J., Debruyne, R., Fisher, D., Poinar, H.** THE COMPLETE MITOGENOME OF THE COLUMBIAN MAMMOTH, WITH EVIDENCE FOR COLUMBIAN/WOOLLY MAMMOTH INTERBREEDING IN NORTH AMERICA

11:15 **Graham, R., Stafford, Jr., T., Semken, Jr., H., Lundelius, Jr., E.** TIME AVERAGING AND AMS RADIOCARBON DATING OF LATE QUATERNARY VERTEBRATE ASSEMBLAGES: IMPLICATIONS FOR HIGH-RESOLUTION ANALYSES

11:30 **Miller, J.** ARCTIC ANTLERS, CARIBOU CALVING GROUNDS, AND THE SPATIAL FIDELITY OF VERTEBRATE DEATH ASSEMBLAGES

11:45 **Feranec, R., Garcia, N.** EVIDENCE FOR NICHE CONSERVATISM IN PLEISTOCENE MAMMALS FROM EUROPE

12:00 **Schikora, T., Schrenk, F.** TEMPO-SPATIAL PATTERNS IN THE EVOLUTION OF EXTANT AFRICAN BOVIDAE BASED ON MOLECULAR, FOSSIL AND CLIMATE NICHE DATA

THURSDAY MORNING, NOVEMBER 3, 2011
SYMPOSIUM 3: THE EVOLUTION AND ECOLOGY OF TERRESTRIAL ECOSYSTEMS OF CAMPANIAN LARAMIDIA (WESTERN NORTH AMERICA)

PARIS LAS VEGAS, VENDOME A

MODERATORS: Mark A. Loewen, Eric M. Roberts, Scott D. Sampson

8:00 **Fiorillo, A., Tykoski, R.** CRETACEOUS DINOSAURS OF ALASKA: IMPLICATIONS FOR BIOGEOGRAPHY IN ANCIENT BERINGIA

8:15 **Schmitt, J., Varricchio, D.** VOLCANO-TECTONIC PARTITIONING OF LARAMIDIA: INFLUENCE ON CAMPANIAN TERRESTRIAL ENVIRONMENTS AND ECOSYSTEMS

8:30 **Roberts, E., Tapanila, L., Rogers, R., Foreman, B.** BASIN-SCALE CONTROLS ON CONTINENTAL VERTEBRATE TAPHONOMY: INSIGHTS FROM THE CAMPANIAN OF LARAMIDIA

8:45 **Miller, I., Johnson, K.** THE CAMPANIAN VEGETATION OF LARAMIDIA

9:00 **Brinkman, D., Eaton, J., Newbrey, M., Kirkland, J., Neuman, A.** LATITUDINAL DIFFERENTIATION OF FISH ASSEMBLAGES FROM THE LATE CRETACEOUS OF WESTERN NORTH AMERICA — EVIDENCE FROM VERTEBRATE MICROFOSSIL LOCALITIES

THURSDAY MORNING, NOVEMBER 3, 2011
SYMPOSIUM 3: THE EVOLUTION AND ECOLOGY OF TERRESTRIAL ECOSYSTEMS OF CAMPANIAN LARAMIDIA (WESTERN NORTH AMERICA) (continued)

9:15 **Eaton, J., Scott, C.** COMPARISON OF LATE SANTONIAN-CAMPANIAN LARAMIDA MAMMALIAN FAUNAS FROM ALBERTA, CANADA, AND UTAH, USA

9:30 **Konishi, T., Brinkman, D., Massare, J., Caldwell, M.** TWO NEW SPECIMENS OF AN ENIGMATIC MOSASAUR (SQUAMATA) *PROGNATHODON OVERTONI* FROM THE UPPER CAMPANIAN OF SOUTHERN ALBERTA, CANADA WITH GUT CONTENTS

9:45 **Nydam, R.** DIVERSITY AND DISTRIBUTION OF CAMPANIAN (LATE CRETACEOUS) SQUAMATES OF LARAMIDIA FROM CANADA TO MEXICO

10:15 **Irmis, R., Sertich, J., Hutchison, J., Titus, A.** CAMPANIAN CROCODYLIFORMS OF LARAMIDIA: NEW INSIGHTS FROM THE KAIPAROWITS BASIN OF SOUTHERN UTAH

10:30 **Drumheller, S., Boyd, C.** DIRECT EVIDENCE OF CROCODYLIFORM PREDATION ON SMALL DINOSAURIANS FROM THE KAIPAROWITS FORMATION OF UTAH

10:45 **Loewen, M., Zanno, L., Irmis, R., Sertich, J., Sampson, S.** CAMPANIAN THEROPOD EVOLUTION AND INTRACONTINENTAL ENDEMISM ON LARAMIDIA

11:00 **Farke, A., Loewen, M., Sampson, S., Forster, C.** THE RADIATION OF HORNED DINOSAURS ON LARAMIDIA

11:15 **Brown, C., Russell, A., Evans, D., Ryan, M., Brinkman, D.** NEW EVIDENCE CONCERNING DIVERSITY AND ABUNDANCE OF SMALL-BODIED ORNITHOPODS FROM THE BELLY RIVER GROUP (CAMPANIAN) OF ALBERTA

11:30 **Evans, D., Gates, T.** NEW PERSPECTIVES ON THE EVOLUTION AND HISTORICAL BIOGEOGRAPHY OF CAMPANIAN HADROSAURIDS (ORNITHISCHIA) OF LARAMIDIA

11:45 **Gates, T.** LATITUDINAL BIODIVERSITY PATTERNS DURING THE CAMPANIAN OF WESTERN NORTH AMERICA

12:00 **Sampson, S., Loewen, M., Irmis, R., Sertich, J., Evans, D.** LAURASIAN FAUNAL INTERCHANGE IN THE LATE CRETACEOUS: THE OUT OF LARAMIDIA HYPOTHESIS

THURSDAY MORNING, NOVEMBER 3, 2011
PREPARATORS' SESSION
PARIS LAS VEGAS, VENDOME B
MODERATORS: Kyle Davies, William Simpson

8:00 **Esker, D.** NEW APPLICATIONS FOR MEDIUM AND SMALL SCALE 3D PHOTOGRAMMETRY IN VERTEBRATE PALEONTOLOGY

8:15 **Breithaupt, B., Matthews, N.** PHOTOGRAMMETRIC ICHNOLOGY: STATE-OF-THE-ART DIGITAL DATA ANALYSIS OF PALEONTOLOGICAL RESOURCES IN NORTH AMERICA, EUROPE, ASIA, AND AFRICA

8:30 **Matthews, N., Noble, T., Musiba, C., Washa, J., Breithaupt, B.** CLOSE-RANGE PHOTOGRAMMETRY OF PARTIAL RE-EXCAVATION OF THE LAETOLI HOMININ FOOTPRINTS, IN NORTHERN TANZANIA

8:45 **Henrici, A., Berman, D., Martens, T., Sumida, S.** COLLECTION AND PREPARATION OF VERTEBRATE FOSSILS FROM THE EARLY PERMIAN BROMACKER QUARRY LOCALITY, CENTRAL GERMANY

9:00 **Getty, M., Lund, E.** COLLECTION, PREPARATION, AND MOUNTING OF TWO LARGE, ORIGINAL GRYPOSAUR SKELETONS FROM THE KAIPAROWITS FORMATION OF GRAND STAIRCASE ESCALANTE NATIONAL MONUMENT, FOR THE NEW UTAH MUSEUM OF NATURAL HISTORY, SALT LAKE CITY

9:15 **Wilkins, W.** THE MAMMOTH SITE OF HOT SPRINGS, SD: CURATION AND PREPARATION OF AN ACTIVE *IN-SITU* DIG SITE

THURSDAY MORNING, NOVEMBER 3, 2011
PREPARATORS' SESSION (continued)

9:30 **Lucking, C., Finlayson, H., Small, B., McFarlane, M., Fisher, D.** BEST PRACTICES IN CLEANING, DRYING, AND STABILIZATION WET PLEISTOCENE MEGAFAUNA MATERIAL FROM SNOWMASS, COLORADO

9:45 **Cavigelli, J.** LESSONS LEARNED FROM "DEAD SHEEP 148", OR THE FINE ART OF DEALING WITH BIG PLASTER JACKETS

10:15 **Roach, B., Fox, M., Bhullar, B.** THE PREPARATION OF YPM 57103, A CASE STUDY

10:30 **Balcarcel, A.** HIGH-RESOLUTION X-RAY COMPUTED TOMOGRAPHIC SCANNING FOR PREPARATION: LOGISTICS AND LIMITATIONS

10:45 **Schulp, A., Schouten, R., Metten, L., van de Sande, A., Bontenbal, A.** USING NEUTRON RADIOGRAPHY TO QUANTIFY CONSOLIDANT PENETRATION IN FOSSIL BONE

11:00 **Brown, M.** IMPROVING THE SCIENCE OF PALEONTOLOGY THROUGH EFFECTIVE COMMUNICATION IN THE LABORATORY

11:15 **Bader, K.** DEFORMATION IN SILICONE MOLDS AND ITS EFFECT ON THE ACCURACY OF CASTS

11:30 **Smith, M., Nunan, E.** SEISMIC MITIGATION FOR PALEONTOLOGICAL DISPLAY SPECIMENS

11:45 **Davies, K., Starly, B.** VIRTUAL AND REAL: USING 3D SCANNING, MODELING, AND PRINTING IN RECONSTRUCTING A JUVENILE *APATOSAURUS* SKELETON

12:00 **Fitzgerald, E., Sereno, P., Keillor, T.** A TUTORIAL ON TIME-LAPSE PHOTOGRAPHY FOR ONLINE DISSEMINATION OF PALEONTOLOGICAL SCIENCE: FOSSIL PREPARATION, SKELETAL MOUNTING, AND FLESH MODEL RESTORATION AS EXAMPLES

THURSDAY AFTERNOON, NOVEMBER 3, 2011
TECHNICAL SESSION VI
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: Gareth Dyke, Brian Andres

1:45 **Carney, R., Vinther, J., Shawkey, M., D'Alba, L., Ackermann, J.** BLACK FEATHER COLOR IN *ARCHAEOPTERYX*

2:00 **Barden, H., Wogelius, R., Edwards, N., Manning, P., van Dongen, B.** GEOCHEMICAL AND MORPHOLOGICAL EVIDENCE OF MELANIN PRESERVATION IN THE FEATHERS OF THE EARLY CRETACEOUS BIRD *GANSUS YUMENENSIS*

2:15 **Wang, X., Dyke, G., Palmer, C.** SCALING IN SIZE AND STIFFNESS OF AVIAN PRIMARY FEATHERS: IMPLICATIONS FOR THE STRENGTH OF MESOZOIC BIRD FEATHERS

2:30 **Li, D., Zhang, F.** A RE-EXAMINATION OF THE CRANIAL MORPHOLOGY OF *CONFUCIUSORNIS SANCTUS*

2:45 **Dyke, G., Vremir, M., Kaiser, G., Naish, D.** A DROWNED MESOZOIC BIRD BREEDING COLONY

3:00 **Huynh, T., Evangelista, D., Chang, C., Kwong, A., Tse, K.** AERODYNAMIC CHARACTERISTICS OF FEATHERED DINOSAUR SHAPES MEASURED USING PHYSICAL MODELS: A COMPARATIVE STUDY OF MANEUVERING

3:15 **Heers, A., Baier, D., Jackson, B., Dial, K.** FROM BABY BIRDS TO FEATHERED DINOSAURS: THE ONTOGENY AND EVOLUTION OF SKELETAL FORM AND FUNCTION

3:30 **English, L., Middleton, K.** PHYLOGENETIC PATTERNS OF PTEROSAUR WING SKELETON ALLOMETRY

3:45 **Andres, B., Howard, L., Steel, L.** PTEROSAURS, MODULES, AND THE ORIGIN OF THE PTERODACTYLOIDEA

THURSDAY AFTERNOON, NOVEMBER 3, 2011
TECHNICAL SESSION VI (continued)

4:00 **Rodrigues, T., Kellner, A.** PHYLOGENETIC RELATIONSHIPS OF THE PTERANODONTOID PTEROSAURS FROM THE LOWER CRETACEOUS OF BRAZIL

THURSDAY AFTERNOON, NOVEMBER 3, 2011
TECHNICAL SESSION VII
PARIS LAS VEGAS, VENDOME A
MODERATORS: Jaelyn Eberle, Robert Anemone

1:45 **Anemone, R., Emerson, C., Conroy, G.** FINDING FOSSILS IN NEW WAYS: A NEURAL NETWORK MODEL FOR PREDICTING THE LOCATION OF FOSSIL-BEARING DEPOSITS

2:00 **Hunter, J., Pearson, D., Bercovici, A.** EARLIEST EVIDENCE FOR THE MAMMALIAN RECOVERY FAUNA IN THE PALEOGENE OF NORTH DAKOTA

2:15 **Wilson, G., Self, C.** MAMMALIAN DENTAL COMPLEXITY ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY WITH IMPLICATIONS FOR ECOLOGICAL RECOVERY AND EXPANSION

2:30 **Calede, J., Wilson, G.** THE LAST SUPPER BEFORE THE IMPACT: MAMMALIAN DIETS ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY

2:45 **Wang, Y., Tong, Y., Ye, J., Li, Q.** A NEW PANTOLAMBDID PANTODONT (MAMMALIA) FROM THE PALEOCENE OF SOUTH CHINA: AN IMMIGRANT TO THE 'EAST OF EDEN' FROM NORTH AMERICA

3:00 **Eberle, J., Dawson, M.** MAMMALIAN DIVERSITY IN THE EARLY EOCENE HIGH ARCTIC

3:15 **Missiaen, P., Rose, K., Rana, R., Kumar, K., Smith, T.** REVISION OF *INDOBUNE* AND *CAMBAYTHERIUM* FROM THE EARLY EOCENE OF VASTAN (INDIA), AND THEIR AFFINITIES WITH ANTHRACOBUNID AND PERISSODACTYL MAMMALS

3:30 **Orliac, M., O'Leary, M.** ENDOCRANIAL STRUCTURES OF *DIACODEXIS* (MAMMALIA, ARTIODACTYLA)

3:45 **Beard, K., Dawson, M., Anemone, R.** PALEOBIOLOGICAL IMPLICATIONS OF THE EARLY EOCENE RODENT *TUSCAHOMYS* BASED ON AN EXTRAORDINARY NEW FAUNAL ASSEMBLAGE FROM THE GREAT DIVIDE BASIN, WYOMING, USA

4:00 **Kohn, M., Stromberg, C., Madden, R., Dunn, R., Carlini, A.** STABLE ISOTOPE RECORD OF MIDDLE EOCENE TO EARLY MIOCENE CLIMATE, GRAN BARRANCA, SOUTHERN ARGENTINA

THURSDAY AFTERNOON, NOVEMBER 3, 2011
TECHNICAL SESSION VIII
PARIS LAS VEGAS, VENDOME B
MODERATORS: Per Ahlberg, Claudia Marsiciano

1:45 **Ahlberg, P., Beznosov, P., Luksevics, E., Clack, J.** A VERY PRIMITIVE TETRAPOD FROM THE EARLIEST FAMENNIAN OF SOUTH TIMAN, RUSSIA

2:00 **Molnar, J., Pierce, S., Clack, J., Hutchinson, J.** NEW FEATURES AND FUNCTIONAL MORPHOLOGY OF THE AXIAL SKELETON IN THE EARLY TETRAPOD *PEDERPES FINNEYAE*

2:15 **Kavanagh, K.** JOINT PATTERNING AND THE EVOLUTION OF SIZE PROPORTIONS IN FINGERS AND TOES

2:30 **Chen, J.** A PHYLOGENETIC EVALUATION OF SEQUENCE HETEROCHRONY IN AMPHIBIAN SKULL DEVELOPMENT

2:45 **Pardo, J.** THE MORPHOLOGY AND RELATIONSHIPS OF THE CARBONIFEROUS-PERMIAN NECTRIDEAN *DIPLOCERASPIS BURKEI*

THURSDAY AFTERNOON, NOVEMBER 3, 2011
TECHNICAL SESSION VIII (continued)

3:00 **Huttenlocker, A., Small, B., Pardo, J., Anderson, J.** GAINING UNDERGROUND: NEW RECUMBIROSTRANS (LEPOSPONDYLI) FROM THE LOWER PERMIAN OF KANSAS AND NEBRASKA AND EARLY MORPHOLOGICAL EVOLUTION OF THE GROUP INFERRED BY MICRO-CT

3:15 **Anderson, J., Reisz, R.** GROWTH SERIES OF THE RECUMBIROSTRAN (LEPOSPONDYLI; GYMNARTHRIDAE) *CARDIOCEPHALUS PEABODYI* FROM RICHARDS SPUR, OKLAHOMA; NEW ANATOMICAL INFORMATION AND IMPLICATIONS FOR THE EVOLUTION OF "MICROSAURS"

3:30 **Reisz, R., Fröbisch, N.** A NEW DISSOROPHID TEMNOSPONDYL FROM THE LOWER PERMIAN OF OKLAHOMA

3:45 **Marsicano, C., Abdala, F., Smith, R., Rubidge, B.** THE EARLY HISTORY OF TETRAPODS IN THE SOUTHERN HEMISPHERE: THE SPATIAL AND TEMPORAL DISTRIBUTION OF PALEOZOIC BASAL TETRAPODS IN WESTERN GONDWANA

4:00 **Fujiwara, S., Hutchinson, J.** ELBOW ADDUCTOR MOMENT ARM AS AN INDICATOR OF SPRAWLING POSTURE OF THE FORELIMB IN QUADRUPEDAL TETRAPODS

THURSDAY AFTERNOON, NOVEMBER 3, 2011
POSTER SESSION II
PARIS LAS VEGAS, RIVOLI B
Authors must be present from 4:15 – 6:15 p.m.

Posters must be removed by 6:30 p.m.

1 **Linn, T., Welsh, E., Carr, J.** THE EFFECTIVE USES OF POLYESTER QUILT BATTING FOR CONSTRUCTING PLASTER JACKETS

2 **Cavin, J.** A TEST OF THREE SOLVENT-BASED CONSOLIDANTS FOR FIELD USE IN THE RAIN

3 **Keillor, T., Sereno, P.** FLESHING OUT A FOSSIL FIND

4 **Rhue, V.** THE MAKING OF THE AGE OF MAMMALS: A BEHIND THE SCENES LOOK AT EXHIBIT PREPARATION AND DISPLAY

5 **Rivin, M.** THE COOPER CENTER: A NOVEL PARTNERSHIP FOR THE MANAGEMENT OF PALEONTOLOGICAL RESOURCES

6 **Tucker, S.** NEBRASKA'S HIGHWAY PALEONTOLOGY PROGRAM: 50 YEARS OF LIFE IN THE PAST LANE

7 **Lively, J., Irmis, R.** NEW BAENID TURTLES FROM THE KAIPAROWITS FORMATION OF SOUTHERN UTAH: IMPLICATIONS FOR LARAMIDIAN BIOGEOGRAPHY

8 **Contessi, M., Fanti, F., Aljane, H.** NEW DINOSAUR-DOMINATED TRACKSITES IN LATE JURASSIC AND EARLY CRETACEOUS OF SOUTHERN TUNISIA

9 **Lovelace, D.** VERTEBRATE ICHNOLOGY OF THE EARLY TRIASSIC RED PEAK FORMATION (CHUGWATER GROUP), CENTRAL WYOMING

10 **Nour-Eddine, J., Belvedere, M., Breda, A., Gattolin, G., Dyke, G.** A VARIED ICHNOCOENOSIS IN THE CRETACEOUS KEM KEM BEDS OF MOROCCO

11 **DeBlieux, D., Hunt, G., Kirkland, J., Ferris-Rowley, D., Milner, A.** SIGNIFICANT NEW MESOZOIC LOCALITIES FOUND DURING A PALEONTOLOGICAL RESOURCE INVENTORY OF BLM WILDERNESS LANDS IN WASHINGTON COUNTY, UTAH

12 **Crandall, J., Hellert, S., Smith, N., Hammer, W., Makovicky, P.** ANATOMY AND AFFINITIES OF LARGE ARCHOSAUROMORPHS FROM THE LOWER FREMOUW FORMATION (EARLY TRIASSIC) OF ANTARCTICA

13 **Peecook, B., Sidor, C., Nesbitt, S., Angielczyk, K., Steyer, S.** NEW DATA ON THE ARCHOSAUR FAUNA OF THE MIDDLE TRIASSIC (ANISIAN) NTAWERE FORMATION OF ZAMBIA

14 **Scheyer, T., Desojo, J., Cerda, I.** COMPARATIVE PALEAEOHISTOLOGY OF TRIASSIC RAUISUCHIAN AND AETOSAURIAN OSTEODERMS (ARCHOSAURIA: PSEUDOSUCHIA)

15 **Parker, W., Martz, J., Dubiel, R.** A NEWLY RECOGNIZED SPECIMEN OF THE PHYTOSAUR *REDONDASAURUS* FROM THE UPPER TRIASSIC OWL ROCK MEMBER (CHINLE FORMATION) AND ITS BIOSTRATIGRAPHIC IMPLICATIONS

16 **Zawiskie, J., Dawley, R., Nesbitt, S.** THE RELATIONSHIPS AND TYPE LOCALITY OF *HEPTASUCHUS CLARKI*, CHUGWATER GROUP (MIDDLE TO UPPER TRIASSIC), SOUTHEASTERN BIG HORN MOUNTAINS, WYOMING, USA

17 **Lucas, S., Heckert, A., Lockley, M.** THE TRACKMAKER OF THE LATE TRIASSIC TETRAPOD FOOTPRINT ICHNOTAXON *BRACHYCHIROTHERIUM* WAS AN AETOSAUR

18 **Schneider, V., Heckert, A., Fraser, N.** DIVERSITY OF AETOSAURS (ARCHOSAURIA:STAGONOLEPIDIDAE) IN THE UPPER TRIASSIC PEKIN FORMATION (DEEP RIVER BASIN), NORTH CAROLINA

19 **Holloway, W., O'Keefe, R.** A VIRTUAL PHYTOSAUR (ARCHOSAURIA: CRUROTARSI) ENDOCAST AND ITS IMPLICATIONS FOR SENSORY SYSTEM EVOLUTION IN ARCHOSAURS

20 **MOVED TO ORAL PLATFORM, WEDNESDAY, NOVEMBER 2**

21 **Fechner, R., Schwarz-Wings, D.** A FUNCTIONAL EXPLANATION FOR THE PROPUBIC AND OPISTHOPUBIC PELVIS IN EXTANT ARCHOSAURS AND DINOSAURS

22 **David, R., Allain, R., Berthoz, A., Janvier, P.** A NEW WAY TO ESTIMATE THE DIRECTIONAL SENSITIVITY OF THE SEMICIRCULAR CANALS SYSTEM

23 **Taylor, E., Schachner, E., Farmer, C.** VARIATION IN HINDLIMB MUSCLE ATTACHMENT SITES IN THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS)* AND IMPLICATIONS FOR PALEOBIOLOGICAL RECONSTRUCTIONS

24 **Felice, R., O'Connor, P.** CROCODYLIFORM AQUATIC LOCOMOTION AND AXIAL FLEXIBLITY: COMPARATIVE VERTEBRAL ANATOMY OF MESOEUCROCODYLIANS

25 **George, I., Holliday, C.** TRIGEMINAL NERVE MORPHOLOGY IN *ALLIGATOR MISSISSIPPIENSIS*: IMPLICATIONS FOR INFERING SENSORY POTENTIAL IN EXTINCT CROCODYLIFORMS

26 **Suzuki, D., Hayashi, S., Chiba, K., Tanaka, K.** JAW MECHANICS OF CROCODILES REVEAL THEIR FAST MASTICATION

27 **Leardi, J., Pol, D., Fernandez, M.** PHYLOGENETIC PATTERNS, HOMOPLASY, AND THE EVOLUTION OF THE ANTORBITAL FENESTRA IN CROCODYLIFORMES

28 **Turner, A., Brochu, C.** FLESHING OUT THE NEOSUCHIAN TREE: A REEVALUATION OF THE CROCODYLIFORM SHAMOSUCHUS FROM THE CRETACEOUS OF ASIA

29 **Schubert, B., Mead, J., Stout, J.** LATE NEOGENE *ALLIGATOR* EVOLUTION AND A DESCRIPTION OF SPECIMENS FROM THE GRAY FOSSIL SITE, SOUTHERN APPALACHIANS, USA

30 **Gold, M.** CRANIAL ANATOMY AND ONTOGENY OF *GAVIALIS GANGETICUS* USING COMPUTERIZED AXIAL TOMOGRAPHY: IMPLICATIONS FOR GAVIALOID PHYLOGENY

31 **Nestler, J.** A GEOMETRIC MORPHOMETRIC ANALYSIS OF *CROCODYLUS NILOTICUS*: OSTEOLOGICAL EVIDENCE FOR A CRYPTIC SPECIES COMPLEX

32 **Noto, C., Drumheller, S., Main, D., Allen, E.** LIFE AND DEATH IN A CRETACEOUS COASTAL SWAMP: EXAMPLE FROM THE WOODBINE FORMATION OF TEXAS

33 **Lockley, M., Lucas, S.** CROCS NOT THEROPODS WERE LIKELY TOP PREDATORS ON THE CRETACEOUS DINOSAUR FREEWAY: IMPLICATIONS OF A LARGE TRACK CENSUS

34 **Bennett, III, G., Main, D., Peterson, R., Anderson, B.** A TAPHONOMIC AND PALEOECOLOGICAL COMPARISON OF ISOLATED CROCODYLIFORM TEETH FROM THE WOODBINE FORMATION OF TEXAS AND THE HELL CREEK FORMATION OF MONTANA

35 **Figueiredo, R., Kellner, A.** A NEW SPECIMEN OF *ARARIPESUCHUS* (MESOEUCROCODYLIA) WITH SOFT TISSUE PRESERVATION FROM THE LOWER CRETACEOUS ROMUALDO FORMATION (ARARIPE BASIN), BRAZIL

36 **Allen, E., Main, D., Noto, C.** A NEW CROCODYLIFORM FROM THE MIDDLE CRETACEOUS WOODBINE FORMATION OF TEXAS

37 **Householder, M., Williams, S., Tremaine, K.** A NEW, SMALL-BODIED ALLIGATOROID FROM THE HELL CREEK FORMATION (LATE MAASTRICHTIAN) OF MONTANA

38 **Hill, R., O'Connor, P.** THE EVOLUTION OF EXOSKELETAL OSSIFICATIONS IN NOTOSUCHIAN CROCODYLIFORMS

39 **Pritchard, A., Turner, A.** THE PALATE AND BRAINCASE IN GONIOPHOLIDID CROCODYLIFORMS: INSIGHTS FROM A NEW SKULL OF *EUTRETAURANOSUCHUS DELFSI*

40 **Skiljan, R., Gant, C., Holliday, C.** STRUCTURE AND FUNCTION OF A PROTOSUCHIAN MANDIBULAR SYMPHYSIS USING ANATOMICAL INSIGHTS FROM *ALLIGATOR MISSISSIPPIENSIS*

41 **Anggraini, N., Schmitt, J., Jackson, F.** RAPID MICROBIALLY-MEDIATED CALCIUM CARBONATE PRECIPITATION: A MODEL FOR PERMINERALIZATION OF EMBRYONIC SOFT TISSUE IN SAUROPOD EGGS

42 **Jackson, F.** INFLUENCE OF VERTISOL DEVELOPMENT ON SAUROPOD EGG TAPHONOMY AND DISTRIBUTION IN NESTING GROUND DEPOSITS

43 **Delcourt, R., Grillo, O., Azevedo, S., Romano, P.** CLAVICULAR RING: A NEW METHOD TO ARTICULATE THE PECTORAL GIRDLE IN STEM-SAUROPODOMORPHS

44 **Bittencourt, J., Langer, M.** NEW INFORMATION ON THE SAUROPODOMORPH FAUNA OF THE UPPER TRIASSIC CATURRITA FORMATION, SOUTH BRAZIL

45 **Holwerda, F., Pol, D., Gröcke D., Rauhut, R.** TOOTH MORPHOTYPES OF SAUROPOD DINOSAURS FROM THE CANADON ASFALTO FORMATION (MIDDLE JURASSIC) OF PATAGONIA

46 **Knoll, F., Witmer, L., Ortega, F., Ridgely, R., Schwarz-Wings, D.** THE BRAINCASE OF THE BASAL SAUROPOD DINOSAUR *SPINOPHOROSAURUS* AND A CT-BASED ANALYSIS OF THE BRAIN AND OTIC REGIONS

47 **Tsuihiji, T., Watabe, M., Tsogtbaatar, K., Barsbold, R., Suzuki, S.** A SAUROPOD (DINOSAURIA: SAURISCHIA) BRAINCASE FROM THE LOWER CRETACEOUS OF THE EASTERN GOBI DESERT IN MONGOLIA

48 **Marpmann, J., Carballido, J., Remes, K., Sander, P.** ONTOGENETIC CHANGES IN THE SKULL ELEMENTS OF THE LATE JURASSIC DWARF SAUROPOD *EUROPASAURUS HOLGERI*

49 **Trujillo, K., DeMar, D., Foster, J., Bilbey, S.** AN EXCEPTIONALLY LARGE JUVENILE *CAMARASAURUS* FROM THE MORRISON FORMATION (UPPER JURASSIC) OF ALBANY COUNTY, WY, USA

50 **Mocho, P., Royo-Torres, R., Ortega, F., Silva, B.** "EUHELOPODIDAE" (SAUROPODA) TEETH FROM THE UPPER JURASSIC OF PORTUGAL

51 **Sassani, N.** THE CHINESE COLOSSUS: AN ANALYSIS OF THE PHYLOGENY OF *RUYANGOSAURUS GIGANTEUS* AND ITS IMPLICATIONS FOR TITANOSAUR EVOLUTION

52 **Fronimos, J.** PATTERNS OF POSTCRANIAL PNEUMATICITY IN THE LATE CRETACEOUS TITANOSAUR *ALAMOSAURUS SANJUANENSIS*

53 **Díez Díaz, V., Pereda Suberbiola, X., Sanz, J.** VARIATION IN THE CAUDAL VERTEBRAE OF THE EUROPEAN TITANOSAUR (DINOSAURIA, SAUROPODA) *LIRAINOSAURUS ASTIBIAE*

54 **Gorscak, E., O'Connor, P., Stevens, N., Roberts, E.** A BASAL TITANOSAURIAN FROM THE MIDDLE CRETACEOUS GALULA FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA

55 **Schroeter, E., Boles, Z., Lacovara, K.** THE HISTOLOGY OF A MASSIVE TITANOSAUR FROM ARGENTINA AND IMPLICATIONS FOR MAXIMUM SIZE

56 **Cerda, I., Paulina Carabajal, A., Salgado, L., Coria, R., Moly, J.** THE FIRST RECORD OF SAUROPOD DINOSAURS FROM ANTARCTICA

57 **Moacdieh, E., Wilson, J.** A QUANTITATIVE APPROACH TO SAUROPOD NECK MORPHOLOGY

58 **Whitlock, J.** CHARACTER VISUALIZATION METHODS IN PHYLOGENETIC ANALYSIS

59 **Deng, T.** MAMMALIAN ZOOGEOGRAPHY OF THE *HIPPARION* FAUNA DURING THE LATE MIOCENE IN CHINA

60 **Davis, E., Scott, E., Jenkins, D.** MULTIVARIATE DISCRIMINANT ANALYSIS OF PHALANGES OF SMALL *EQUUS* ALLOWS IDENTIFICATION OF PLEISTOCENE SPECIES AT PAISLEY CAVES, OREGON

61 **Wolf, D., Bernor, R., Hussain, S.** SYSTEMATICS, BIOSTRATIGRAPHY, GEOCHRONOLOGY AND PALEODIET OF THE SIWALIK HIPPARIONS FROM THE POTWAR PLATEAU, NORTHERN PAKISTAN

62 **Asami, R., Ibarra, Y., Scott, E., Dundas, R.** *EQUUS* FROM THE MIDDLE IRVINGTONIAN FAIRMEAD LANDFILL LOCALITY, MADERA COUNTY, CALIFORNIA

63 **Barrón-Ortiz, C., Theodor, J., Arroyo-Cabrales, J.** FEEDING ECOLOGY OF THE LATE PLEISTOCENE EQUIDS FROM EL CEDRAL, SAN LUIS POTOSI, MEXICO, AS EVIDENCED BY DENTAL WEAR

64 **Baskin, J., Scott, E., Lundelius, E.** EVIDENCE FROM MORPHOLOGICAL VARIATION IN LARGE SAMPLES ON THE NUMBER OF SPECIES OF *EQUUS* IN THE LATE PLEISTOCENE OF NORTH AMERICA

65 **Hernesniemi, E., Fortelius, M.** MESOWEAR ANALYSIS APPLIED TO LOWER MOLARS OF HORSE SPECIES

66 **O'Sullivan, J.** X-RAY VISION SEES THROUGH 'THE FEROCIOUS PONY HYPOTHESIS'

67 **Sanisidro, O., Alberdi, M., Morales, J.** SEXUAL DIMORPHISM IN ELASMOTHERIINA (MAMMALIA, RHINOCEROTIDAE) WITH REMARKS ON *HISPANOTHERIUM MATRITENSE*

68 **Holbrook, L., Coombs, M.** ON THE PHYLOGENY OF THE CHALICOTHERIIDAE (MAMMALIA, PERISSODACTYLA)

69 **Coombs, M., Rounds, C.** A SKULL OF *MOROPUS* (PERISSODACTYLA, CHALICOTHERIIDAE, SCHIZOTHERIINAE) WITH AN ASSOCIATED PREMAXILLA FROM THE EARLY HEMINGFORDIAN OF NORTHWEST NEBRASKA, USA

70 **Saarinen, J., Fortelius, M.** PATTERNS OF BODY MASS AND DIET OF LARGE UNGULATES FROM MIDDLE AND LATE PLEISTOCENE OF UK AND GERMANY AND THEIR CONNECTIONS WITH ENVIRONMENT

71 **Nakaya, H., Onodera, M., Yamada, E., Kunimatsu, Y., Nakatsukasa, M.** PALEOENVIRONMENTS OF THE LATE MIOCENE NAKALI AND SAMBURU HILLS, KENYA, FROM RODENT FAUNA AND HERBIVORE MESOWEAR

72 **Prado, J., Alberdi, M.** CLIMATIC CHANGE AND PLEISTOCENE MAMMAL DIVERSITY IN THE PAMPEAN REGION OF ARGENTINA

73 **Ferrusquía-Villafranca, I., Ruiz-González, J., Torres Hernández, J.** A NEW MIOCENE LOCAL FAUNA FROM THE SIERRA MADRE ORIENTAL AT SAN LUIS POTOSÍ, CENTRAL-EAST MEXICO, AND ITS PALEONTOLOGIC SIGNIFICANCE

74 **Alberdi, M., Prado, J., Azanza, B.** HOW DID PAST ENVIRONMENTAL CHANGE AFFECT LARGE MAMMAL DIVERSITY IN SPAIN?

75 **Säilä, L., Fortelius, M., Werdelin, L., Corfe, I., Tuomola, A.** TAXON REPLACEMENT: INVASION OR SPECIATION? FIRST RESULTS FROM A SUPERTREE OF NEOGENE MAMMALS

76 **Gould, F.** CONSTRUCTING A ROBUST ECOMORPHOLOGICAL INDICATOR OF LOCOMOTOR MODE FROM THE DISTAL FEMORAL ARTICULAR SURFACE MORPHOLOGY

77 **Du, A., Behrensmeyer, A., Blumenschine, R., Faith, J.** LANDSCAPE NEOTAPHONOMY AND EAST AFRICAN CARNIVORE GUILD STRUCTURE: MODELING HOMININ SCAVENGING OPPORTUNITIES

78 **Linden, E.** MORPHOLOGICAL RESPONSES OF THE DIRE WOLVES *(CANIS DIRUS)* OF RANCHO LA BREA OVER TIME DUE TO CLIMATIC CHANGES

79 **Koper, L.** DESCRIPTION OF THE DIRE WOLF FORELIMB *CANIS DIRUS GUILDAYI* FROM RANCHO LA BREA

80 **Binder, W.** IT'S COMPLICATED: CHANGES IN *CANIS DIRUS* TEETH AND LIMBS AT RANCHO LA BREA GIVE SIMILAR EVIDENCE OF OPPOSING TRENDS OVER TIME

81 **Madan, M., Prothero, D., Sutyagina, A.** SIZE AND SHAPE STASIS IN RANCHO LA BREA FELIDS DURING THE LATE PLEISTOCENE: UNIVARIATE AND MULTIVARIATE STATISTICAL APPROACHES

82 **Carlon, B., Hubbard, C.** MORPHOMETRIC ANALYSIS OF RANCHO LA BREAN FELID ILIA

83 **Christine, J., Wallace, S.** IDENTIFICATION OF FRAGMENTARY LATE PLEISTOCENE MUSTELOIDS THROUGH MORPHOMETRIC ANALYSES

84 **Ruez, Jr., D.** PRAIRIE PALEOECOLOGY: ICE AGE MAMMALS AND TEMPERATURES IN THE U.S. MIDWEST

85 **Ferrer, E., Matzke, N.** PHYLOGENETIC DIVERSITY VERSUS SPECIES RICHNESS ACROSS THE MID-MIOCENE CLIMACTIC OPTIMUM: A CASE STUDY IN CANIDS

86 **Cullen, T., Rybczynski, N., Schr-Adams, C.** PRELIMINARY DESCRIPTION OF A SMALL SKULL SPECIMEN OF *ENALIARCTOS* (CARNIVORA, PINNIPEDIMORPHA) FROM THE MIOCENE OF WESTERN OREGON

87 **Siliceo, G., Salesa, M., Antón, M., Morales, J.** COMPARATIVE STUDY OF TWO POPULATIONS OF THE SABERTOOTHED FELID *PROMEGANTEREON OGYGIA* (FELIDAE, MACHAIRODONTINAE) FROM BATALLONES-1 AND BATALLONES-3 SITES (LATE MIOCENE, MN 10, TORRESÓN DE VELASCO, MADRID, SPAIN)

88 **Robles, J., Alba, D., Fortuny, J., Rotgers, C., Moyà-Solà, S.** NEW CRANIODENTAL REMAINS OF THE FALSE SABERTOOTH *SANSANOSMILUS JOURDANI* FROM THE MIOCENE OF THE VALLÈS-PENEDÈS BASIN (NE IBERIAN PENINSULA) AND THE PHYLOGENY OF THE BARBOUROFELIDAE (CARNIVORA)

89 **Naples, V.** MASTICATORY MUSCLE MORPHOLOGY AND FUNCTION AMONG THE FOUR TYPES OF SABER-TOOTH AND CONICAL-TOOTH FELIDS: COMPARISON OF CONSTRAINTS ON THE BITING CAPABILTIES OF REPRESENTATIVE COOKIE-CUTTER, SCIMITAR-TOOTH, DIRK-TOOTH AND CONICAL-TOOTH CATS

90 **Domingo, M., Domingo, L., Badgley, C., Morales, J.** DIET OF THREE MIOCENE HYPERCARNIVORES FROM THE MADRID BASIN (SPAIN) BASED ON CARBON-ISOTOPE COMPOSITION OF TOOTH ENAMEL

91 **Wallace, S., Hulbert, R.** A NEW MACHAIRODONT FROM THE PALMETTO FAUNA (LATE HEMPHILLIAN) OF FLORIDA, WITH COMMENTS ON THE ORIGIN OF THE SMILODONTINI

92 **Campbell, T., Bromm, G., Hilton, R.** OSTEOARTHRITIS IN AN AMPHICYONID FROM THE EARLY BARSTOVIAN, YELLOW HILLS FAUNA, NORTHWESTERN NEVADA

93 **Lynch, E., Wallace, S.** IN THE TREES OR ON THE GROUND?: READRESSING THE LOCOMOTOR CLASSIFICATION OF EXTINCT AND EXTANT MUSTELOIDS USING PRINCIPLE COMPONENTS ANALYSIS

94 **Hensley-Marschand, B.** HYAENIDAE: DIVERSITY AND PHYLOGENETICS IN THE LATE CENOZOIC

95 **Hartstone-Rose, A., Simpler, E., Heckler, A.** THE DIET OF THE MIO-PLIOCENE CARNIVORES OF LANGEBAANWEG, SOUTH AFRICA

96 **King, L., Wallace, S.** EFFECT OF THE GENETIC BOTTLENECK ON THE SEXUAL DIMORPHISM OF THE BLACK FOOTED FERRET (MUSTELA NIGRIPES)

97 **Serrano, F., Figueirido, B., Martín, A., Wallace, S., Palmqvist, P.** USING GEOMETRIC MORPHOMETRICS TO EXPLORE THE MASTICATORY SYSTEM OF AILURIDS

98 **WITHDRAWN**

99 **Canavan, R., Clementz, M., Bywater-Reyes, S.** STABLE ISOTOPE COMPOSITION OF GLYPTODONT OSTEODERMS: A TOOL FOR INTERPRETING PALEO-ENVIRONMENT

100 **Shaw, B., Ruedas, L.** ELUCIDATING SEMI-ARBOREAL LOCOMOTION OF SMALL GROUND SLOTHS (SUPERORDER XENARTHRA, ORDER PILOSA) THROUGH INDEX ANALYSES

101 **González Ruiz, L., Zurita, A., Alejo, S., Scillato-Yané, G., Tejedor, M.** TAXONOMIC REVISION OF THE GLYPTODONTIDAE (MAMMALIA, XENARTHRA) PROPALAEHOPLOPHORINAE AND A PHYLOGENETIC ANALYSIS OF THE GLYPTODONTIDAE HOPLOPHORINI

102 **Holte, S.** THE OSTEOLOGICAL ONTOGENY OF THE *MEGALONYX JEFFERSONII* MATERIAL FROM ACB-3 CAVE, COLBERT COUNTY, ALABAMA

103 **McAfee, R.** EXPANDING THE POST-CRANIAL TAXONOMIC CHARACTERIZATION OF THE LATE PLEISTOCENE GROUND SLOTH *MYLODON DARWINI*

104 **Raymond, K., Prothero, D.** STASIS IN THE LATE PLEISTOCENE GROUND SLOTHS (*PARAMYLODON HARLANI*) FROM RANCHO LA BREA TAR PITS, CALIFORNIA

105 **Lindsey, E.** A SLOTH-DOMINATED LATE-QUATERNARY ASPHALT SEEP FROM SANTA ELENA, ECUADOR

106 **Haupt, R., DeSantis, L., Green, J.** DENTAL MICROWEAR TEXTURE ANALYSIS OF DENTIN

107 **Grimm, B., Graham, R.** THE EFFECTS OF WEATHERING ON RARE EARTH ELEMENT (REE) UPTAKE: A STUDY FROM THE PLEISTOCENE TARKIO VALLEY AND EOCENE BONES GALORE FOSSIL SITES

108 **Kalthoff, D., Rose, K., von Koenigswald, W.** WHO IS EATING MY TEETH? BIOEROSIONAL TUNNELING IN FOSSIL MAMMAL DENTITIONS

109 **Hodnett, J., Elliott, D., Olsen, T.** THE PETALODONTIFORMES (CHONDRICTHYES; EUCHONDROCEPHALI) FROM THE MARINE PERMIAN (LEONARDIAN/GUADELOUPIAN) KAIBAB FORMATION, NORTHERN ARIZONA

110 **Richards, K., Clack, J.** A MID-CARBONIFEROUS CHONDRICHTHYAN BRAINCASE FROM THE PEAK DISTRICT OF DERBYSHIRE, UK

111 **Koot, M., Twitchett, R., Cuny, G., Hart, M.** EFFECTS OF THE LATE PERMIAN EXTINCTION ON THE PERMIAN-TRIASSIC SHARK FAUNA

112 **Shimada, K., Everhart, M., Reilly, B., Rigsby, C.** FIRST ASSOCIATED SPECIMEN OF THE LATE CRETACEOUS SHARK, *CRETODUS* (ELASMOBRANCHII: LAMNIFORMES)

113 **Dickerson, A., Shimada, K., Reilly, B., Rigsby, C.** NEW DATA ON THE LATE CRETACEOUS CARDABIODONTID SHARK BASED ON AN ASSOCIATED SPECIMEN FROM KANSAS, USA

THURSDAY AFTERNOON, NOVEMBER 3, 2011
POSTER SESSION II (continued)

114 **King, L., Main, D., Noto, C., Bennett, G.** SHARK COPROLITES AS PALEOENVIRONMENTAL AND PALEOECOLOGICAL INDICATORS AT THE ARLINGTON ARCHOSAUR SITE, WOODBINE FORMATION (CENOMANIAN), NORTH CENTRAL TEXAS

115 **Harrison, L., Vavrek, M., Becker, M., Larsson, H.** INSIGHT INTO THE CENOMANIAN (LATE CRETACEOUS) TERRESTRIAL AND MARINE VERTEBRATE FAUNA OF BYLOT ISLAND, NUNAVUT

116 **Klug, S., Kriwet, J.** NODE AGE ESTIMATIONS AND THE ORIGIN OF ANGEL SHARKS, SQUATINIFORMES (NEOSELACHII, SQUALOMORPHII)

117 **Pimiento, C., Hendy, A., MacFadden, B., Ehret, D., Jaramillo, C.** MIOCENE CHONDRICHTHYANS FROM PANAMA

118 **Tulu, Y., Chinsamy, A.** LANGEBAANWEG QUARRY, WESTERN CAPE, SOUTH AFRICA: THE ELASMOBRANCH FAUNA AND COMPARISONS TO FAUNAS OF PCS (LEE CREEK) PHOSPHATE MINE AND SHARKTOOTH HILL

119 **Popov, E., Takeuchi, G.** MIOCENE - EARLY PLIOCENE CHIMAEROID FISHES (HOLOCEPHALI, CHIMAEROIDEI) FROM CALIFORNIA AND A REVIEW OF THE GLOBAL NEOGENE CHIMAEROID DIVERSITY AND DISTRIBUTION

120 **Qu, Q., Ahlberg, P., Blom, H., Zhu, M., Li, G.** WHAT IS A PORE-CANAL SYSTEM?

121 **Chen, D., Blom, H., Ahlberg, P.** THREE-DIMENSIONAL HISTOLOGY OF TOOTH CUSHIONS OF *LOPHOSTEUS* FROM THE LATE SILURIAN OF ESTONIA

122 **Jerve, A.** EVIDENCE OF ENDOCHONDRAL OSSIFICATION IN SPINE MATERIAL FROM THE UPPER DEVONIAN, SCAT CRAIG LOCALITY, SCOTLAND

123 **Fielitz, C., Shimada, K., Friedman, M.** A FOURTH SPECIES OF *APATEODUS* (TELEOSTEI: AULOPIFORMES) AND ITS IMPLICATIONS TO THE DIVERSITY OF *APATEODUS*

124 **Youssef, M., Sallam, H., Friedman, M., O'Connor, P., Sertich, J.** A SAURODONTID FISH FROM THE LATE CRETACEOUS OF DAKHLA OASIS, WESTERN DESERT, EGYPT

125 **Romano, C., Brinkmann, W., Ware, D., Jenks, J., Lucas, S.** NEW EARLY TRIASSIC FISH FAUNAS FROM THE WESTERN UNITED STATES AND THE RECOVERY OF FISHES AFTER THE END-PERMIAN MASS EXTINCTION

FRIDAY MORNING, NOVEMBER 4, 2011
SYMPOSIUM 4: VERTEBRATE DIVERSITY PATTERNS AND SAMPLING BIAS
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: Roger B. J. Benson, Philip D. Mannion, Richard J. Butler

8:00 **Lloyd, G., Friedman, M.** 400-MILLION YEARS OF 'FISHES': A SURVEY OF SAMPLING BIASES BASED ON THE UK RECORD

8:15 **Brusatte, S., Lloyd, G., Wang, S., Montanari, S., Yi, H.** COPING WITH ROCK RECORD BIAS IN STUDIES OF MORPHOLOGICAL EVOLUTION: NEW METHODS FOR ANALYZING DISPARITY AND EVOLUTIONARY RATES

8:30 **Benson, R., Ruta, M., Atkinson, E.** THE COLONISATION OF LAND: POOR SAMPLING OF EARLY AMNIOTES AND SUSTAINED HIGH EVOLUTIONARY RATES IN THE ORIGIN OF THERAPSIDS

8:45 **Benton, M., Ruta, M.** TETRAPOD EVOLUTION THROUGH THE PERMIAN AND TRIASSIC: ROCK RECORD, SUPERTREES, AND DETECTING EVENTS

9:00 **Fröbisch, J.** VERTEBRATE DIVERSITY ACROSS THE END-PERMIAN EXTINCTION - SEPARATING BIOLOGICAL AND GEOLOGICAL SIGNALS

FRIDAY MORNING, NOVEMBER 4, 2011
SYMPOSIUM 4: VERTEBRATE DIVERSITY PATTERNS AND SAMPLING BIAS (continued)

9:15 **Whiteside, J., Irmis, R.** NON-BIOTIC CONTROLS OF PERMO-TRIASSIC TETRAPOD DIVERSITY: IMPLICATIONS FOR UNDERSTANDING THE END-PERMIAN EXTINCTION ON LAND

9:30 **Butler, R., Barrett, P., Benson, R., Brusatte, S., Andres, B.** THE TAXONOMIC DIVERSITY AND MORPHOLOGICAL DISPARITY OF PTEROSAURS: UNTANGLING SAMPLING BIASES, THE IMPACT OF LAGERSTÄTTEN, AND DIVERSIFICATION TRAJECTORIES

9:45 **Upchurch, P., Mannion, P., Benson, R., Butler, R., Carrano, M.** GEOLOGICAL AND ANTHROPOGENIC CONTROLS ON THE SAMPLING OF THE TERRESTRIAL FOSSIL RECORD: A CASE STUDY FROM THE DINOSAURIA

10:15 **Carrano, M., Oreska, M.** THE IMPORTANCE OF VERTEBRATE MICROFOSSIL BONEBEDS IN UNDERSTANDING THE FOSSIL RECORD: EXAMPLES FROM THE CLOVERLY FORMATION

10:30 **Vavrek, M., Brinkman, D.** BASELINE LEVELS OF ALPHA AND BETA DIVERSITY IN VERTEBRATE MICROFOSSIL ASSEMBLAGES

10:45 **Campione, N., Hsieh, S., Evans, D.** DIVERSITY DYNAMICS IN THE LATE CRETACEOUS OF NORTH AMERICA: SAMPLING AND BODY SIZE BIASES

11:00 **Mannion, P., Benson, R., Upchurch, P., Butler, R., Carrano, M.** A TEMPERATE PALEODIVERSITY PEAK IN MESOZOIC DINOSAURS AND EVIDENCE FOR LATE CRETACEOUS GEOGRAPHICAL PARTITIONING

11:15 **Chew, A., Oheim, K.** SPATIALLY CONSTRAINED RAREFACTION AND GEOGRAPHIC INFORMATION SYSTEMS: MITIGATING THE EFFECTS OF THE SPECIES-AREA RELATIONSHIP IN DIVERSITY ANALYSIS

11:30 **Carrasco, M.** COMPARING EXTANT MAMMALIAN SPECIES DIVERSITY TO PALEOSPECIES RICHNESS: PROBLEMS AND SOLUTIONS

11:45 **Stegner, M., Holmes, M.** USING PALEONTOLOGICAL DATABASES TO ASSESS SPATIAL AND TEMPORAL CONSERVATION OF MAMMALIAN COMMUNITY STRUCTURE AS AN AID TO CONSERVATION PLANNING

12:00 **Rook, D., Heim, N., Marcot, J., Peters, S.** CONTRASTING PATTERNS OF ROCK AND BIOTIC DIVERSITY IN THE MARINE AND TERRESTRIAL FOSSIL RECORDS OF NORTH AMERICA

FRIDAY MORNING, NOVEMBER 4, 2011
TECHNICAL SESSION IX
PARIS LAS VEGAS, VENDOME A
MODERATORS: Patrick Druckenmiller, Jack Conrad

8:00 **Druckenmiller, P., Hurum, J., Knutsen, E., Nakrem, H.** AN EXCEPTIONAL NEW ICHTHYOSAUR FROM THE UPPER JURASSIC AGARDHFJELLET FORMATION (VOLGIAN), SVALBARD, NORWAY

8:15 **Beardmore, S., Orr, P., Furrer, H.** DEATH, DECAY AND DISARTICULATION: RECONSTRUCTING TAPHONOMIC HISTORIES OF TRIASSIC MARINE REPTILES FROM MONTE SAN GIORGIO, SWITZERLAND

8:30 **Jiang, L., Motani, R., Chen, G., Jiang, D., Tintori, A.** THE EMERGENCE OF MARINE REPTILES DURING THE TRIASSIC RECOVERY—RECORDS FROM THE LOWER TRIASSIC OF CHAOHU, CHINA

8:45 **Neenan, J., Scheyer, T.** THE BRAINCASE OF *PLACODUS GIGAS* AGASSIZ, 1833 (SAUROPTERYGIA: PLACODONTIA) - A NEW RECONSTRUCTION BASED ON μ CT SCANNING

9:00 **O'Keefe, F., Chiappe, L.** VIVIPARITY AND CETACEAN-LIKE LIFE HISTORY IN A MESOZOIC MARINE PLESIOSAUR (REPTILIA: SAUROPTERYGIA)

FRIDAY MORNING, NOVEMBER 4, 2011
TECHNICAL SESSION IX (continued)

9:15 **Conrad, J.** RE-EXAMINATION SHOWS THAT *SINEOAMPHISBAENA HEXATABULARIS* IS A MICRO-TEIID (GYMNOPHTHALMIDAE, SQUAMATA), NOT AN ABERRANT AMPHISBAENIAN OR MACRO-TEIID

9:30 **Hipsley, C., Müller, J.** CRANIAL OSTEOLOGY OF THE EOCENE AMPHISBAENIAN *SPATHORHYNCHUS FOSSORIUM* AS REVEALED BY X-RAY COMPUTED TOMOGRAPHY

9:45 **Stocker, M., Kirk, E.** DISCERNING THE DIVERSITY AND BIOGEOGRAPHIC HISTORY OF AMPHISBAENIANS (SQUAMATA) IN THE LATE UINTAN (MIDDLE EOCENE) BASED ON THE FIRST SPECIMENS FROM WEST TEXAS

10:15 **Jones, M., Hipsley, C., Anderson, C., Schoch, R., Hipsley, C.** THE FIRST RECORD OF MIDDLE TRIASSIC LEPIDOSAURS

10:30 **Curtis, N., Jones, M., O'Higgins, P., Fagan, M., Evans, S.** DYNAMIC ANALYSIS OF THE SPECIALISED JAW MOVEMENTS IN *SPHENODON* AND RELATED CHARACTER ACQUISITION IN FOSSIL RHYNCHOCEPHALIA (DIAPSIDA: LEPIDOSAURIA)

10:45 **Evans, S., Wang, Y.** THE EARLY CRETACEOUS LIZARD *YABEINOSAURUS*: INSIGHTS FROM NEW SPECIMENS

11:00 **Edwards, N., Barden, H., Manning, P., Bergmann, U., Wogelius, R.** SYNCHROTRON RAPID SCANNING X-RAY FLUORESCENCE OF SOFT-TISSUE PRESERVED IN FOSSILS

11:15 **Head, J., Bloch, J., Rincon, A., Bourque, J., Jaramillo, C.** AN ENIGMATIC DERIVED SNAKE FROM THE EARLIEST EOCENE OF EQUATORIAL SOUTH AMERICA

11:30 **Williams, M.** FOSSIL SNAKES AND CLIMATE CHANGE: CORRELATING THE NEOGENE COLUBRID SNAKE RADIATION TO GLOBAL CLIMATIC CHANGES

11:45 **Danilov, I., Hirayama, R., Sukhanov, V., Watabe, M., Suzuki, S.** CRETACEOUS SOFT-SHELLED TURTLES (TRIONYCHIDAE) OF MONGOLIA: NEW DATA AND A REVISION

12:00 **Ehret, D., Bourque, J., Hulbert, Jr., R.** GIANT BOX TURTLES (TESTUDINES: EMYDIDAE) OF THE *TERRAPENE PUTNAMI* COMPLEX FROM THE LATE BLANCAN (EARLY PLEISTOCENE) OF FLORIDA

FRIDAY MORNING, NOVEMBER 4, 2011
TECHNICAL SESSION X
PARIS LAS VEGAS, VENDOME B
MODERATORS: Richard Kay, Stephen Chester

8:00 **Habersetzer, J., Rabenstein, R.** STUDIES IN TAPHONOMY OF EXTANT AND MESSEL BATS

8:15 **Padian, K., Dial, K.** PHYLOGENETIC DISTRIBUTION OF ECOLOGICAL TRAITS IN THE ORIGIN AND EARLY EVOLUTION OF BATS

8:30 **Manz, C., Bloch, J.** EVIDENCE FOR SCANSORIALITY IN THE FORELIMB OF NORTH AMERICAN PALEOCENE INSECTIVORES (MAMMALIA, EULIPOTYPHLA)

8:45 **Yapuncich, G., Boyer, D., Secord, R., Bloch, J.** THE FIRST DENTALLY ASSOCIATED SKELETON OF PLAGIOMENIDAE (MAMMALIA, DERMOPTERA) FROM THE LATE PALEOCENE OF WYOMING

9:00 **Chester, S., Bloch, J., Sargis, E., Silcox, M., Williamson, T.** ARBOREALITY IN PALAECHTHONID PLESIADAPIFORMS (MAMMALIA, PRIMATES): NEW EVIDENCE FROM A PARTIAL SKELETON OF EARLY PALEOCENE *TORREJONIA WILSONI*

9:15 **Secord, R., Bloch, J., Chester, S., Boyer, D., Krigbaum, J.** FOREST STRUCTURE, CLIMATE, AND TIMING OF MAMMALIAN IMMIGRATIONS DURING THE PALEOCENE-EOCENE THERMAL MAXIMUM IN NORTH AMERICA

9:30 **Jones, K., Rose, K.** PREMOLAR EVOLUTION IN THE EARLIEST EUPRIMATES OF WYOMING

FRIDAY MORNING, NOVEMBER 4, 2011
TECHNICAL SESSION X (continued)

9:45 **Maiolino, S., Boyer, D., Lemelin, P., Bloch, J., Groenke, J.** SEMI-ARTICULATED FOOT OF EOCENE NOTHARCTUS: NEW EVIDENCE FOR A GROOMING CLAW IN AN ADAPIFORM PRIMATE FROM NORTH AMERICA

10:15 **Pérez de los Ríos, M., Moyà-Solà, S., Alba, D., Fortuny, J.** COMPUTED-TOMOGRAPHY SCAN ANALYSIS OF THE INTERNAL FACIAL ANATOMY OF THE MIDDLE MIOCENE APE *PIEROLAPITHECUS CATALAUNICUS* (PRIMATES: HOMINIDAE): PHYLOGENETIC IMPLICATIONS

10:30 **Matson, S., Fox, D., Rook, L., Oms, O.** CARBON ISOTOPIC RECORD OF THE RELATIVE ROLES OF BIOTIC AND ABIOTIC FACTORS IN THE LATE MIOCENE EXTINCTION OF *OREOPITHECUS BAMBOLII*, BACCINELLO BASIN, TUSCANY

10:45 **Alba, D., Almécija, S., Moyà-Solà, S., Casanovas-Vilar, I., Méndez, J.** A NEW PARTIAL SKELETON OF THE FOSSIL GREAT APE *HISPANOPITHECUS* (PRIMATES: HOMINIDAE) FROM THE LATE MIOCENE OF CAN FEU (VALLÈS-PENEDÈS, BASIN, NE IBERIAN PENINSULA)

11:00 **Cooke, S.** A NEW THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC APPROACH FOR DIETARY RECONSTRUCTION IN EXTINCT PLATYRRHINE PRIMATES FROM PATAGONIA, COLOMBIA, AND THE CARIBBEAN

11:15 **Kay, R., Allen, K., Gonzales, L., Krueger, K.** DIETARY RECONSTRUCTION OF *ANTILLOTHRIX BERNENSIS*, A HOLOCENE MONKEY FROM THE DOMINICAN REPUBLIC

11:30 **Crowley, B., Godfrey, L.** STABLE ISOTOPES EXPLAIN ANACHRONISTIC PLANT DEFENSES IN MADAGASCAR

11:45 **Musiba, C., Matthews, N., Noble, T., Kim, J., Domuez-Rodrigo, M.** HOW MANY INDIVIDUALS LEFT THEIR FOOTPRINTS AT LAETOLI? REINTERPRETATION OF THE TRACKWAYS BASED ON RECENTLY ACQUIRED 3D DATA

12:00 **Bates, K., Bennett, M., Lei, R., Russell, S., Crompton, R.** UNDER PRESSURE: HOW MUCH DO FOOTPRINTS TELL US ABOUT FOOT MOTION AND PRESSURE?

FRIDAY AFTERNOON, NOVEMBER 4, 2011
TECHNICAL SESSION XI
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: P. Martin Sander, Hans-Dieter Sues

1:45 **Falkingham, P., Bates, K., Mannion, P.** EVOLUTIONARY TRENDS IN SAUROPOD BODY PLAN EXPRESSED IN FOSSIL TRACKS AND TRACKWAYS

2:00 **Sereno, P., Ogrodnik, J.** MASS DISTRIBUTION AND FOOTPRINT AREA IN ELEPHANTS: FUNCTIONAL RAMIFICATIONS FOR LARGE-BODIED EXTANT AND EXTINCT TERRESTRIAL VERTEBRATES

2:15 **Dumont, M., Borbely, A., Kostka, A., Sander, M., Kaysser-Pyzalla, A.** CRYSTALLOGRAPHIC INVESTIGATIONS OF A GROWTH SERIES OF *APATOSAURUS* LONG BONES: IMPLICATIONS FOR BIOMECHANICS

2:30 **Waskow, K., Sander, P.** THE AGE OF GIANTS — HISTOLOGICAL EVIDENCE FOR ONTOGENY IN POST CRANIAL ELEMENTS OF SAUROPODS AND ITS IMPLICATIONS FOR GROWTH HISTORY

2:45 **Sander, P., Oliver, W., Griebeler, E., Fowler, D., Henderson, D.** HIGH MAXIMUM GROWTH RATE IN CF. *MAMENCHISAURUS* ARGUES AGAINST LOW BASAL METABOLIC RATE AS THE EXPLANATION FOR SAUROPOD DINOSAUR GIGANTISM

3:00 **Boehmer, C., Rauhut, O., Woerheide, G.** COMPARATIVE SHAPE ANALYSIS OF THE NECK IN EXTINCT AND EXTANT ARCHOSAURS: IMPLICATIONS FOR VERTEBRAL EVOLUTION IN SAUROPOMORPH DINOSAURS

FRIDAY AFTERNOON, NOVEMBER 4, 2011
TECHNICAL SESSION XI (continued)

3:15 **Gee, C.** SAUROPOD HERBIVORY DURING LATE JURASSIC TIMES: NEW EVIDENCE FOR CONIFER-DOMINATED VEGETATION IN THE MORRISON FORMATION IN THE WESTERN INTERIOR OF NORTH AMERICA

3:30 **D'Emic, M.** EARLY EVOLUTION OF TITANOSAURIFORM SAUROPOD DINOSAURS: TAXONOMIC REVISION, PHYLOGENY, AND PALEOBIOGEOGRAPHY

3:45 **Sues, H., Witmer, L., Averianov, A.** TITANOSAURIA (SAUROPODA) FROM THE UPPER CRETACEOUS (TURONIAN) BISSEKTY FORMATION OF UZBEKISTAN

4:00 **Wilson, J., D'Emic, M.** THE VALIDITY AND PALEOBIOGEOGRAPHIC HISTORY OF THE TITANOSAUR SAUROPOD *ALAMOSAURUS SANJUANENSIS* FROM THE LATEST CRETACEOUS OF NORTH AMERICA

FRIDAY AFTERNOON, NOVEMBER 4, 2011
TECHNICAL SESSION XII
PARIS LAS VEGAS, VENDOME A
MODERATORS: Nathan Smith, Michael Habib

1:45 **Dial, K.** FROM EXTANT TO EXTINCT: EMPIRICAL STUDIES OF TRANSITIONAL FORMS AND ALLOMETRIC CORRELATES DELIMIT BOUNDARIES OF FUNCTIONAL CAPACITY

2:00 **Atterholt, J.** PHYLOGENETIC MAPPING OF TRAITS OF THE AVIAN ALTRICIAL-PRECOCIAL SPECTRUM, AND ITS IMPLICATIONS FOR INFERRING EARLY AVIALAN LIFE HISTORY

2:15 **Smith, N.** BODY MASS AND FORAGING ECOLOGY PREDICT EVOLUTIONARY PATTERNS OF SKELETAL PNEUMATICITY IN THE DIVERSE "WATERBIRD" CLADE

2:30 **Bourdon, E., Cracraft, J.** *GASTORNIS* IS A TERROR BIRD: NEW INSIGHTS INTO THE EVOLUTION OF THE CARIAMAE (AVES, NEORNITHES)

2:45 **Ando, T., Fordyce, R.** MORPHOLOGY AND FUNCTION IN *WAIMANU* PENGUINS: EARLY WING-PROPELLED DIVERS

3:00 **Habib, M., Hall, J.** FLIGHT PERFORMANCE OF GIANT PSEUDODONTORN BIRDS

3:15 **Ksepka, D., Thomas, D.** EVIDENCE FOR MULTIPLE CENOZOIC INVASIONS OF AFRICA BY PENGUINS (AVES, SPHENISCIFORMES)

3:30 **Meijer, H., James, H., Sutikna, T., Due, R., Tocheri, M.** THE LIANG BUA AVIFAUNA: FAUNAL COMPOSITION, DIVERSITY, AND EXTINCTION

3:45 **Prassack, K.** A LITTLE BIRD TOLD ME: WETLANDS DOMINATED THE PLIO-PLEISTOCENE LANDSCAPE (LOWERMOST BED II DEPOSITS, ~1.75MA) AT OLDUVAI GORGE, TANZANIA

4:00 **Hargrave, J.** FOSSIL AVIFAUNA OF THE PLEISTOCENE FOSSIL LAKE FORMATION (OREGON): CAN BIRDS BE USED AS A PROXY TO DETERMINE PALEOCLIMATIC CONDITIONS?

FRIDAY AFTERNOON, NOVEMBER 4, 2011
TECHNICAL SESSION XIII
PARIS LAS VEGAS, VENDOME B
MODERATORS: Matthew Mihlbachler, Brian Beatty

1:45 **Simpler, E., Hartstone-Rose, A., Kristen, M., Jonathan, P.** DETERMINING DIET FROM THE CROSS-SECTIONAL SHAPE AND INTERCUSPID NOTCHES OF THE TEETH OF CARNIVORANS FROM RANCHO LA BREA

2:00 **Schultz, J., Martin, T.** STRUCTURE AND FUNCTION OF DRYOLESTID MOLARS (MAMMALIA, CLADOTHERIA)

FRIDAY AFTERNOON, NOVEMBER 4, 2011
TECHNICAL SESSION XIII (continued)

2:15 **Fraser, D.** MODEL SELECTION AND THE PHYLOGENETIC COMPARATIVE METHOD: RUMINANT GRAZERS DO NOT HAVE LARGER MASSETER MUSCLES

2:30 **Gailer, J., Kaiser, T.** QUANTIFYING CHEWING EFFICIENCY OF RUMINANT DENTAL PATTERNS —AN APPROACH USING THREE-DIMENSIONAL METROLOGY SYSTEMS

2:45 **Landwehr, C., Kaiser, T.** THREE-DIMENSONAL QUANTIFICATION OF OCCLUSAL PATTERN IN EXTANT EQUIDS

3:00 **Calandra, I., Schulz, E., Pinnow, M., Krohn, S., Kaiser, T.** FRUIT PROPORTION AND CONSUMPTION OF HARD ITEMS IN THE DIETS OF PRIMATES CORRELATE WITH MICROTEXTURES

3:15 **Mihlbachler, M., Beatty, B.** EFFECTS OF VARIABLE MAGNIFICATION AND IMAGING RESOLUTION ON PALEODIETARY INTERPRETATIONS DERIVED FROM DENTAL MICROWEAR ANALYSIS

3:30 **Hoffman, J., Clementz, M.** THE DISTRIBUTION OF GRIT-INDUCED MICROWEAR FEATURES ACROSS THE OCCLUSAL SURFACES OF ARTIODACTYL MOLARS

3:45 **Boardman, G., Secord, R.** RECONSTRUCTING THE DIETS AND MICROHABITATS OF FOUR LATEST EOCENE - EARLIEST OLIGOCENE PERISSODACTYLS (MAMMALIA) BASED ON STABLE ISOTOPES, DENTAL MESOWEAR, AND DENTAL MICROWEAR TEXTURE

4:00 **Beatty, B., Mihlbachler, M.** DENTAL MESOWEAR AND LONG-TERM PALEODIETARY TRENDS IN HORSES AND OTHER UNGULATES FROM THE EARLY MIOCENE-EARLY HOLOCENE OF FLORIDA

FRIDAY AFTERNOON, NOVEMBER 4, 2011
POSTER SESSION III
PARIS LAS VEGAS, RIVOLI B
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Pearson, M., Benson, R., Upchurch, P., Fröbisch, J., Kammerer, C.** RECONSTRUCTING THE DIVERSITY OF THE EARLIEST TERRESTRIAL HERBIVOROUS TETRAPODS

2 **WITHDRAWN**

3 **Bennett, S.** FIRST EVIDENCE OF A CRANIAL CREST IN THE PTEROSAUR *RHAMPHORHYNCHUS MUENSTERI*

4 **Pereda-Suberbiola, X., Knoll, F., Ruiz-Omeñaca, J., Company, J., Torcida Fernández-Baldor, F.** FIRST CTENOCHASMATOID PTEROSAUR FROM THE EARLY CRETACEOUS OF SPAIN: *PREJANOPTERUS CURVIROSTRA* REVISITED

5 **Carroll, N., Poust, A., Varricchio, D.** A THIRD AZHDARCHID PTEROSAUR FROM THE TWO MEDICINE FORMATION (CAMPANIAN) OF MONTANA

6 **Paulina Carabajal, A., Rauhut, O., Codorniu, L., Pol, D.** NEUROANATOMY OF A PTEROSAUR FROM THE JURASSIC OF PATAGONIA USING COMPUTERIZED TOMOGRAPHY

7 **Burch, S., Sertich, J.** GIANT PTEROSAUR REMAINS FROM THE CAMPANIAN OF THE MORONDAVA BASIN, WESTERN MADAGASCAR

8 **Cunningham, J., Habib, M.** CAPACITY OF THE PTEROSAUR, *ANHANGUERA SANTANAE*, TO LAUNCH FROM WATER

9 **Vila Nova, B., Sayao, J.** USE OF LINEAR MORPHOMETRY TO DEFINE DIAGNOSTIC MORPHOLOGICAL VARIATION IN THE APPENDICULAR SKELETON OF ANHANGUERIDAE AND TAPEJARIDAE PTEROSAURS (PTEROSAURIA, PTERODACTYLOIDEA)

10 **Kawabe, S., Endo, H., Shimokawa, T., Miki, H., Matsuda, S.** ALLOMETRIC MORPHOLOGICAL CHANGES IN THE AVIAN BRAIN

11 **Boyd, C., Ksepka, D.** QUANTIFYING HISTORICAL TRENDS IN THE COMPLETENESS OF THE AVIAN FOSSIL RECORD

12 **Taras, J., Clarke, J., Baier, D.** VARIATION IN THE DELTOPECTORAL CREST IN BIRDS

13 **Chinsamy-Turan, A., Marugán-Lobón, J., Chiappe, L.** LIFE HISTORY OF THE EARLY CRETACEOUS BIRD *CONFUCIUSORNIS*: A HISTOLOGICAL PERSPECTIVE

14 **Li, Z., Zhou, Z., Clarke, J.** A REEVALUATION OF THE RELATIONSHIPS AMONG BASAL ORNITHURINE BIRDS FROM CHINA AND NEW INFORMATION ON THE ANATOMY OF *HONGSHANORNIS LONGICRESTA*

15 **Case, J., Patrick, D., Nezat, C., Clarke, J.** RARE EARTH ELEMENT FINGERPRINTING AND 87SR/86SR RATIOS SUPPORT A LATEST MAASTRICHTIAN AGE FOR ANTARCTICA'S FIRST DISCOVERED CRETACEOUS BIRD, *POLARORNIS GREGORYI*

16 **Naish, D., Dyke, G., Cau, A., Escuillié, F., Godefroit, P.** A GIGANTIC BIRD FROM THE UPPER CRETACEOUS OF CENTRAL ASIA

17 **O'Connor, P., Rogers, R., Groenke, J., Burch, S., Turner, A.** A MULTI-TAXON THEROPOD DINOSAUR ACCUMULATION FROM THE LATE CRETACEOUS OF MADAGASCAR: NEAR-INSTANTANEOUS ENTOMBMENT OF SMALL-BODIED AVIALANS

18 **Lü, J., Xu, L., Zhang, Jia, S., Chang, H.** A NEW GOBIPTERYGID BIRD FROM THE LATE CRETACEOUS CENTRAL CHINA AND ITS BIOGEOGRAPHIC IMPLICATIONS

19 **Lyson, T., Bercovici, A., Chester, S., Sargis, E., Pearson, D.** DINOSAUR EXTINCTION: CLOSING THE "THREE METER GAP"

20 **Hedrick, B., Dodson, P., Manning, P.** DECIPHERING THE DINOSAURIAN BODY PLAN: USING MORPHOMETRICS TO INFER FUNCTIONAL MORPHOLOGY

21 **Davis, M.** COMPLETE CENSUS OF PUBLISHED FOSSIL DINOSAUR INTEGUMENT QUANTIFIES TAPHONOMIC BIAS TOWARDS PREVALENCE OF HADROSAURID SKIN

22 **Boatman, E., Fakra, S., Marcus, M., Schweitzer, M., Goodwin, M.** COMPOSITION OF *TYRANNOSAURUS* AND *BRACHYLOPHOSAURUS* SOFT TISSUES AT HIGH SPATIAL RESOLUTION: NEW INSIGHTS INTO PROTEIN DIAGENESIS

23 **Iijima, M., Sato, T., Watabe, M., Tsogtbaatar, K., Ariunchimeg, Y.** BONE BED OF BABY OVIRAPTOROSAUR AND HADROSAUROID DINOSAURS FROM THE BAYANSHIREE FORMATION (LATE CRETACEOUS) IN SOUTHEASTERN MONGOLIA

24 **Hall, L., Goodwin, M.** A DIVERSE DINOSAUR TOOTH ASSEMBLAGE FROM THE UPPER JURASSIC OF ETHIOPIA: IMPLICATIONS FOR GONDWANAN DINOSAUR BIOGEOGRAPHY

25 **Birthisel, T., Milner, A., Hurlbut, M.** THE REINTERPRETATION OF AN EARLY JURASSIC DINOSAUR TRACKSITE IN WARNER VALLEY, WASHINGTON COUNTY, UTAH

26 **Zhang, S., Zhao, Z., Xu, X.** A LARGE CLUTCH OF DINOSAUR EGGS SHOWING UNEXPECTED VARIABILITY FROM YUN COUNTY, HUBEI PROVINCE, CHINA

27 **Croghan, J., Barta, D., Brundridge, K., Drost, J.** EGGSHELL THICKNESS VARIATION IN CHINESE EGGS

28 **Oser, S., Jackson, F.** EGGSHELL ABRASION: AN EXPERIMENT TO CHARACTERIZE THE RESULT OF SEDIMENT INTERACTION ON FRAGMENTARY FOSSIL AND MODERN EGGSHELL

29 **Drost, J., Bury, C., Jackson, F., Varricchio, D., Jin, X.** DIAGENETIC ALTERATION AND COLORATION BANDING IN SPHEROOLITHID EGGS FROM THE TIANTAI BASIN, CHINA

FRIDAY AFTERNOON, NOVEMBER 4, 2011
POSTER SESSION III (continued)

30 **Brundridge, K., Barta, D., Jackson, F., Varricchio, D., Jin, X.** FOSSIL EGGS FROM ZHEJIANG PROVINCE, CHINA: EVIDENCE OF A REDUCING ENVIRONMENT FACILITATED BY ORGANIC DECOMPOSITION

31 **Barta, D., Brundridge, K., Jackson, F., Varricchio, D., Jin, X.** SPHEROOLITHID EGGS FROM THE CRETACEOUS TIANTAI BASIN, ZHEJIANG PROVINCE, CHINA

32 **Cadena, E., Bourque, J., Rincon, A., Bloch, J., Jaramillo, C.** CENOZOIC FOSSIL TURTLES FROM THE PANAMA CANAL BASIN

33 **Luján, À., Alba, D., Delfino, M., Fortuny, J., Carmona, R.** CRANIAL REMAINS OF *CHEIROGASTER* (TESTUDINES: TESTUDINIDAE) FROM THE LATE MIOCENE OF ECOPARC DE CAN MATA (VALLÈS-PENEDÈS BASIN, NE IBERIAN PENINSULA): TAXONOMIC AND PHYLOGENETIC IMPLICATIONS

34 **Hirayama, R., Sonoda, T., Kato, T., Takahashi, A.** OLIGOCENE PIG-NOSED TURTLES (CARETTOCHELYIDAE: TESTUDINES) FROM WESTERN JAPAN

35 **Morris, Z., Ferrer, E.** ONTOGENETIC VARIATION IN EPIPLASTRAL SHAPE AMONG EOCENE TESTUDINOID TURTLES (*ECHMATEMYS*) OF WESTERN NORTH AMERICA

36 **Cherney, M., Gingerich, P., Wilson, J., Zalmout, I., Antar, M.** NEW SPECIMENS OF *CORDICHELYS* (PLEURODIRA, PODOCNEMIDIDAE) FROM LATE EOCENE MARINE STRATA OF FAYUM, EGYPT, AND A REEVALUATION OF *CORDICHELYS ANTIQUA*

37 **Burroughs, R.** NEW FOSSIL BOX TURTLES FROM THE PALEOGENE OF WEST TEXAS: A NEW TAXON WITH CRITICAL INSIGHTS INTO THE EVOLUTIONARY HISTORY OF BOX TURTLES

38 **Jasinski, S., Lucas, S., Moscato, D.** INVESTIGATION INTO THE TURTLES FROM THE LATE CRETACEOUS TO PALEOCENE IN THE SAN JUAN BASIN, NEW MEXICO

39 **Vitek, N.** GIANT FOSSIL SOFT-SHELLED TURTLES OF NORTH AMERICA

40 **Li, L., Liu, J., Joyce, W., Tong, H.** THE OLDEST MORPHOLOGICALLY MODERN SOFT-SHELLED TURTLE (TESTUDINES, PAN-TRIONYCHIDAE) FROM THE JEHOL BIOTA OF CHINA

41 **Lawver, D., Jackson, F., Horner, J.** TURTLE EGGS AND EMBRYOS IN A CLUTCH FROM THE UPPER CRETACEOUS (CAMPANIAN) JUDITH RIVER FORMATION OF MONTANA

42 **Syromyatnikova, E., Danilov, I., Sukhanov, V.** THE MORPHOLOGY AND PHYLOGENETIC POSITION OF *ADOCUS/ADOCOIDES AMTGAI*, AN ADOCID TURTLE FROM THE LATE CRETACEOUS OF MONGOLIA

43 **Ullmann, P., Lacovara, K.** LARGEST KNOWN SPECIMEN AND FIRST MANDIBLE OF THE CRETACEOUS SIDE-NECKED TURTLE *TAPHROSPHYS SULCATUS* (TESTUDINES: PLEURODIRA)

44 **Early, C., Cadena, E., Ksepka, D.** INFERENCES OF THE PALEOECOLOGY OF THE BASAL PLEURODIRE *NOTOEMYS ZAPATOCAENSIS* BASED ON COMPUTED TOMOGRAPHY IMAGERY

45 **Chapman, S., Joyce, W., Moody, R., Walker, C.** THE SKULL OF THE SOLEMYDID TURTLE *HELOCHELYDRA NOPCSAI* FROM THE EARLY CRETACEOUS OF THE ISLE OF WIGHT, UNITED KINGDOM, AND THE GLOBAL BIOGEOGRAPHY OF SOLEMYDID TURTLES

46 **Pérez-García, A., Ortega, F., Gasulla, J., Ortega, F.** A NEW LARGE CRYPTODIRAN TURTLE FROM THE LOWER CRETACEOUS OF SPAIN

47 **Marinheiro, J., Mateus, O.** OCCURRENCE OF THE MARINE TURTLE *THALASSEMYS* IN THE KIMMERIDGIAN OF OKER, GERMANY

48 **Suarez, C., Kohn, M.** DOES CARBONATE CONTENT OF BIOGENIC APATITE CORRELATE WITH BODY TEMPERATURE?

49 **Sload, E., Heckert, A., Lucas, S., Schneider, V.** THREE DIMENSIONAL DIGITAL MICROSCOPY OF SMALL- AND MICROVERTEBRATE FOSSILS

50 **Evans, T.** A TERRESTRIAL VERTEBRATE TAPHOFACIES MODEL OF A HIGH ENERGY LAKESHORE ENVIRONMENT

51 **Tomiya, S.** QUANTITATIVE INFERENCES ON MICROVERTEBRATE DEATH ASSEMBLAGES BASED ON RIGHT-LEFT DISPARITY OF SKELETAL PRESERVATION

52 **Crofts, S.** FINITE ELEMENT ANALYSIS OF CANONICAL DUROPHAGOUS TEETH

53 **Mitchell, J.** USING PHYLOGENETIC CHARACTERS TO INFER EVOLUTIONARY RATES

54 **Belvedere, M., Baucon, A., Furin, S., Mietto, P., Muttoni, G.** SHARING ICHNOLOGICAL DATA: FROM THE THEORETICAL MODEL TO THE DEVELOPMENT OF ICHNOBASE

55 **Daniel, J.** NOT ALL GHOST LINEAGES ARE REAL: MISPERCEPTIONS OF WHAT TAXA REPRESENT MAY CAUSE ILLUSIONS

56 **Moses, R., Kohn, M.** EXPERIMENTAL BONE DIAGENESIS: DIFFUSION PROFILES AND TIMING OF RARE EARTH AND TRACE ELEMENT UPTAKE

57 **Bezold, S., Kondrashov, P., Lucas, S.** A NEW SPECIES OF HERPETOTHERIINAE (MAMMALIA, MARSUPIALIA) FROM THE TORREJONIAN OF NEW MEXICO

58 **Williamson, T., Peppe, D., Secord, R., Brusatte, S., Weil, A.** A LONG-TERM TERRESTRIAL RECORD OF EARLY PALEOCENE CLIMATE AND ECOSYSTEM CHANGE IN THE SAN JUAN BASIN, NEW MEXICO

59 **DeSantis, L., Beavins Tracy, R., Koontz, C., Roseberry, J., Velasco, M.** MAMMALIAN NICHE CONSERVATION THROUGH DEEP TIME

60 **Christensen, H.** MAMMALIAN COMMUNITY CHANGE IN THE PALEOCENE OF NORTH AMERICA

61 **De Bast, E., Sigé, B., Smith, T.** PRESENCE OF PENTACODONTID MAMMALS IN THE EUROPEAN PALEOCENE

62 **Coster, P., Benammi, M., Mahboubi, M., Tabuce, R., Tabuce, R.** MAGNETIC POLARITY STRATIGRAPHY, BIOSTRATIGRAPHY AND AGE OF THE EARLY MIDDLE CONTINENTAL EOCENE DEPOSITS OF EL KOHOL AND GOUR LAZIB FORMATIONS (ALGERIA)

63 **Voss, M.** VERTEBRAL ANOMALIES IN FOSSIL SEA COWS (MAMMALIA, SIRENIA): DID THEY CAUSE BACKACHES?

64 **Fahlke, J., Bastl, K., Semprebon, G.** DIETARY ADAPTATIONS IN EOCENE ARCHAEOCETE WHALES REVEALED BY MICROWEAR AND MACROWEAR ANALYSIS AND STOMACH CONTENTS

65 **Field, D., Racicot, R., Uhen, M.** A NEW MARINE TETRAPOD ASSEMBLAGE FROM THE EOCENE OF WESTERN SAHARA

66 **Glynn, A., Marcot, J.** ENVIRONMENTAL INFLUENCES ON MAMMALIAN UNGULATE GUILD COMPOSITION IN THE LATE PALEOGENE: A TAXON-FREE APPROACH USING DENTAL MEASUREMENTS

67 **Theodor, J., Seale, B.** PETROSAL MORPHOLOGY OF THE PROTOCERATID CETARTIODACTYL *PROTOCERAS CELER*

68 **Welsh, E.** NEW APPROACHES IN UNDERSTANDING THE SYSTEMATICS OF LEPTAUCHENIINE OREODONTS (ARDIODACTYLA: MERYCOIDODONTIDAE) AND IMPLICATIONS OF A NEW STRATIGRAPHIC OCCURRENCE OF *SESPIA* IN THE HIGH PLAINS

69 **Ruf, I., Czubak, A.** CT ANALYSIS OF THE ETHMOIDAL REGION IN CAINOTHERIIDAE (ARTIODACTYLA, MAMMALIA)

70 **Papazian, J., Dewar, E.** CONCORDANCE OF DIETARY SIGNALS BETWEEN TOOTH CREST LENGTHS AND ENAMEL MICROWEAR OF EOCENE AND OLIGOCENE UNGULATES

71 **O'Brien, H.** ADVANTAGEOUS ARTIODACTYL ANATOMY: ASSESSING THE FUNCTION AND EVOLUTIONARY HISTORY OF THERMOREGULATORY CRANIAL VASCULATURE WITHIN THE RUMINANTIA

72 **Tabrum, A.** BRIDGERIAN MAMMALS FROM THE TYPE LOCALITY OF THE SAGE CREEK FORMATION, SAGE CREEK BASIN, BEAVERHEAD COUNTY, MONTANA

73 **Burger, B.** DIVERSITY, EXTINCTION, AND GAPS: AN OVERVIEW OF THE MAMMALIAN RECORD DURING THE LATE PALEOCENE AND EOCENE IN THE ROCKY MOUNTAIN REGION OF NORTH AMERICA

74 **Zack, S.** THE DECIDUOUS DENTITION OF *DIDYMICTIS* (VIVERRAVIDAE) AND THE FIRST APPEARANCE OF HYAENODONTIDAE

75 **Figueirido, B., Janis, C., Pérez-Claros, J., Palmqvist, P.** MAMMALIAN FAUNAL DYNAMICS IN NORTH AMERICA OVER DEEP TIME

76 **Janis, C., Figueirido, B., Pérez-Claros, J., Palmqvist, P.** MAMMALIAN FAUNAL DYNAMICS OVER DEEP TIME II: COMPARISON BETWEEN CARNIVORES AND HERBIVORES

77 **Spaulding, M.** THE TAXONOMIC POSITION OF *PALAEOGALE* (MAMMALIA: CARNIVORAMORPHA)

78 **Hoffmann, S., Martin, T.** REVISED PHYLOGENY OF PHOLIDOTA: IMPLICATIONS FOR FERAE

79 **Bastl, K., Semprebon, G., Nagel, D.** THE DIETARY PREFERENCE OF *HYAENODON* (HYAENODONTIDAE, MAMMALIA) USING STEREOMICROWEAR WITH NEW INSIGHTS REGARDING ITS ECOMORPHOLOGY

80 **Ahrens, H.** POSTCRANIAL MORPHOLOGY OF *DIPSALIDICTIS TRANSIENS* (MAMMALIA: OXYAENIDAE): FUNCTIONAL INTERPRETATIONS AND TAXONOMIC SIGNIFICANCE

81 **Morse, P., Bloch, J.** PARTIAL HYAENODONTID (MAMMALIA, CREODONTA) SKELETON FROM THE PALEOCENE-EOCENE THERMAL MAXIMUM OF NORTH AMERICA

82 **Sartin, C.** VARIATION IN THE MOLAR MORPHOLOGY OF *DIDELPHIS VIRGINIANA* AND ITS IMPLICATIONS FOR THE FOSSIL RECORD

83 **Burrows, A.** DIET CATEGORIZATION FOR DIDELPHID MARSUPIALS USING TOOTH ENAMEL MICROWEAR

84 **Bennett, C., Goswami, A.** MORPHOLOGICAL CONSTRAINT IN THE METATHERIAN CRANIUM

85 **Bravo-Cuevas, V., Baños-Rodríguez, R., Olvera-Badillo, P.** ECOLOGICAL DIVERSITY OF A LARGE MAMMALIAN COMMUNITY FROM THE LATE PLEISTOCENE OF HIDALGO, CENTRAL MEXICO: A PRELIMINARY APPROACH

86 **Stilson, K., Hopkins, S., Davis, E.** DETECTING AND ACCOUNTING FOR DEPOSITIONAL BIAS IN THE LATE MIOCENE MCKAY RESERVOIR FAUNA

87 **George, C.** COMPARISON OF IDENTIFICATION TECHNIQUES FROM QUATERNARY DEPOSITS USING FOSSIL SHREWS (SORCIDAE: MAMMALIA)

88 **Furió, M., Alba, D., Carmona, R., Rifà, E.** NEW FOSSIL REMAINS OF *LANTANOTHERIUM* (ERINACEIDAE, MAMMALIA) FROM THE VALLESIAN (LATE MIOCENE) OF VILADECAVALLS (NE SPAIN)

89 **Horovitz, I., Scheyer, T., Carlini, A., Aguilera, O., Sánchez-Villagra, M.** NEW ASTRAPOTHERE POSTCRANIAL REMAINS FROM THE LATE MIOCENE OF VENEZUELA

90 **Eastham, L., Feranec, R., Begun, D., Laszlo, K.** RESOURCE PARTITIONING IN LATE MIOCENE CENTRAL EUROPEAN MAMMALS: ISOTOPIC EVIDENCE FROM THE RUDABANYA FAUNA

91 **Miller, W., Delgado de Jesus, R., Gomez Nunez, R., Vallejo Gonzalez, J., Lopez Espinosa, J.** A NEW LATE PLEISTOCENE VERTEBRATE SITE FROM COAHUILA, MEXICO

92 **Peppe, D., Deino, A., Lehmann, T., Dunsworth, H., Harcourt-Smith, W.** NEW AGE CONSTRAINTS FOR THE EARLY MIOCENE FAUNAS OF RUSINGA AND MFANGANO ISLANDS (LAKE VICTORIA, KENYA)

93 **Soibelzon, E., Santiago, R., Avilla, L., Soibelzon, L., Zurita, A.** MAMMALS OF THE TARIJA VALLEY (SOUTHERN BOLIVIA): DIVERSITY, ENDEMISM AND THE PROBLEM WITH ITS ANTIQUITY

94 **Milideo, L., Graham, R., Falk, C., Semken, H.** EFFECTS OF GEOGRAPHIC AREA AND SAMPLE SIZE ON TAPHONOMIC OVERPRINTING

95 **Murray, L., Jefferson, G.** THE PROBLEM OF FAUNAL LISTS

96 **Bridges, T., Evans, T., Novak, B., Varricchio, D.** THE EFFECTS OF VARIOUS ENVIRONMENTS AND SEDIMENTS ON THE DECAY OF SOFT TISSUE WITHIN *ODOCOILEUS VIRGINIANUS PHALANGES*

97 **Gill, F.** FAECAL LIPID BIOMARKERS FROM MODERN AND ANCIENT HERBIVORES

98 **Nachman, B., Milleson, M., Kappelman, J., Tabor, N., Todd, L.** ISOTOPIC INDICATORS OF SEASONALITY IN THE LATE PLEISTOCENE OF NORTHWEST ETHIOPIA

99 **Domingo, L., Koch, P., Grimes, S., Morales, J., López-Martínez, N.** THE ISOTOPIC ECOLOGY OF MIDDLE MIOCENE HERBIVORES FROM THE MADRID BASIN (SPAIN)

100 **Ditchfield, P., Vaughan, A., Bishop, L., Kingston, J., Plummer, T.** ENVIRONMENTAL RECORDS OF BED I, OLDUVAI, TANZANIA FROM STABLE ISOTOPES OF MAMMALIAN TOOTH ENAMEL

101 **Steininger, C.** ECOLOGICAL PROFILE FOR SOUTH AFRICA AND EAST AFRICAN EARLY HOMININ FOSSIL SITES USING STABLE CARBON ISOTOPES FROM FOSSIL BOVID DENTITION

102 **Yann, L., Haupt, R., DeSantis, L., Romer, J., Corapi, S.** MAMMALIAN OXYGEN ISOTOPE VALUES AS AN INDICATOR OF REGIONAL CLIMATIC DIFFERENCES IN THE PLEISTOCENE NORTH AMERICA

103 **Bibi, F., Boisserie, J., White, T.** PALEOENVIRONMENTAL CHANGE IN EASTERN AFRICA THROUGH THE FOSSIL RECORD OF BOVIDAE

104 **Winkler, D., Kaiser, T., Schulz, E.** NO GRASS TODAY: DIETARY RECONSTRUCTION AND DENTAL EVOLUTION OF THE BALEARIC CAVE GOAT *MYOTRAGUS* (PLIO-HOLOCENE, SPAIN)

105 **Carr, J., Pagnac, D.** WHY THE LONG FACE? DENTAL MICROWEAR COMPARISON OF *LONGIROSTROMERYX* AND *BLASTOMERYX* (ARTIODACTYLA, MOSCHIDAE)

106 **Goble, E.** SKELETAL ELEMENT AND BOVID ABUNDANCE ANALYSES IN PALEOENVIRONMENTAL RECONSTRUCTION OF THE CHEMERON FORMATION, TUGEN HILLS, KENYA

107 **Rowland, S., Hardy, F., McLaurin, B.** THE WILKIN-QUARRY RANCHOLABREAN BIOTA OF LINCOLN COUNTY, NEVADA

108 **Tsubamoto, T., Htike, T., Maung-Thein, Z., Egi, N., Takai, M.** THE ANTHRACOTHERES (MAMMALIA, ARTIODACTYLA) FROM THE NEOGENE OF CENTRAL MYANMAR

109 **Miller, E., Gunnell, G., Clementz, M., Abdel Gawad, M., Hamdan, M.** NEW ANTHRACOTHERES (ARTIODACTYLA) FROM WADI MOGHRA, EGYPT, AND THEIR BEARING ON HIPPOPOTAMUS PHYLOGENY

110 **Rincon, A., Bloch, J., MacFadden, B., Jaramillo, C.** FIRST OCURRENCE OF ANTHRACOTHERES (ARTIODACTYLA, ANTHRACOTHERIIDAE) FROM THE EARLY MIOCENE OF CENTRAL AMERICA

111 **Prothero, D., Pollen, A.** A NEW SPECIES OF THE PECCARY *MACROGENIS* FROM THE LATE CLARENDONIAN (LATE MIOCENE) BLACK HAWK RANCH LOCALITY, CONTRA COSTA COUNTY, CALIFORNIA

112 **Grenader, J., Prothero, D.** A NEW, PRIMITIVE SPECIES OF THE FLAT-HEADED PECCARY *PLATYGONUS* FROM THE LATE HEMPHILLIAN (LATEST MIOCENE) OF KANSAS, NEBRASKA, AND TEXAS

113 **Hou, S., Deng, T.** THE SYSTEMATIC POSITION OF *CHLEUASTOCHOERUS*

114 **McHorse, B., Hopkins, S., Davis, E.** TAXONOMY, PALEOECOLOGY, AND FUNCTIONAL MORPHOLOGY OF MIOCENE CAMELIDS IN THE JUNTURA FORMATION

115 **Curran, S.** A VERY COMPLETE *DORCATHERIUM PIGOTTI* (TRAGULIDAE, MAMMALIA) SKELETON FROM RUSINGA ISLAND, KENYA: IMPLICATIONS FOR FUNCTIONAL MORPHOLOGY

FRIDAY AFTERNOON, NOVEMBER 4, 2011
POSTER SESSION III (continued)

116 **Kottachchi, N., Ibarra, Y., Dundas, R.** *CAMELOPS* FROM THE MIDDLE PLEISTOCENE (MIDDLE IRVINGTONIAN) FAIRMEAD LANDFILL LOCALITY, MADERA COUNTY, CALIFORNIA

117 **Bredehoeft, K.** MORPHOMETRICS OF THE MOOSE TRIBE, ALCEINI: *CERVALCES* VS. *ALCES*

118 **Grossman, A., Solounias, N.** NEW GIRAFFID FOSSILS FROM KALODIRR (WEST TURKANA, KENYA): IMPLICATIONS FOR OUR UNDERSTANDING OF THE DIVERSITY OF EARLY GIRAFFIDAE

119 **Vietti, L., Bailey, J., Flood, B.** EARLY FRAMBOIDAL PYRITE FROM A SIMULATED WHALE FALL: NEW INSIGHTS INTO MARINE TETRAPOD BONE DIAGENESIS

120 **Varadian, E., Beatty, B., Geisler, J.** 3D MORPHOMETRIC ANALYSIS OF INTERSPECIFIC VARIATION IN ODONTOCETE PETROSALS

121 **Dooley, Jr., A.** CHARACTERISTICS OF THE CARMEL CHURCH BONEBED, A MARINE VERTEBRATE DEPOSIT FROM THE MIOCENE OF VIRGINIA

122 **El Adli, J., Boessenecker, R.** THE MUSCULATURE OF THE TEMPOROMANDIBULAR REGION IN THE MIO-PLIOCENE BALEEN GENUS *HERPETOCETUS* AND ITS INFERRENCE FOR FEEDING STRATEGY

123 **Racicot, R., Field, D., Vinther, J., Behlke, A., Gauthier, J.** THE FIRST MAJOR VERTEBRATE FOSSIL FROM THE PLIOCENE OF ICELAND: AN ODONTOCETE (CETACEA: ODONTOCETI) FROM THE TJÖRNES FORMATION

SATURDAY MORNING, NOVEMBER 5, 2011
TECHNICAL SESSION XIV
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: Max Langer, Jonah Choiniere

8:00 **Langer, M., Cabreira, S., Bittencourt, J., Silva, L., Schultz, C.** A NEW EUSAURISCHIAN FROM THE SANTA MARIA FORMATION, LATE TRIASSIC OF BRAZIL, HIGHLIGHTS MOSAIC PATTERN OF CHARACTER EVOLUTION DURING THE RISE OF DINOSAURS

8:15 **Cutler, A., Britt, B., Scheetz, R., Cotton, J.** THE OPISTHOTONIC DEATH POSE AS A FUNCTION OF MUSCLE TONE AND AQUEOUS IMMERSION

8:30 **Souter, T., Abourachid, A., Baylac, M., Cornette, R., Hutchinson, J.** FUNCTIONAL 3D KINEMATICS AND SURFACE MORPHOMETRICS OF THEROPOD HIP-JOINT

8:45 **Du, T., Larsson, H.** THEROPODS IN MORPHOSPACE: A GEOMETRIC MORPHOMETRIC APPROACH TO VARIATION AND DIVERSITY IN THEROPOD CRANIOFACIAL MORPHOLOGY

9:00 **Zelenitsky, D., Therrien, F., Ridgely, R., McGee, A., Witmer, L.** IMPORTANCE OF OLFACTION DURING THEROPOD EVOLUTION

9:15 **Bourke, J., Witmer, L.** COMPUTER MODELING OF NASAL AIRFLOW IN TWO EXTANT AVIAN DINOSAURS (TURKEY AND OSTRICH), WITH IMPLICATIONS FOR MODELING AIRFLOW IN EXTINCT THEROPODS

9:30 **Lee, A., O'Connor, P.** VARIATION IN BONE HISTOLOGY AND GROWTH OF THE NOASAURID THEROPOD *MASIAKASAURUS KNOPFLERI*

9:45 **Zanno, L., Makovicky, P.** BODY MASS EVOLUTION IN OMNIVOROUS/HERBIVOROUS COELUROSAURIAN DINOSAURS

10:15 **Miyashita, T.** CRANIAL MORPHOLOGY OF THE BASAL TYRANNOSAUROID *ITEMIRUS MEDULLARIS* AND EVOLUTION OF THE BRAINCASE PNEUMATICITY IN NON-AVIAN COELUROSAURS

10:30 **Carr, T.** A COMPARATIVE STUDY OF ONTOGENY BETWEEN DERIVED TYRANNOSAUROIDS: EVIDENCE FOR HETEROCHRONY

SATURDAY MORNING, NOVEMBER 5, 2011
TECHNICAL SESSION XIV (continued)

10:45 **Goodwin, M., Stanton, K., Stanton, K., Horner, J., Carlson, S.** OXYGEN ISOTOPIC VARIABILITY AND PRESERVATION IN TYRANNOSAURUS REX, MODERN RATITES AND CROCODYLIANS: REVISITING THE THERMOPHYSIOLOGY OF T. REX USING $\delta^{18}O$

11:00 **Allain, R., Vullo, R., Leprince, A., Néraudeau, D., Tournepiche, J.** AN ORNITHOMIMOSAUR-DOMINATED BONEBED FROM THE EARLY CRETACEOUS OF SOUTHWESTERN FRANCE

11:15 **Choiniere, J., Norell, M., Dyke, G.** THE ANATOMY OF THE PARVICURSORINE BRAINCASE AND ITS IMPLICATIONS FOR ALVAREZSAUROID SYSTEMATICS AND EVOLUTION

11:30 **Xu, X., Sullivan, C., Zhang, F., O'Connor, J.** A NEW EUMANIRAPTORAN PHYLOGENY AND ITS IMPLICATIONS FOR AVIALAN ORIGINS

11:45 **Lamanna, M., Sues, H., Schachner, E., Lyson, T.** A NEW CAENAGNATHID OVIRAPTOROSAUR (THEROPODA: MANIRAPTORA) FROM THE UPPER CRETACEOUS (MAASTRICHTIAN) HELL CREEK FORMATION OF THE WESTERN UNITED STATES

12:00 **Müeller, J., Bussert, R., David, E., Klein, N., Salih, K.** NEW DISCOVERIES AND INVESTIGATIONS ON THE LATE CRETACEOUS VERTEBRATE FAUNA OF NORTHERN SUDAN

SATURDAY MORNING, NOVEMBER 5, 2011
TECHNICAL SESSION XV
PARIS LAS VEGAS, VENDOME A
MODERATORS: Kenneth Angielczyk, Christian Kammerer

8:00 **Hawthorn, J., Reisz, R.** A NEW SMALL OPHIACODONTID (SYNAPSIDA, EUPELYCOSAURIA) FROM THE LATE PENNSYLVANIAN OF GARNETT, KANSAS

8:15 **Brink, K., Reisz, R., Scott, D.** ONTOGENY AND TAXONOMY OF A NEW SPHENACODONTID SPECIMEN FROM THE EARLY PERMIAN OF TEXAS

8:30 **Sigurdsen, T., Huttenlocker, A., Modesto, S., Rowe, T., Damiani, R.** REASSESSMENT OF THE MORPHOLOGY AND PALEOBIOLOGY OF THE THEROCEPHALIAN *TETRACYNODON DARTI* (THERAPSIDA) BASED ON CT-SCANNING, AND THE PHYLOGENETIC RELATIONSHIPS OF BAURIOIDEA

8:45 **Angielczyk, K., Steyer, J., Sidor, C., Smith, R., Whatley, R.** DICYNODONT (THERAPSIDA, ANOMODONTIA) ASSEMBLAGES FROM THE LUANGWA BASIN, ZAMBIA: TAXONOMIC UPDATE AND IMPLICATIONS FOR BIOSTRATIGRAPHY AND BIOGEOGRAPHY

9:00 **Camp, J., Liu, J.** THE TAXONOMY AND CRANIAL MORPHOLOGY OF CHINESE *LYSTROSAURUS*

9:15 **Smith, R., Botha-Brink, J.** ANATOMY OF AN EXTINCTION: END-PERMIAN DROUGHT INDUCED DIE-OFF IN THE KAROO BASIN, SOUTH AFRICA

9:30 **Kammerer, C.** THE ORIGIN AND EARLY EVOLUTION OF THE GORGONOPSIA

9:45 **Rubidge, B., Day, M., Angielczyk, K., Guven, S.** MIDDLE PERMIAN BIODIVERSITY CHANGES AND THE GUADALUPIAN EXTINCTION ON LAND; UNRAVELING EVIDENCE FROM THE BEAUFORT GROUP, SOUTH AFRICA

10:15 **Jasinoski, S., Chinsamy, A.** MICROSTRUCTURAL ANALYSIS AND GROWTH OF THE *TRITYLODON* MANDIBLE

10:30 **Luo, Z.** NEGATIVE ALLOMETRY IN ONTOGENY AND EVOLUTION OF MAMMALIAN MIDDLE EAR IN MESOZOIC MAMMALS

10:45 **Rowe, T., Macrini, T., Luo, Z.** OLDEST FOSSIL EVIDENCE ON ORIGIN OF THE MAMMALIAN BRAIN

11:00 **Martin, T., Averianov, A., Lopatin, A.** MIDDLE JURASSIC MAMMALS FROM THE ITAT FORMATION AT BEREZOVSK QUARRY IN WESTERN SIBERIA (RUSSIA)

SATURDAY, NOVEMBER 5, 2011
TECHNICAL SESSION XV (continued)

11:15 **Rougier, G., Gaetano, L., Makovicky, P.** AN ENIGMATIC LARGE-SIZED PARTIAL SKELETON OF AN EUCYNODONT FROM THE ANTLERS FORMATION, TRINITY GROUP, EARLY CRETACEOUS OF TEXAS

11:30 **Corfe, I., Smith, A., Häkkinen, T., Gill, P., Jernvall, J.** THE DEVELOPMENTAL BASIS OF 200 MILLION YEAR OLD MAMMAL TEETH

11:45 **Evans, A., Proctor, K.** THE INHIBITORY CASCADE IN MARSUPIALS

12:00 **Buchholtz, E., Yang, J., Bailin, H., Laves, S., Drozd, L.** LOCALIZATION OF THE DIAPHRAGM AND AXIAL PATTERNING IN MAMMALS

SATURDAY MORNING, NOVEMBER 5, 2011
TECHNICAL SESSION XVI
PARIS LAS VEGAS, VENDOME B
MODERATORS: Catherine Boisvert, Katharine Criswell

8:00 **Gai, Z., Donoghue, P., Janvier, P.** THE TRUE TRABECULAE CRANII IN STEM-GNATHOSTOME GALEASPIDS (AGNATHA)

8:15 **Scott, B., Wilson, M.** NEW OSTEOSTRACAN TAXA FROM THE LOWER DEVONIAN (LOCHKOVIAN) MAN ON THE HILL LOCALITY IN CANADA, INCLUDING A NEW NON-CORNUATE OSTEOSTRACAN

8:30 **Zhu, M., Yu, X., Qu, Q.** NEW CHARACTER DIAGNOSIS YIELDS NOVEL PERSPECTIVES ON THE INTERRELATIONSHIPS OF MAJOR GNATHOSTOME GROUPS

8:45 **Brazeau, M., Friedman, M.** THREE-DIMENSIONAL GILL ARCH STRUCTURE IN A STEM GNATHOSTOME REVEALED BY SYNCHROTON TOMOGRAPHY

9:00 **Anderson, P., Friedman, M., Brazeau, M., Rayfield, E.** THE INITIAL RADIATION OF JAWS: FUNCTIONAL STABILITY IN THE FACE OF FAUNAL AND ENVIRONMENTAL CHANGE

9:15 **Boisvert, C., Trinajstic, K., Currie, P.** INSIGHTS ON THE EVOLUTION OF THE PELVIC GIRDLE OF EARLY GNATHOSTOMES FROM THE DEVELOPMENT OF THE ELEPHANT SHARK (*CALLORHINCHUS MILII*) AND PRESERVED SOFT TISSUE IN DEVONIAN PLACODERMS

9:30 **Finarelli, J., Coates, M.** RE-DESCRIPTION OF THE SKELETAL ANATOMY OF *CHONDRENCHLYES PROBLEMATICA* AND ANCESTRAL CONDITIONS IN THE HOLOCEPHALI

9:45 **Choo, B.** A TALE OF TWO *"MIMIA"*S. A NEW BASAL ACTINOPTERYGIAN FROM THE LATE DEVONIAN GOGO FORMATION, WESTERN AUSTRALIA

10:15 **Sallan, L.** WHEN IS AN EEL NOT AN EEL? AXIAL REGIONALIZATION AND SPECIALIZATION IN AN EARLY ACTINOPTERYGIAN FISH, *TARRASIUS PROBLEMATICUS*

10:30 **Khalloufi, B., Grand, A., Zarageta i Bagils, R.** INFERRING AGE AND BIOGEOGRAPHIC RELATIONSHIPS FROM A VERTEBRATE FOSSIL ASSEMBLAGE: NEW METHODOLOGIES FOR JBEL TSELFAT (UPPER CRETACEOUS, MOROCCO)

10:45 **Kriwet, J.** ORIGIN AND DIVERSIFICATION OF CODS AND ALLIES (TELEOSTEI, GADIFORMES)

11:00 **Dutel, H., Maisey, J., Schwimmer, D., Janvier, P., Clément, G.** THE GIANT COELACANTH *MEGALOCOELACANTHUS DOBIEI* FROM THE UPPER CRETACEOUS OF NORTH AMERICA AND ITS BEARINGS ON THE PHYLOGENY OF MESOZOIC COELACANTHS

11:15 **Criswell, K.** THE PHYLOGENETIC RELATIONSHIPS AND EVOLUTIONARY HISTORY OF LEPIDOSIRENID LUNGFISHES: A TOTAL-EVIDENCE APPROACH

11:30 **Qiao, T., Lu, J., Zhu, M., John, A.** CRANIAL ANATOMY OF A PRIMITIVE OSTEICHTHYAN *PSAROLEPIS* BASED ON HIGH-RESOLUTION COMPUTED TOMOGRAPHY

SATURDAY MORNING, NOVEMBER 5, 2011
TECHNICAL SESSION XVI (continued)

11:45 **Lemberg, J., Taft, N., Daeschler, T., Shubin, N.** VASCULARIZATION AND DORSOVENTRAL ASYMMETRIES IN THE PECTORAL FIN OF *TIKTAALIK ROSEAE* SHED LIGHT ON THE FIN TO LIMB TRANSITION

12:00 **Liu, J., Wilson, M., Chang, M., Murray, A.** THE EARLY DIVERSITY OF NON-CYPRINID CYPRINIFORMS (OSTARIOPHYSI, CYPRINIFORMES) IN THE EOCENE OF EAST ASIA AND NORTH AMERICA

SATURDAY AFTERNOON, NOVEMBER 5, 2011
TECHNICAL SESSION XVII
PARIS LAS VEGAS, CONCORDE A/B
MODERATORS: Aaron Wood, Julien Louys

1:45 **Ross, D., Marcot, J.** RATES AND PATTERNS OF NORTH AMERICAN CAMELID LIMB EVOLUTION IN THE CONTEXT OF CENOZOIC ENVIRONMENTAL CHANGE

2:00 **Bormet, A.** ENVIRONMENTAL INFLUENCES ON THE EVOLUTION AND GEOGRAPHIC DISTRIBUTION OF CAMELIDAE (ARTIODACTYLA, MAMMALIA)

2:15 **Levering, D., Hopkins, S., Davis, E.** DECREASING LIMB INERTIA AMONG NORTH AMERICAN UNGULATES ACROSS THE PALEOGENE NEOGENE BOUNDARY

2:30 **Rössner, G., Mörs, T., Mayda, S., Göhlich, U., Sánchez, I.** EXTENDING KNOWLEDGE ON THE EVOLUTIONARY HISTORY OF TRAGULIDAE (MAMMALIA, CETARTIODACTYLA) — NEW DISCOVERIES FROM EUROPE AND AFRICA

2:45 **Souron, A.** SYSTEMATICS OF EXTANT AND EXTINCT AFRICAN SUIDAE INFERRED FROM LANDMARK-BASED GEOMETRIC MORPHOMETRIC ANALYSIS OF CRANIO-MANDIBULAR SHAPE

3:00 **Louys, J., Montanari, S., Plummer, T., Hertel, F., Bishop, L.** DIVERGENT TOES: EVOLUTION OF AFRICAN ANTELOPE PROXIMAL PHALANGES AND IMPLICATIONS FOR DIVERGENCE OF SHAPE AND SIZE

3:15 **Wood, A.** REGIONAL DIFFERENCES IN TARSAL MORPHOTYPES AMONG LATE MIOCENE-PLIOCENE EQUIDS: A 3D GEOMETRIC MORPHOMETRIC STUDY

3:30 **Mkrtchyan, R., Belmaker, M., Hynek, S., Belyaeva, E., Aslanian, S.** *STEPHANORHINUS* CF. *HUNDSHEIMENSIS* FROM KURTAN, A NEW EARLY PLEISTOCENE SITE IN THE LORI PLATEAU, ARMENIA: IMPLICATIONS FOR THE BIOGEOGRAPHY OF RHINOCEROTIDAE SEDN AWARD

3:45 **Kapner, D., Mihlbachler, M.** FUNCTIONAL MORPHOLOGY AND EVOLUTION OF LOCKING MECHANISM IN THE SHOULDER OF RHINOCEROTID PERISSODACTYLS

4:00 **Matzke, N., Maguire, K.** INCLUSION OF FOSSIL SPECIES RANGE DATA IN DISPERSAL-EXTINCTION-CLADOGENESIS (DEC) ANALYSES CORRECTS LOW ESTIMATES OF EXTINCTION RATE AND IMPROVES ESTIMATES OF HISTORICAL BIOGEOGRAPHY

SATURDAY AFTERNOON, NOVEMBER 5, 2011
TECHNICAL SESSION XVIII
PARIS LAS VEGAS, VENDOME A
MODERATORS: Casey Holliday, Joseph Sertich

1:45 **Pol, D., Rauhut, O., Lecuona, A., Leardi, J.** A NEW BASAL CROCODYLOMORPH FROM THE LATE JURASSIC OF PATAGONIA AND ITS IMPLICATIONS FOR THE EVOLUTION OF THE CROCODYLIFORM BRAINCASE

2:00 **Holliday, C., Gardner, N.** A NEW EUSUCHIAN CROCODYLIFORM WITH NOVEL CRANIAL INTEGUMENT AND THE ORIGIN OF CROCODYLIA

SATURDAY AFTERNOON, NOVEMBER 5, 2011
TECHNICAL SESSION XVIII (continued)

2:15 **Sertich, J.** NEW REMAINS OF *MIADANASUCHUS OBLITA* FROM THE LATE CRETACEOUS OF MADAGASCAR AND A REEVALUATION OF TREMATOCHAMPSIDAE

2:30 **Hastings, A., Bloch, J., Rincon, A., MacFadden, B., Jaramillo, C.** NEW PRIMITIVE CAIMANINE (CROCODYLIA, ALLIGATORIDAE) FROM THE MIOCENE OF PANAMA

2:45 **Brochu, C., Turner, A., Allen, E., Wilberg, E.** THE MYTH OF THE LIVING FOSSIL: BASAL CROWN GROUP RELATIONSHIPS, REVERSING POLARITIES, AND RESTORATION OF THE ANCESTRAL CROCODYLIAN

3:00 **Wilberg, E.** COMPARATIVE MORPHOMETRICS AND PHYLOGENETIC PERSPECTIVES ON THE MORPHOSPACE OF THE CROCODYLIFORM SKULL

3:15 **Montefeltro, F., Larsson, H.** EVOLUTION OF THE OTIC REGION OF FOSSIL CROCODYLIFORMES

3:30 **Schachner, E., Metzger, R., Farmer, C.** DEVELOPMENT OF THE LUNG IN *ALLIGATOR MISSISSIPPIENSIS* (ARCHOSAURIA: CROCODYLOMORPHA) AND THE EVOLUTION OF THE ARCHOSAURIAN RESPIRATORY SYSTEM

3:45 **Owerkowicz, T., Yang, J., Blank, J., Eme, J., Hicks, J.** MICROSTRUCTURE OF THE FEMORAL GROWTH PLATE IN THE AMERICAN ALLIGATOR: EFFECTS OF GROWTH RATE, LOCOMOTOR ACTIVITY AND CIRCULATORY PATTERN

4:00 **Tsai, H., Holliday, C., Ward, C.** PELVIC ANATOMY OF *ALLIGATOR MISSISSIPPIENSIS* AND ITS SIGNIFICANCE FOR INTERPRETING LIMB FUNCTION IN FOSSIL ARCHOSAURS

SATURDAY AFTERNOON, NOVEMBER 5, 2011
TECHNICAL SESSION XIX
PARIS LAS VEGAS, VENDOME B
MODERATORS: Robert Fordyce, Mark Clementz

1:45 **Uhen, M.** A NEW PROTOCETID WHALE FROM THE MIDDLE EOCENE OF MISSISSIPPI

2:00 **Fordyce, R.** A NEW LATE OLIGOCENE ARCHAIC SQUALODONTID FROM NEW ZEALAND

2:15 **Graf, J., Jacobs, L., Polcyn, M., Mateus, O., Schulp, A.** NEW FOSSIL WHALES FROM ANGOLA

2:30 **Aguirre-Fernández, G., Fordyce, R.** NEW ZEALAND FOSSILS REVEAL EARLY MIOCENE GLOBAL DISTRIBUTION FOR SMALL *KENTRIODON* DOLPHINS

2:45 **Martin, J., Berta, A., Deméré, T.** INTERPRETING THE FOSSIL RECORD OF MYSTICETI (CETACEA) USING NEW METHODOLOGIES IN DIVERGENCE DATING

3:00 **Geisler, J., Martinez, M., Lambert, O., Boessenecker, R.** EVOLUTION OF HIGH-FREQUENCY HEARING IN ODONTOCETES (MAMMALIA: CETACEA)

3:15 **Govender, R., Chinsamy, A.** EARLY PLIOCENE (5MA) SHARK—CETACEAN INTERACTION AT LANGEBAANWEG, WEST COAST, SOUTH AFRICA

3:30 **Hayashi, S., Nakajima, Y., Chiba, K., Sawamura, H., Ando, T.** BONE HISTOLOGY SUGGESTS INCREASING AQUATIC ADAPTATIONS IN DESMOSTYLIA

3:45 **Clementz, M., Sewall, J.** REDUCED MERIDIONAL GRADIENT IN EOCENE SEAWATER TEMPERATURES INFERRED FROM THE STABLE ISOTOPE COMPOSITION OF FOSSIL SIRENIAN TOOTH ENAMEL

4:00 **Motani, R., Montañez, I.** PAST GLOBAL WARMING AND EMERGENCE OF MARINE MAMMALS AND REPTILES

SATURDAY AFTERNOON, NOVEMBER 5, 2011
POSTER SESSION IV

PARIS LAS VEGAS, RIVOLI B

Authors must be present from 4:15 – 6:15 p.m.

Posters must be removed by 6:30 p.m.

1 **Snyder, D.** INTERPRETATIONS OF A FOSSIL TRACKWAY FROM THE ST. LOUIS LIMESTONE

2 **Martens, T., Berman, D., Henrici, A., Sumida, S.** PALEOGEOGRAFICAL AND PALEONTOLOGICAL CHARACTERISTICS OF THE LOWER PERMIAN REDBEDS OF NORTH-CENTRAL TEXAS AND THE BROMACKER QUARRY IN THE LOWER PERMIAN TAMBACH FORMATION IN CENTRAL GERMANY

3 **Whatley, R., Behrensmeyer, A., Amaral, W., Parker, W., Domeischel, J.** FIRST LATE TRIASSIC VERTEBRATE LOCALITIES IN THE OWL ROCK MEMBER, UPPER CHINLE FORMATION, PETRIFIED FOREST NATIONAL PARK, AZ

4 **Heckert, A., Mitchell, J., Schneider, V., Olsen, P., Sload, E.** MICROVERTEBRATES DRAMATICALLY INCREASE THE DIVERSITY OF THE CUMNOCK FORMATION (NEWARK SUPERGROUP: CHATHAM GROUP) IN THE SANFORD SUB-BASIN, NORTH CAROLINA

5 **Behrensmeyer, A., Whatley, R., Parker, W., McIntire, S.** TAPHONOMIC INFORMATION FROM LABORATORY EXCAVATION OF A NEW MICROVERTEBRATE LOCALITY IN THE OWL ROCK MEMBER OF THE CHINLE FORMATION, PETRIFIED FOREST NATIONAL PARK, ARIZONA

6 **Milner, A., Irmis, R., Jeffrey, M., Birthisel, T., Lockley, M.** NEW INFORMATION ON LATE TRIASSIC TERRESTRIAL ECOSYSTEMS OF UTAH: TETRAPOD FOSSILS FROM THE CHINLE FORMATION OF LISBON VALLEY

7 **Sullivan, C., Wang, Y., Hone, D., Wang, Y., Xu, X.** THE VERTEBRATE FAUNA OF THE JURASSIC DAOHUGOU BIOTA FROM NORTHEASTERN CHINA, AND ITS ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS

8 **Larson, D., Brinkman, D., Currie, P., Evans, D., Ryan, M.** NEW INFORMATION ON THE VERTEBRATE ASSEMBLAGE OF THE SANTONIAN-AGED MILK RIVER FORMATION OF ALBERTA (CANADA) AND THE EMERGENCE OF LATEST CRETACEOUS VERTEBRATE COMMUNITIES IN NORTH AMERICA

9 **Torices, A., Barroso-Barcenilla, F., Cambra-Moo, O., Pérez, S., Serrano, H.** VERTEBRATE MICROFOSSIL ANALYSIS IN THE PALAEONTOLOGICAL SITE OF 'LO HUECO' (UPPER CRETACEOUS, CUENCA, SPAIN)

10 **Bamforth, E., Larsson, H.** CYCLING OF VERTEBRATE ALPHA DIVERSITY PRECEDING THE CRETACEOUS MASS EXTINCTION: EVIDENCE FROM THE LATEST MAASTRICHTIAN OF CENTRAL CANADA

11 **Callapez, P., Barroso-Barcenilla, F., Cambra-Moo, O., Segura, M.** FIRST MOLLUSC DATA AND PALAEOENVIRONMENTAL IMPLICATIONS IN "LO HUECO" VERTEBRATE SITE (UPPER CRETACEOUS, CUENCA, SPAIN)

12 **Rivera-Sylva, H., Hedrick, B., Guzman-Gutierrez, R., González, A., Dodson, P.** A NEW CAMPANIAN VERTEBRATE LOCALITY FROM NORTHWESTERN COAHUILA, MEXICO

13 **Gallagher, W., Miller, K., Sherrell, R., Field, P., Olsson, R.** VERTEBRATE FOSSIL ASSEMBLAGES AND IRIDIUM CONCENTRATIONS IN THE CRETACEOUS-PALEOGENE SECTION OF THE NEW JERSEY COASTAL PLAIN

14 **Yamamura, D., Schmitt, J.** SANDSTONE DIAGENESIS AS A PROXY INDICATOR OF PORE FLUID GEOCHEMISTRY: IMPLICATIONS FOR FOSSILIZATION OF VERTEBRATE SKELETAL MATERIAL IN THE HELL CREEK FORMATION (UPPER CRETACEOUS), EASTERN MONTANA

15 **Canoville, A., Chinsamy, A.** GROWTH PATTERNS AND PALAEOECOLOGY OF PAREIASAURS (PARAREPTILIA, PAREIASAURIDAE) INFERRED FROM LONG BONE HISTOLOGY AND MICROANATOMY

SATURDAY AFTERNOON, NOVEMBER 5, 2011

POSTER SESSION IV (continued)

16 **MacDougall, M., Reisz, R.** A NEW PARAREPTILE FROM THE LOWER PERMIAN RICHARDS SPUR FISSURE FILL DEPOSITS OF OKLAHOMA

17 **Li, C., Zhao, L., Liu, J.** COMPARATIVE STUDY OF TWO POPULATIONS OF THE SABERTOOTHED FELID *PROMEGANTEREON OGYGIA* (FELIDAE, MACHAIRODONTINAE) FROM BATALLONES-1 AND BATALLONES-3 SITES (LATE MIOCENE, MN 10, TORREJÓN DE VELASCO, MADRID, SPAIN)

18 **Kobayashi, Y., Lu, J., Wei, X., Liu, Y.** PARENTAL CARE IN A CRETACEOUS CHORISTODERAN DIAPSID

19 **Sato, T., Konishi, T., Hirayama, R., Caldwell, M.** A REVIEW OF THE CRETACEOUS MARINE REPTILES FROM JAPAN

20 **Hsiang, A.** APPLICATION OF NONSTATIONARY MODELS OF SEQUENCE EVOLUTION TO HIGHER-ORDER AMNIOTE AND SQUAMATE SYSTEMATICS

21 **Pellegrini, R., Beatty, B.** ENAMEL AND DENTINE HISTOLOGY OF A MOSASAUR PTERYGOID TOOTH: IMPLICATIONS FOR DEVELOPMENT

22 **Moscato, D., Wallace, S.** ANALYSIS OF VARIATION IN SNAKE VERTEBRAE USING GEOMETRIC MORPHOMETRICS

23 **Kennedy, A., Bauer, A.** AN ANALYSIS OF THE HERPETOFAUNA FROM THE PINDAÏ CAVES OF NEW CALEDONIA: AN EXAMPLE OF HUMAN-INDUCED EXTINCTION IN THE LATE QUATERNARY SOUTH PACIFIC?

24 **Delfino, M., Alba, D., Carmona, R., Lujn, A., Robles, J.** EUROPEAN MONITOR LIZARDS (ANGUIMORPHA, VARANIDAE, *VARANUS*): NEW MATERIALS AND NEW PERSPECTIVES

25 **Burk, D., Sandau, S., Alderks, D.** NEW ASSOCIATED SKELETAL MATERIAL OF A VARANID LIZARD, *SANIWA CF. ENSIDENS*, FROM THE EOCENE UINTA FORMATION OF THE UINTA BASIN, UTAH, USA

26 **Sim, T., Kellner, A.** REMARKABLE NEW LIZARD SPECIMENS FROM THE EARLY CRETACEOUS OF BRAZIL

27 **Tuomola, A., Säilä, L.** A NEW ANGUIMORPH LIZARD (REPTILIA: SQUAMATA) FROM EARLY CRETACEOUS OF ÖÖSH, MONGOLIA

28 **Montanari, S., Norell, M.** DIETARY INFERENCES OF PROTOCERATOPSIAN DINOSAURS FROM THE LATE CRETACEOUS OF MONGOLIA BASED ON STABLE ISOTOPE GEOCHEMISTRY

29 **Frederickson, J.** A QUANTITATIVE CLADISTIC RECONSTRUCTION OF CRANIOFACIAL ONTOGENY IN *PROTOCERATOPS ANDREWSI*

30 **Baker, K., Scannella, J., Hall, L., Horner, J.** BIOGEOGRAPHIC IMPLICATIONS OF A PARTIAL CERATOPSID SKELETON FROM THE LOWER TWO MEDICINE FORMATION (CAMPANIAN), MONTANA

31 **Tanoue, K.** DEPRESSION OF JAW JOINT IN EARLY EVOLUTION OF CERATOPSIANS

32 **Borkovic, B., Russell, A.** BOVID HORNS AS MODELS FOR CERATOPSID CRANIAL HORNS

33 **Cummins, R., Farke, A.** FLEXIBILITY ALONG THE VERTEBRAL COLUMN OF *LEPTOCERATOPS GRACILIS* AND ITS IMPLICATIONS FOR LOCOMOTION

34 **Levitt, C.** BONE HISTOLOGY AND GROWTH OF CHASMOSAURINE CERATOPSID DINOSAURS FROM THE LATE CAMPANIAN KAIPAROWITS FORMATION, SOUTHERN UTAH

35 **Brandau, D., Irmis, R.** THE ORIGIN AND TAPHONOMY OF CHASMOSAURINE (ORNITHISCHIA: CERATOPSIDAE) DINOSAUR BONEBEDS IN THE UPPER CRETACEOUS KAIPAROWITS FORMATION, SOUTHERN UTAH

36 **McDonald, A.** A SUBADULT SPECIMEN OF *RUBEOSAURUS OVATUS* (DINOSAURIA: CERATOPSIDAE) AND ITS IMPLICATIONS FOR CENTROSAURINE PHYLOGENY

SATURDAY AFTERNOON, NOVEMBER 5, 2011

POSTER SESSION IV (continued)

37 **Chiba, K., Kobayashi, Y., Ryan, M., Evans, D., Brown, C.** TAPHONOMY OF A NEW *CENTROSAURUS* BONEBED FROM THE OLDMAN FORMATION (CAMPANIAN) OF SOUTHERN ALBERTA, A COMPARISON ACROSS FORMATIONS AND TIME

38 **Tikson, J., Evans, D., Ryan, M.** ENDOCRANIAL MORPHOLOGY OF *CENTROSAURUS* (ORNITHISCHIA: CERATOPSIDAE) AND BRAIN-BODY SIZE RELATIONSHIPS IN CERATOPSIAN DINOSAURS

39 **Beach, A.** TRICERATOPS AND TOROSAURUS SYNONYMY: AN EVALUATION OF TWO LARGE SPECIMENS FROM BRIGHAM YOUNG UNIVERSITY

40 **Scannella, J., Fowler, D., Trevethan, I., Roberts, D., Horner, J.** INDIVIDUAL VARIATION IN *TRICERATOPS* FROM THE HELL CREEK FORMATION, MONTANA: IMPLICATIONS FOR DINOSAUR TAXONOMY

41 **Fowler, D., Scannella, J., Horner, J.** REASSESSING CERATOPSID DIVERSITY USING UNIFIED FRAMES OF REFERENCE

42 **Tykoski, R., Fiorillo, A.** A NEW SPECIES OF PACHYRHINOSAUR (CERATOPSIDAE:CENTROSAURINAE) FROM THE LOWER MAASTRICHTIAN OF THE NORTH SLOPE OF ALASKA

43 **Schott, R., Evans, D.** NEW INFORMATION ON PACHYCEPHALOSAUR DINOSAUR DIVERSITY IN THE FOREMOST FORMATION (CAMPANIAN) OF ALBERTA

44 **Ryan, M., Evans, D., Bell, P., Tsogtbaatar, K., Badamgarav, D.** TAPHONOMY OF THE "DRAGON'S TOMB" *SAUROLOPHUS* (DINOSAURIA:HADROSAURIDAE) BONEBED, NEMEGT FORMATION (LATE CRETACEOUS), MONGOLIA

45 **You, H., Li, D.** BASAL HADROSAURIFORM DINOSAURS FROM THE EARLY CRETACEOUS MAZOGNSHAN AREA OF GANSU PROVINCE, NORTHWESTERN CHINA

46 **Stack, K., Druckenmiller, P.** ANATOMY AND RELATIONSHIPS OF A NEW TURONIAN HADROSAUROID FROM THE MATANUSKA FORMATION OF SOUTHERN ALASKA

47 **Prieto-Marquez, A.** USING SUBADULT SPECIMENS FOR PHYLOGENETIC INFERENCE IN HADROSAUROID DINOSAURS: *BACTROSAURUS* (LATE CRETACEOUS OF CHINA) AS A CASE STUDY

48 **Erickson, G., Norell, M.** THE HISTOLOGY OF HADROSAURID DINOSAUR TEETH -- REPTILES THAT EXCEEDED MAMMALS IN DENTAL COMPLEXITY?

49 **Clayton, K., Irmis, R., Getty, M., Lund, E., Nicholls, W.** AN EXCEPTIONALLY PRESERVED HADROSAURID DINOSAUR SKELETON WITH INTEGUMENT IMPRESSIONS FROM THE UPPER CRETACEOUS KAIPAROWITS FORMATION OF UTAH

50 **Bailleul, A., Horner, J.** EARLY OSSIFICATION AND CALCIFIED TISSUES IN THE SKULL OF *HYPACROSAURUS STEBINGERI* (ORNITHISCHIA, LAMBEOSAURINAE): A PRELIMINARY STUDY

51 **Marquart, C.** POPULATIONS, PLASTICITY AND PHENOTYPE: THE PROBLEMS OF CONTINUOUS VARIATION AND MISSING LINKS IN IGUANODONTIAN DINOSAURS

52 **Norman, D.** *HYPSELOSPINUS FITTONI*: AN EXEMPLAR OF NOMENCLATURAL CONFUSION AND STANDARDS OF TAXONOMIC PRACTICE IN WEALDEN IGUANODONTIANS

53 **Gasulla, J., Sanz, J., Ortega, F., Escaso, F.** THE MAXILLAE OF *IGUANODON BERNISSARTENSIS* FROM MORELLA: NEW INFORMATION ON UNKNOWN FEATURES

54 **Sobral, G., Mueller, J.** NEW INFORMATION ON THE BRAINCASE AND INNER EAR OF THE ORNITHOPOD DINOSAUR *DYSALOTOSAURUS LETTOWVORBECKI* BASED ON X-RAY COMPUTED MICROTOMOGRAPHY

55 **Arbour, V., Currie, P.** TAPHONOMIC FILTERS OF AGE GROUPS OF THE ANKYLOSAURID DINOSAUR *PINACOSAURUS*

56 **Foster, J.** ECOLOGICAL SEGREGATION OF THE LATE JURASSIC ORNITHISCHIAN DINOSAURS *STEGOSAURU*S AND *CAMPTOSAURUS* (MORRISON FORMATION, NORTH AMERICA): WAS IT PRONOUNCED OR SUBTLE?

57 **Escaso, F., Ortega, F., Sanz, J., Malafaia, E.** THE SYSTEMATIC UTILITY OF THE ILIO-SACRAL BLOCKS OF THE EUROPEAN STEGOSAUR *DACENTRURUS ARMATUS*

58 **WITHDRAWN**

59 **Porro, L., Barrett, P., Witmer, L.** A 3D SKULL OF *LESOTHOSAURUS DIAGNOSTICUS*: DIGITAL PREPARATION, RECONSTRUCTION AND FEEDING MECHANICS

60 **Li, J., Lockley, M., Matsukawa, M., Zhigiang, B.** AN EXCEPTIONAL ORNITHISCHIAN TRACKSITE FROM THE EARLY MESOZOIC OF SHAANXI, CHINA

61 **Spencer, M.** DISTRIBUTIONAL PATTERNS IN ORNITHISCHIA: A COMPREHENSIVE SPECIES-LEVEL BIOGEOGRAPHICAL ANALYSIS

62 **Hoganson, J., Person, J., Gould, B.** PALEONTOLOGY OF THE MEDORA SITE (PALEOCENE: SENTINEL BUTTE FORMATION), BILLINGS COUNTY, NORTH DAKOTA

63 **Fox, R., Scott, C.** DENTAL AND CRANIAL STRUCTURE OF LAINORYCTES (MAMMALIA: EUTHERIA; PALAEORYCTIDAE)

64 **Schwermann, A., Martin, T.** PARTIAL SKELETON OF AN OLIGOCENE MOLE FROM THE FOSSILAGERSTÄTTE ENSPEL (GERMANY)

65 **Gunnell, G., Habersetzer, J., Schlosser-Sturm, E., Simmons, N., Smith, T.** MOSAIC EVOLUTION IN PRIMITIVE EOCENE CHIROPTERAN DENTITIONS—*ARCHAEONYCTERIS TRIGONODON* (LUTETIAN, GERMANY) AND *ONYCHONYCTERIS FINNEYI* (WASATCHIAN, WYOMING)

66 **Smith, T., Habersetzer, J., Schlosser-Sturm, E., Simmons, N., Gunnell, G.** PRESENCE OF ONYCHONYCTERID BATS IN THE EARLY EOCENE OF EUROPE

67 **Penkrot, T., Zack, S., Strait, S.** TARSALS OF *NIPTOMOMYS* (MAMMALIA: MICROSYOPIDAE) FROM THE CASTLE GARDENS LOCALITY, WYOMING (EARLY EOCENE)

68 **Boyer, D., Silcox, M., Bloch, J., Coleman, M., Dobrota, T.** NEW SKULL AND ASSOCIATED POSTCRANIA OF *IGNACIUS GRAYBULLIANUS* (MAMMALIA, ? PRIMATES) FROM THE EOCENE OF WYOMING

69 **Ladevèze, S., Smith, T.** VIRTUAL ENDOCAST OF *PLESIADAPIS TRICUSPIDENS*, TYPE-SPECIES OF THE 'PLESIADAPIFORMS'

70 **Gladman, J., Boyer, D., Seiffert, E., Simons, E.** MORPHOLOGY AND MORPHOMETRIC AFFINITIES OF THE FIRST KNOWN CALCANEUS OF *PROTEOPITHECUS SYLVIAE* FROM THE LATE EOCENE OF EGYPT

71 **Carter, K.** EVOLUTIONARY TRAJECTORIES OF EARLY EOCENE PRIMATE EVOLUTION

72 **Roig Secall, I., Moya Sola, S.** THE POSTCRANIAL MORPHOLOGY OF *ANCHOMOMYS FRONTANYENSIS* AND ITS IMPLICATIONS FOR UNDERSTANDING THE LOCOMOTION OF THE EARLIEST PRIMATES

73 **Stait, S., Gunnell, G., Boudreau, J., Kissel, D.** 3D METHODS OF DIETARY RECONSTRUCTION IN THE EARLIEST ANTHROPOIDS

74 **Schumaker, K., Kihm, A., Weiler, M., Hartman, J.** GEOLOGY AND MAMMALIAN PALEONTOLOGY OF THE CVANCARA LOCALITY (PALEOCENE), TONGUE RIVER MEMBER, FORT UNION FORMATION, GRANT COUNTY, NORTH DAKOTA

75 **Kirk, E., Williams, B.** *MESCALEROLEMUR HORNERI*: A NEW ADAPIFORM PRIMATE FROM THE MIDDLE EOCENE OF WEST TEXAS

76 **Scott, C., Boyer, D.** NEW SPECIES OF *UNUCHINIA* (MAMMALIA, APATOTHERIA) FROM THE PALEOCENE OF ALBERTA, CANADA: PHYLOGENETIC AND BIOSTRATIGRAPHIC IMPLICATIONS

77 **Minwer-Barakat, R., Marigó, J., Badiola, A., Moyà-Solà, S.** NEW DISCOVERIES OF MICROCHOERINES (OMOMYIDAE, PRIMATES) FROM THE EOCENE OF THE IBERIAN PENINSULA

78 **Fostowicz-Frelik, L., Meng, J.** NEW LAGOMORPH MATERIAL FROM THE EOCENE-OLIGOCENE BOUNDARY OF WYOMING AND IMPLICATIONS FOR THE PHYLOGENY OF *CHADROLAGUS* AND *LITOLAGUS*

79 **Jiménez-Hidalgo, E., Smith, K., Guerrero-Arenas, R., Alvarado-Ortega, J.** NO EVIDENCE OF CAVIOMORPH RODENTS IN A NEW, LATE EOCENE TERRESTRIAL VERTEBRATE LOCALITY IN NORTHWESTERN OAXACA, SOUTHERN MEXICO

80 **Stevens, N., Egberts, S., Roberts, E., O'Connor, P.** FAUNAL COMPOSITION OF THE LATE OLIGOCENE SONGWE MEMBER OF THE NSUNGWE FORMATION, TANZANIA

81 **Neumann, A., Zonneveld, J., Bartels, W., Gunnell, G.** STRATIGRAPHY OF A FOSSILIFEROUS LATE WASATCHIAN (LOSTCABINIAN) FLUVIAL SECTION IN THE RED DESERT, NORTH EASTERN GREEN RIVER BASIN, WYOMING

82 **Shoup, B., Adams, J., Schaaf, C.** MONUMENT VALLEY PALEONTOLOGICAL SURVEY, PART III: NEW LOCALITIES FROM THE LATEST BRIDGERIAN—EARLIEST UINTAN NALMA TRANSITION IN THE ADOBE TOWN MEMBER OF THE WASHAKIE FORMATION, WASHAKIE BASIN, SOUTHWESTERN WYOMING

83 **Casanovas-Vilar, I., Van Dam, J.** ASSESSING THE EFFECTS OF SIZE, ECOLOGY AND PHYLOGENY ON MANDIBLE SHAPE IN SQUIRRELS (SCIURIDAE, RODENTIA)

84 **Townsend, B., Croft, D.** CAVIOMORPH MICROWEAR REVISITED USING HDR IMAGING

85 **Schulz, E., Piotrowski, V., Clauss, M., Gildas, M., Kaiser, T.** WHERE DO ALL THE PITS COME FROM? THE EFFECT OF ABRASIVE SILICA PARTICLES ON TOOTH WEAR AND ITS IMPLICATION FOR PALEODIETARY INTERPRETATIONS

86 **Haveles, A., Fox, D.** ISOTOPIC RECONSTRUCTION OF MODERN SMALL MAMMAL DIETS AND IMPLICATION FOR UNDERSTANDING THE EVOLUTION OF THE C4-DOMINATED GRASSLAND OF THE GREAT PLAINS

87 **Fox, D., Marcot, J.** COMPARING CLIMATE CHANGE AND MAMMALIAN TAXONOMIC RICHNESS IN THE NEOGENE OF THE GREAT PLAINS, USA

88 **López-Antoñanzas, R., Knoll, F.** NEW INSIGHTS INTO THE VERTEBRATE FAUNA FROM THE MIOCENE OF CHIOS (GREECE)

89 **McLaughlin, W., Hopkins, S.** PALEOECOLOGY, PALEOENVIRONMENT, PALEONTOLOGY, AND PALEOPEDOLOGY OF HAWK RIM, CENTRAL OREGON, USA

90 **Lewis, P., Thies, M., Campbell, T., Tutalo, R., Kennedy, A.** THE SMALL MAMMAL FAUNA FROM KOANAKA SOUTH AND THE UTILITY OF RODENTS AS PALEOENVIRONMENTAL INDICATORS

91 **Carpenter, N.** BIOSTRATIGRAPHY OF EARLY HEMPHILLIAN BEAVERS (RODENTIA: CASTORIDAE) FROM THE PACIFIC NORTHWESTERN UNITED STATES OF AMERICA

92 **Lee, Y., Jacobs, L.** THE PLATACANTHOMYINE RODENT *NEOCOMETES* FROM THE MIOCENE OF SOUTH KOREA AND ITS PALEOBIOGEOGRAPHICAL IMPLICATIONS

93 **Morgan, G., Rincon, A., Morse, P., Denetclaw, U., Vallejo, M.** MIOCENE MICROVERTEBRATES FROM PANAMA

94 **Czaplewski, N., Smith, K.** SYSTEMATIC RELATIONSHIPS OF MID MIOCENE SPECIES OF *MONOSAULAX* (RODENTIA: CASTORIDAE) FROM THE GREAT BASIN OF NORTH AMERICA

95 **Dionne, D., Mitchell, W., Rybczynski, N., Schröder-Adams, C.** EVALUATION OF PLIOCENE FOSSIL RABBIT PHYLOGENY (GENUS: *HYPOLAGUS*) USING EIGENSHAPE ANALYSIS

96 **Thies, M., Arney, I., Denova, B., Taylor, J., Lewis, P.** SPECIES-LEVEL APOMORPHIES IN SOUTHERN AFRICAN MICROFAUNA: DATA FROM THE POSTCRANIA

97 **Marcy, A., Hadly, E.** DIGGING MORPHOLOGY AND THE INTERACTION BETWEEN SOIL AND CLIMATE DETERMINE POCKET GOPHER (*THOMOMYS*) DISTRIBUTION ACROSS TIME AND SPACE

98 **Hansen, K., Hill, R., Johnson, K., Stucky, R.** ASHES TO ASHES, DUST TO ECM; PROTEOMIC ANALYSIS OF VERTEBRATE SAMPLES FROM THE SNOWMASTODON PROJECT

99 **Shirley, E., Rountrey, A., Fisher, D., Tikhonov, A., Buigues, B.** X-RAY COMPUTED TOMOGRAPHY OF TWO EXCEPTIONALLY PRESERVED NEONATE MAMMOTHS FROM SIBERIA

100 **Wang, Y., Jin, C., Mead, J.** A REVIEW OF THE PLEISTOCENE PROBOSCIDEAN EVOLUTION IN SOUTH CHINA

101 **Sanders, W., Haile-Selassie, Y.** NEW FOSSIL PROBOSCIDEANS FROM MID-PLIOCENE WORANSO-MILLE, ETHIOPIA: IMPLICATIONS FOR ELUCIDATING THE DIVERSIFICATION AND EVOLUTION OF BASAL TAXA OF CROWN ELEPHANT LINEAGES

102 **Wu, Y., Chang, C., Wei, K.** A NEW RECORD OF *STEGODON* IN TAIWAN AND ITS BIOGEOGRAPHICAL IMPLICATIONS

103 **Hayden, A., Fisher, D.** COILING GEOMETRY OF PROBOSCIDEAN TUSKS

104 **Lofgren, D., Pagnac, D., Liskanich, P., Hess, A., Silver, D.** PROBOSCIDEANS FROM THE MIDDLE MIOCENE BARSTOW FORMATION OF CALIFORNIA

105 **Semprebon, G., Tao, D., Solounias, N., Hasjanova, J.** DIETARY RECONSTRUCTION OF CHINESE SHOVEL-TUSKED GOMPHOTHERES (MAMMALIA: PROBOSCIDEA): EVIDENCE FROM DENTAL MICROWEAR OF MOLAR TEETH AND TUSKS

106 **Lambert, W.** A NEW SHOVEL-TUSKED GOMPHOTHERE (PROBOSCIDEA) FROM THE CLARENDONIAN OF OREGON

107 **Stucky, R., Fisher, D., Graham, R., Holen, S., McDonald, G.** A NEW HIGH ALTITUDE LATE PLEISTOCENE INTERGLACIAL/GLACIAL SITE (MIS 5?) PRESERVING LARGE AND SMALL VERTEBRATE FOSSILS FROM WESTERN COLORADO: THE SNOWMASTODON SITE AT ZIEGLER RESERVOIR, PITKIN COUNTY

108 **Dundas, R., Ibarra, Y., Asami, R., Ngo, M., Canchola, J.** FAIRMEAD LANDFILL, A DIVERSE MIDDLE IRVINGTONIAN BIOTA IN CALIFORNIA'S CENTRAL SAN JOAQUIN VALLEY

109 **Moretti, J., Johnson, E.** ROLAND SPRINGS RANCH LOCALITY 1, AN EARLY PLEISTOCENE FAUNA FROM THE SOUTHERN PLAINS OF TEXAS

110 **Johnson, E., Moretti, J., Hurst, S.** A NEW RANCHOLABREAN (LATE PLEISTOCENE) FAUNA FROM THE SOUTHEASTERN EDGE OF THE TEXAS SOUTHERN HIGH PLAINS

111 **Kuhn, B., Hopley, P., Herries, A., Menter, C., Bountalis, A.** TAUNG ... A RIVER RAN THROUGH IT

112 **Anglen, J., Chatters, J., Dundas, R.** DEPOSITIONAL ENVIRONMENT OF ISOLATED SKELETAL ELEMENTS FROM THE FAIRMEAD LANDFILL LOCALITY (PLEISTOCENE, IRVINGTONIAN), MADERA COUNTY, CALIFORNIA

113 **Buynevich, I., Hasiotis, S.** GEORADAR APPLICATIONS IN VERTEBRATE TAPHONOMY AND ICHNOLOGY

114 **Nyborg, T., Buchheim, P., Santucci, V.** AGE, STRATIGRAPHY, DEPOSITIONAL ENVIRONMENT AND VERTEBRATE ICHNOLOGY OF THE MIOCENE-PLIOCENE COPPER CANYON FORMATION, DEATH VALLEY, CALIFORNIA

115 **Hieronymus, T., Bhandari, A., Tiwari, B., Bajpai, S.** EARLY MIOCENE TERRESTRIAL VERTEBRATE FAUNA FROM CENTRAL KUTCH (GUJARAT), WESTERN INDIA

116 **Reynolds, R., Miller, D., Woodburne, M., Albright III, L.** GEOGRAPHIC EXTENT OF THE BARSTOW FORMATION, CENTRAL MOJAVE DESERT

117 **Carranza-Castañeda, O., Wang, X., Aranda-Gómez, J.** IMPORTANCE OF THE JUCHIPILA FAUNA (LATE EARLY HEMPHILLIAN, HH2), STATE OF ZACATECAS, IN THE BIOSTRATIGRAPHIC CORRELATION OF THE HEMPHILLIAN FAUNAS OF CENTRAL MEXICO

118 **Littlewood, R., Vietti, L.** CONSTRAINTS ON THE FORMATION OF MARINE BONE CONCENTRATIONS

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Technical Session XIX (Saturday, November 5, 2:30 pm)

NEW ZEALAND FOSSILS REVEAL EARLY MIOCENE GLOBAL DISTRIBUTION FOR SMALL *KENTRIODON* DOLPHINS

AGUIRRE-FERNNDEZ, Gabriel, University of Otago, Dunedin, New Zealand; FORDYCE, Robert, University of Otago, Dunedin, New Zealand

Archaic dolphins in the extinct family Kentriodontidae (Delphinoidea) have been reported widely from Northern Hemisphere Miocene localities. Kentriodontids have been implicated in the origins of the living groups Delphinidae, Monodontidae and Phocoenidae. New species of kentriodontids from New Zealand expand the record beyond well-documented Northern Hemisphere fossils. Of note are: a generalized Early Miocene (basal?) kentriodontid (OU22066; Paturau); a species of Pithanodelphininae (ZMT 114; Kakahu); a *Kentriodon*-like species from near the Oligo-Miocene boundary (AUGD V9; Port Waikato); and 2 skulls (OU22375 and OU22172; Karitane) phenetically close to *K. pernix* (type species of *Kentriodon*). The 2 *Kentriodon* skulls were recovered from the Caversham Sandstone, New Zealand Altonian Stage (about 16-19 Ma, Early Miocene) which is roughly contemporaneous with the Calvert Formation of the Atlantic Coastal Plain. They represent a species with an estimated condylobasal length of 360-400 mm, and body length of about 1.7 m, comparable in size to living costero dolphins (*Sotalia guianensis*). The New Zealand skulls provide compelling evidence that Early Miocene *Kentriodon*, and perhaps *K. pernix*, ranged from temperate North Atlantic (and South Atlantic?) waters across the tropics to the temperate Southwest Pacific. Amongst living dolphins, the genus *Stenella* has comparable distributions. Other contemporaneous (Altonian) cetaceans from southern New Zealand include an unprepared cf. *Kentriodon*, the eurhinodelphinid *Phocaenopsis mantelli*, and an archaic squalodelphinid (?), all from the Mt Harris Formation. These, and other unprepared Odontoceti and Mysticeti, will broaden our understanding of southern Early Miocene assemblages beyond that of the widely-discussed Patagonian Cetacea. The new *Kentriodon* sp(p) may elucidate the phylogeny and diversity of Kentriodontidae, and perhaps the early history of stem delphinoids.

Technical Session VIII (Thursday, November 3, 1:45 pm)

A VERY PRIMITIVE TETRAPOD FROM THE EARLIEST FAMENNIAN OF SOUTH TIMAN, RUSSIA

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Three field seasons collecting in the Sosnogorsk Formation, a basal Famennian lacustrine or lagoonal deposit from a tropical coastal setting in present-day South Timan, Russia, has yielded an extensive collection of cranial, mandibular and some postcranial stem tetrapod bones. They are preserved in limestone and prepared using acetic acid, producing clean surfaces even on complex structures such as sutural areas. All bones are attributable to a single previously unknown species, on the basis of a shared distinctive ornament and close morphological match between duplicate elements. Furthermore, several suites of bones can be assigned to single individuals because of sutural fit. The material also includes an articulated snout and several articulated skull tables, enabling us to present a provisional but fairly well constrained skull reconstruction. We tentatively identify it as a tetrapod sensu stricto, i.e. a taxon with limbs rather than paired fins, because a cleithrum + partial scapulocoracoid shows a characteristic tetrapod morphology, similar to *Ichthyostega* and quite different from *Panderichthys* or *Tiktaalik*. However, the material shows a number of primitive characteristics, which suggest that it is the least crownward of known tetrapods. The snout does not have the spade shape typical of early tetrapods, vomeral morphology is intermediate between the elpistostegid and tetrapod conditions, the pterygoids are separated by the parasphenoid, the braincase has a well-developed crista parotica attached to the skull roof, the postorbital separates the squamosal from the supratemporal as in *Tiktaalik*, and the cleithrum carries dermal ornament. The Sosnogorsk Formation tetrapod will thus provide important data for character polarization among stem-group tetrapods. Notably, its otoccipital braincase differs from those of *Ichthyostega* and *Acanthostega*, themselves very different from each other, but represents a pattern that could be antecedent to both.

Poster Session III (Friday, November 4)

POSTCRANIAL MORPHOLOGY OF *DIPSALIDICTIS TRANSIENS* (MAMMALIA: OXYAENIDAE): FUNCTIONAL INTERPRETATIONS AND TAXONOMIC SIGNIFICANCE

AHRENS, Heather, Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Oxyaenidae comprises Late Paleocene to Late Eocene archaic carnivores, which are considered part of the paraphyletic assemblage ‘Creodonta’. Though oxyaenids are quite common in Early Eocene deposits of western North America, little is known about the postcranial morphology and phylogenetic relationships within the family or to other members of Ferae. One factor complicating our understanding of the relationships of Oxyaenidae is the debated validity of the genus *Dipsalidictis*. Here, I describe a well-preserved specimen of *Dipsalidictis transiens* (YPM–PU 16161) from the Willwood Formation (Early Eocene) of the Bighorn Basin, Wyoming. This is the first detailed description of the skeleton of *Dipsalidictis*. Notable features of the forelimb include a greater tubercle of the humerus extending higher than the humeral head, a radial head which is more ovoid than round, and a well-developed attachment surface for the pronator quadratus muscle on the medial aspect of the distal radius. Notable features of the pelvis and hind limb include a well-developed anterior inferior iliac tubercle and a fairly deep and narrow patellar groove. There are also several important characteristics of the tarsals, including a shallow astragalar trochlea, an astragalar sustentacular facet that is continuous with the plantar surface of the astragalar head, a convex and smooth calcaneal ectal facet, and a distally positioned calcaneal sustentacular facet. The mix of both arboreal and terrestrial features in *Dipsalidictis transiens* indicates that the taxon was likely scansorial, with numerous features of the ankle suggesting the ability to climb. Additionally, several features of *Dipsalidictis transiens* are inconsistent with previously discussed postcranial generic differences between *Dipsalidictis* and *Oxyaena*. Thus, the taxonomic assignment of *Dipsalidictis transiens* and postcranial distinction of the genus should be reassessed.

Technical Session X (Friday, November 4, 10:45 am)

A NEW PARTIAL SKELETON OF THE FOSSIL GREAT APE *HISPANOPITHECUS* (PRIMATES: HOMINIDAE) FROM THE LATE MIOCENE OF CAN FEU (VALLÈS-PENEDÈS BASIN, NE IBERIAN PENINSULA)

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A new partial skeleton of the fossil great ape *H. laietanus*, recovered in 2001 during the construction of a building in Can Feu (Sant Quirze del Vallès, Catalonia, Spain), is reported. Associated small mammal remains indicate an estimated age of 9.99-9.72 Ma (early Vallesian), based on the occurrence of *Cricetulodon* cf. *sabadellensis* and the lack of *Progonomys*. IPS34575 includes dentognathic and postcranial elements from a single individual: right i1, p3 and m1-m3; left p3-m3; partial left ulna; fragment of radial diaphysis; distal fragment of left humeral diaphysis; proximal fragment of first rib; fragment of clavicle; and several scapular fragments. Dental morphology and proportions suggest an attribution to *H. laietanus*. A body mass (BM) of 23-25 kg can be estimated for IPS34575 on the basis of ulnar articular measurements and radial diaphyseal diameters. The smaller dental and postcranial size of IPS34575 as compared with male specimens of *H. laietanus*—particularly the partial cranium and skeleton IPS18000/IPS18800 from Can Llobateres 2 (9.6 Ma), with an estimated BM of 39 kg. Both postcranial size and p3 morphology indicate that IPS34575 corresponds to a female individual. Unique amongst available remains of *Hispanopithecus,* IPS34575 almost completely preserves the proximal morphology of the ulna. The latter is remarkably modern hominoid-like, as evidenced by the short olecranon process (although less reduced than in *Oreopithecus* and *Pongo*), and the relatively broad trochlear notch (more so than in *Griphopithecus*) with a median keel (less marked than than in *Oreopithecus*, but fully comparable with *H. hungaricus*). Overall, IPS34575 most closely resembles the incomplete ulna known for *H. hungaricus* in both size and shape, although differing from the latter by the more slender proximal diaphysis and the more protruding and less inclined coronoid process. Overall, IPS34575 reflects an elbow complex suitable for preserving stability along the full range of flexion/extension and enabling a broad range of pronation/supination, thereby confirming previous inferences of specialized suspensory behaviors in *Hispanopithecus*.

Poster Session II (Thursday, November 3)

HOW DID PAST ENVIRONMENTAL CHANGE AFFECT LARGE MAMMAL DIVERSITY IN SPAIN?

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The Cenozoic basins of Spain provide one of the most valuable and rich records of fossil mammals and continental environments, giving exceptional opportunities to evaluate the ecological and evolutionary responses of mammalian communities to climatic change over the span of millions of years. This knowledge is essential for linking the dynamics of biotic change from ecological to evolutionary time scales and for understanding the processes that transform ecosystems over geologic time. We present the patterns of large mammal diversity and home range-size changes during the Late Miocene to Pleistocene in order to identify the tempo and mode of the major ecological shifts in community structure, and to put them in the context of late Cenozoic climatic change. We seek to understand the manner in which assemblages of large mammals that occur together in Spain are distributed in time, and the ways in which these assemblages can be influenced by dispersal constraints, environmental constraints, and internal dynamics. This knowledge is essential for recognizing the patterns behind the temporal distribution that leads to the forming of hypotheses about the origin and genuine structure of the Iberian biome. Trends in mammal diversity over time were analyzed using a taxon-free characterization. Species were assigned to various ecological categories in accordance with feeding and preferred habitat. Home range-size of fossil species was estimated using the regression for each family, habitat preference and trophic categories. Our results support the idea of the major role of past climatic changes as drivers of mammalian evolution.

Technical Session XIV (Saturday, November 5, 11:00 am)

AN ORNITHOMIMOSAUR-DOMINATED BONEBED FROM THE EARLY CRETACEOUS OF SOUTHWESTERN FRANCE

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Lignitic deposits from the new Hauterivian-Barremian locality of Angeac-Charente (southwestern France) have yielded a rich and diverse vertebrate assemblage. Besides fish microremains mostly referable to hybodontiform sharks, semionotiforms and ionoscopiforms, several reptilian taxa, including three turtles, one plesiosaur, four crocodilians and four dinosaurs (one ornithopod, one sauropod, two theropods), have been identified. However, first preliminary results indicate that this bonebed is largely dominated by ornithomimosaur remains. To date, 207 disarticulated postcranial elements representing at least 8 individuals have been unearthed from a surface of about 10 square meters. Furthermore, it is worth to note that pelvic and hindlimb bones are dominant and that no cranial elements have been found so far. While most of these ornithomimosaur bones are well preserved, with no abrasion, long bones often display post-mortem fractures with sharp edges. Some scratches can be observed on the bone surface. Such observations reveal peculiar taphonomic conditions and are congruent with the hypothesis of a single, short-term burial event possibly followed by trampling. Distinct age-classes are present, with juveniles, sub-adults and adults. This would suggest gregarious habits, a behavior previously reported for this group of herbivorous theropod dinosaurs. According to the preliminary anatomical study, the ornithomimosaur of Angeac-Charente belongs to a new taxon. The unambiguous fossil record of European ornithomimosaurs has been so far restricted to *Pelecanimimus* from the Spanish Barremian locality of Las Hoyas, a primitive toothed form known only by a single specimen. Comparisons with historical material from the Wealden of the Isle of Wight suggest that ornithomimosaurs were also present in the Early Cretaceous of England. The new, abundant material from Angeac-Charente will provide crucial information on the phylogeny and paleobiogeography of ostrich dinosaurs.

Poster Session II (Thursday, November 3)

A NEW CROCODYLIFORM FROM THE MIDDLE CRETACEOUS WOODBINE FORMATION OF TEXAS

ALLEN, Eric, University of Iowa, Iowa City, IA, USA; MAIN, Derek, University of Texas at Arlington, Arlington, TX, USA; NOTO, Christopher, University of Wisconsin-Parkside, Kenosha, WI, USA

The Arlington Archosaur Site (AAS) is a prolific fossil locality in the Cretaceous (Cenomanian) Woodbine Formation of Texas. It represents a Cretaceous delta plain ecosystem preserving a diverse coastal fauna including sharks, rays, lungfish, turtles, ornithischians, theropods, and crocodyliforms. Here, we report on the discovery of a new large mesoeucrocodylian crocodyliform with a short dentary symphysis, paired dentary pseudocanines, and a robust triangular snout which differentiates this taxon from the longirostrine crocodyliform *Woodbinesuchus*, also from the Woodbine Formation. As such, it represents an ecomorphotype not previously reported from the formation. Remains include a disarticulated partially complete skull and considerable postcranial material from a single large (~5m) adult individual and additional disarticulated material from a second adult, at least one subadult, and several juveniles, elucidating a partial growth series. Phylogenetic analysis of the new form indicates a relationship basal to alternatively Goniopholididae with which it shares rostral and osteoderm morphology but is excluded based on the lack of a mandibular fossa, or Thalattosuchia primarily based on the shape of the postorbital. Either hypothesis would require a substantial ghost lineage as both of these lineages originate in the Early Jurassic. These results have profound implications for crocodyliform phylogeny and evolution as broad-scale relationships among mesoeucrocodylians are in flux, particularly in regard to the placement and interrelationships of goniopholidids. This find may represent a previously unknown component of mesoeucrocodylian diversity.

Poster Session I (Wednesday, November 2)

EVALUATION OF UPPER MOLAR OCCLUSAL MORPHOLOGY FOR DIETARY INFERENCE IN MID- TO LARGE-BODIED PLATYRRHINI (PRIMATES)

ALLEN, Kari, Duke University, Durham, NC, USA; GONZALES, Lauren, Duke University, Durham, USA; COOKE, Siobhan, Duke University, Durham, NC, USA; KAY, Richard, Duke University, Durham, NC, USA

Previous work on lower molar morphology has demonstrated quantifiable differences in shear crest length and occlusal relief among animals of differing diets. We explore the use of upper molar occlusal morphology to predict diet in platyrrhine primates and compare the results to those obtained from associated lower molars.

The sum of shear crest lengths and mesiodistal tooth lengths were measured for associated upper and lower first molars of large samples of nine platyrrhine genera (*Alouatta, Ateles, Brachyteles, Cacajao, Callicebus, Chiropotes, Lagothrix, Pithecia, Saimiri*), Shear quotients (SQ) were calculated as residuals taken from a line with slope 1.0 (isometry) and passed through the mean log molar length and log sum of crest lengths for extant platyrrhines. The Relief Index (RFI) was measured using laser scan models of upper and lower first molars. RFI was calculated as the 3D crown surface area relative to the projected 2D area. Species were assigned to one of three diet categories based on most frequently consumed food (soft fruit, hard-objects (nuts), and leaves).

For both upper and lower molars, pair-wise comparisons of species mean SQ values, with a Bonferroni correction, show significant differences among all diet categories ($p<0.02$). Using discriminant function analysis (DFA), we examined classification success of SQ and RFI values to assign individual specimens to a diet category. RFIs for lower molars only separate hard-object feeders from other diets; with no significant separation found using upper molar RFI. DFAs for 82 individuals show that SQ correctly predicts diet for both lower and upper molars (82% and 76% respectively, assuming all diet groups have the same number of individuals). The combination of upper and lower molar SQ has even higher predictive power (87% successfully classified). Upper and lower molar RFI values produce lower correct classification rates for individuals (47% and 53% correct). As with lower molar data, upper molar RFIs and SQs provide a strong dietary signal. Misclassification of individual specimens, but not species, cautions against the use of single specimens to infer diet in extinct species.

Poster Session I (Wednesday, November 2)

PROXIMAL FEMORAL AFFINITIES OF MIOCENE APES AND EARLY HOMININS ON THE BASIS OF 3D GEOMETRIC MORPHOMETRICS ANALYSES

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Elucidating the path of the evolutionary changes that occurred in hominins since their divergence from African apes requires a good understanding of the most likely morphotype of their last common ancestor (LCA). Most researchers rely only on extant taxa as comparative models for this LCA, and, in particular, chimpanzees. This is especially relevant for making inferences about hominin origins and the appearance of bipedalism, which is a very ancient acquisition in our lineage. The morphology of the proximal femur is commonly used for making locomotor inferences in primates, and is considered by itself to be a good indicator of bipedal capabilities in early hominins. For the first time in the literature, we compare the morphological affinities of the proximal femora of early hominins with all extant great apes, hylobatids, cercopithecid monkeys, and the most complete available Miocene apes using three-dimensional geometric morphometrics. We collected 14 landmarks on the proximal femur, which were designed to capture the functional morphology of this region. Our results indicate that Miocene ape and hylobatid femora are close to the mean, while both extant great apes and hominins diverge from this consensus in opposite directions. Some early hominin femora, especially that of *Orrorin tugenensis,* are morphologically intermediate between Miocene apes and humans, whereas extant great apes, particularly chimpanzees, display an autapomorphic pattern. The middle Miocene fossil record reveals that the evolution of orthogrady was decoupled from below-branch suspensory adaptations, the former allowing for enhanced vertical climbing in relatively large apes. Thus, we agree with the previous suggestion that the adoption of habitual bipedalism could have merely co-opted many earlier adaptations to vertical climbing, which must therefore be regarded as exaptations for bipedalism. Our results therefore support previous suggestions that the LCA's morphotype is more closely reflected by the highly conservative postcranial morphology of middle Miocene apes than by the derived morphology displayed by extant great apes.

Technical Session IV (Wednesday, November 2, 1:45 pm)

DIVERSITY OF SCIURAVIDAE (MAMMALIA: RODENTIA) INCLUDING A NEW SPECIES FROM THE MIDDLE EOCENE OF WYOMING

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Diversity of sciuravids fluctuated from the time of their first appearance in the Wasatchian (early Eocene) to their extinction in the Uintan (late middle Eocene). These fluctuations in diversity are known to have occurred during a time period marked by dramatic global climatic change, but potential correlations between climatic events and morphological disparity are obscured by the fact that the genotype, *Sciuravus nitidus*, with its high level of intraspecific variation, has become a wastebasket taxon. Here we present a critical reevaluation of the alpha taxonomy of *S. nitidus* based on a relatively large sample size of well-preserved specimens, including associated maxillary and mandibular fragments collected from the Middle Eocene of Wyoming. The sample includes over 150 sciuravid specimens from Wa7-Br2, from which a total of 11 species representing five different genera were identified, including a new species from the middle Eocene (Br2) of Wyoming. The new species is intermediate in size between *S. wilsoni* and *S. nitidus* and has features common to sciuravids (e.g. trigonid elevated above the talonid, retention of cusp with lophs, rectangular lower molars) as well as unique features (e.g. wide external valley studded with ectostylids and mesolophid dividing the central valleys of m1-2, m3 hypolophid connecting to the hypoconulid). Other species recognized include: *S. nitidus*, *S. undans*, *S. popi*, *S. wilsoni, Dawsonomys woodi, Knightomys depressus, K. senior, K. cremneus, Taxymys sp.*, and *Tillomys senex*. Overall patterns of diversity change support previous hypotheses about the impact of climate on Eocene mammals. In particular, sciuravid species diversity increased during the wet, paratropical conditions of Wa7-Br1b, peaking at Br2, a time followed by cooler, more arid conditions. New species appearing during Br2, such as *S. wilsoni, S. bridgeri, Dawsonomys woodi*, and *S. sp. nov*. are responsible for the increased species richness documented during

that interval and make Sciuravidae the most diverse group of middle Eocene rodents known in North America.

Technical Session VIII (Thursday, November 3, 3:15 pm)

GROWTH SERIES OF THE RECUMBIROSTRAN (LEPOSPONDYLI; GYMNARTHRIDAE) *CARDIOCEPHALUS PEABODYI* FROM RICHARDS SPUR, OKLAHOMA; NEW ANATOMICAL INFORMATION AND IMPLICATIONS FOR THE EVOLUTION OF (MICROSAURS)

ANDERSON, Jason, University of Calgary, Calgary, AB, Canada; REISZ, Robert, University of Toronto, Mississauga, Mississauga, ON, Canada

Developmental data represent a rapidly growing new source for information on character evolution in fossils; even partial growth series have the potential to inform on the acquisition of new features within higher taxa. We have assembled a partial growth series of the recumbirostran lepospondyl *Cardiocephalus peabodyi*, a group currently undergoing intensive investigation because of their possible role in the origin of the extant caecilians. Digital dissection using micro-CT has revealed for the first time the complete anatomy of the palate, usually obscured by closely articulating lower jaws. *C. peabody* lacks an ossified tectum synoticum and a distinct orbitosphenoid as recently described in other recumbirostrans; similar to these other taxa the sphenethmoid articulates with the medial portion of a longitudinally-oriented ventral flange of the frontal.

Importantly, the smallest skull in the series possesses a ventral emargination of the cheek region. This emargination additionally has distinct small ossicles where fully ossified bone is present in the adult. This is very similar to what has been described in presumably adult specimens of the ostodolepids *Micraroter* and *Pelodosotis*. Other 'microsaurs' with an emarginated cheek include *Hapsidoparieon* and *Llistrofus*, although these taxa lack described ossicles and the latter may be a juvenile. Thus, the bridge between the maxillary arcade and suspensorium appears to be a late forming structure in 'microsaurs' (although following a relatively unique pattern). It is therefore a relatively simple heterochrony to achieve the distinctive morphologies of ostodolepids and hapsidopareiontids rather than the result of an adaptive change in mandibular musculature, as previously hypothesized.

Technical Session XVI (Saturday, November 5, 9:00 am)

THE INITIAL RADIATION OF JAWS: FUNCTIONAL STABILITY IN THE FACE OF FAUNAL AND ENVIRONMENTAL CHANGE

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Of the approximately 58,000 living vertebrate species, 99% have jaws. In the Silurian and earliest Devonian (~ 444-410 Million years ago), this major clade (known as gnathostomes) shared ecological space with a wide range of jawless fishes (agnathans) which often dominated the vertebrate faunas. However, by the end of the Devonian, 100 million years later, a major faunal shift occurred that left younger assemblages composed almost exclusively of gnathostomes. Several qualitative scenarios have been inspired by this pattern to explain the trophic radiation and ecological ascendance of the earliest gnathostomes. Here we present the first quantitative analysis of functional variation in early gnathostome mandibular elements, placing constraints on our understanding of evolutionary patterns during this critical interval.

A series of biomechanically relevant morphological metrics were collected from lower jaws of 198 Devonian gnathostome genera and were used to create a functionally informed mandibular morphospace. Disparity metrics were calculated across stratigraphic bins. Resulting profiles of morphospace occupancy were compared with richness data documenting the relative contribution of gnathostomes and agnathans to faunal assemblages throughout the Devonian.

Functional disparity among Early Devonian gnathostomes is comparable with that seen in the Late Devonian even as the taxonomic richness of the clade increases substantially over the period. As much as half of mandibular morphospace is occupied by stem gnathostomes, specifically placoderms. By contrast, major groups of living vertebrates (ray-finned fishes, tetrapods) show conservative morphologies with little indication of functional diversification. Much of early mandibular functional innovation seems to have occurred on the stem, suggesting that ecological proliferation is not coincident with the initial radiation of extant gnathostomes. Steady levels of gnathostome functional diversity in the face of the plummeting relative richness of agnathans raises questions about the role of active displacement in this fundamental shift in vertebrate biodiversity between the beginning and close of the Devonian.

Technical Session XII (Friday, November 4, 2:45 pm)

MORPHOLOGY AND FUNCTION IN *WAIMANU* PENGUINS: EARLY WING-PROPELLED DIVERS

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

Species in the archaic fossil penguin genus *Waimanu* (Sphenisciformes, Aves) show features structurally intermediate between volant seabirds and more-crownward penguins, in addition to some archaic characters seen in Mesozoic birds. *Waimanu* includes two species from New Zealand: the larger and older *W. manneringi* (Early Paleocene) and smaller *W. tuatahi* (Late Paleocene), both from marine shelf strata of Waipara Greensand, North Canterbury. These species, the oldest named penguins, are known from 4 specimens that include the skull, vertebrae, pelvis, wing elements, and hind-limb elements. The skull has a distinct nasal gland fossa consistent with a marine lifestyle. The straight, slender bill, comparable to that of *Icadyptes* and *Platydyptes*, and unexceptional cervical vertebrae, rule out a specialized diet; there is no reason to propose a crustacean diet (as in some living penguins) or fish-spearing habits. The nearly flat, amphicoelous thoracic vertebrae contrast with the opisthocoelic condition in later penguins, and allow that condition in more-crownward penguins evolved independently from the opisthocoelous thoracic vertebrae of other marine birds. The *Waimanu* wing elements are dense (osteosclerotic, with limited cancellous bone) and moderately flattened, with a sigmoidal humerus with developed head and deep tricipital fossa, less flattened ulna with distinct olecranon, and narrow radius. Wing structure, including the coracoid, is consistent with wing-propelled propulsion in water, and a non-volant lifestyle. More-crownward penguins show more-derived flattening of all elements and modifications to support a less mobile elbow joint. Both species of *Waimanu* have a plesiomorphic elongate tarsometatarsus with a posterior-directed medial trochlea indicating different foot function from crown penguins; perhaps foot propulsion supplemented the wing propelled diving. The *Waimanu* morphology is consistent with an obligate marine habit, probably in a shallow shelf setting. Structural attributes that allowed more-pelagic habits, such as the thermoregulation-linked humeral sulcus arose later in penguin history, linked with expanding geographic range.

Technical Session VI (Thursday, November 3, 3:45 pm)

PTEROSAURS, MODULES, AND THE ORIGIN OF THE PTERODACTYLOIDEA

ANDRES, Brian, Southern Methodist University, Dallas, TX, USA; HOWARD, Lauren, Natural History Museum, London, United Kingdom; STEEL, Lorna, Natural History Museum, London, United Kingdom

Pterosaurs underwent both a massive restructuring of their bauplan and a total replacement of their basal forms halfway through their extensive history. This was the origin of the Pterodactyloidea, which has consistently had the longest and most supported branch in pterosaur phylogeny. This branch has been shortened by recent findings including the discovery of wukongopterid pterosaurs with a mosaic of pterodactyloid skull and neck character states and non-pterodactyloid body and limb character states. This led to hypotheses that the skull and neck character states found pterodactyloids evolved earlier, modules are present in pterosaur evolution, and modules were the principal focus of natural selection.

Rediscovered pterosaur specimens in the Natural History Museum, London, originally identified by Sir Richard Owen are identifiable as the earliest wukongopterid pterosaurs. They lack the elongate skull and cervical vertebrae previously uniting the wukongopterids with the pterodactyloids and cast doubt on this conception of modular evolution in pterosaurs. Phylogenetic analysis of these specimens and the Pterosauria confirms this placement but also confirms the shared early evolution of the other pterodactyloid skull character states. To test the presence and importance of modules in pterosaur evolution, a Bayesian phylogenetic approach was applied to the analysis. Partitioning and analyzing the data according to these two modules does not explain the data better than without these use of these modules. However, the modules do outperform random partitions. A more defensible hypothesis would be that modules were present in pterosaur evolution but were not the principal focus of natural selection to the exclusion of all individual characters. The independent elongation of the skull and neck in wukongopterids is most consistent with a functional complex related to the aerial predator ecology originally suggested for the group.

Technical Session VII (Thursday, November 3, 1:45 pm)

FINDING FOSSILS IN NEW WAYS: A NEURAL NETWORK MODEL FOR PREDICTING THE LOCATION OF FOSSIL-BEARING DEPOSITS

ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA; EMERSON, Charles, Western Michigan University, Kalamazoo, MI, USA; CONROY, Glenn, Washington University, St. Louis, MO, USA

Locating productive fossil-bearing localities in the field typically requires expert knowledge in geology and anatomy, the hard work of experienced field crews, and some degree of good luck. One way to reduce the role of serendipity in increasingly expensive paleontological fieldwork is to develop predictive models for the location of productive fossil-bearing deposits. We have developed, trained, and evaluated an artificial neural network (ANN) model to identify the characteristic spectral signatures of known, productive Paleogene mammal-bearing localities in the Great Divide Basin (GDB) of southwestern Wyoming. Our model uses remote sensing imagery derived from the ETM+ sensor carried aboard Landsat 7 to identify the spectral signature of five different classes of land cover in the GDB, one of which is represented by known, productive localities. Six bands from the visible and reflective infrared parts of the electromagnetic spectrum were analyzed within a geographic

information system (GIS) database with a spatial resolution of 14.5 meters. We used a feed-forward, back-propagated multilayer perceptron ANN model to locate other areas within the basin which shared the spectral signature of our known localities. Our algorithm identifies patterns of features that are common to fossil bearing deposits, and looks for these features in a "fuzzy" fashion throughout the entire study area. The model's output provides a classification of all pixels within the study area into one of the five land cover classes, along with associated probabilities. Post-hoc accuracy testing based on roughly 25% of the nearly 100 known localities in the GDB resulted in a correct classification of 79% of localities, while for all five land cover classes, a correct classification of 85% was achieved. The neural network approach that we have developed in the Paleogene of Wyoming is generalizable to paleontological field research in other geographic areas or time periods wherever productive localities share distinctive sets of geospatial and spectral features.

Poster Session II (Thursday, November 3)

RAPID MICROBIALLY-MEDIATED CALCIUM CARBONATE PRECIPITATION: A MODEL FOR PERMINERALIZATION OF EMBRYONIC SOFT TISSUE IN SAUROPOD EGGS

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Extraordinary preservation of the embryonic contents of sauropod eggs in the Upper Cretaceous Anacleto Formation at Auca Mahuevo, Argentina provides evidence of rapid, microbially-mediated precipitation of calcium carbonate. We develop a preservational model for the Acua Mahuevo embryonic material (embryonic skin and eggshell membrane) by characterizing mineralogical composition and microfabrics of the fossilized egg contents using optical and cathode-luminescence (CL) petrography, X-ray diffractometry (XRD), and field-emission scanning electron microscopy (FEM).

Microfabric features within the fossilized embryos include spherulites comprising radiating acicular calcite, ooids, peloids, pellets, *Microcodium*, calcified filaments, and microcrystalline calcite (micrite). Collectively, these features represent the interplay of metabolic activity and chemical factors (e.g. pH, [Ca2+], anoxia) proximal to and within the decaying embryonic tissue facilitated by cyanobacterial and EPS (extracellular polymeric substances) biofilms and mucilaginous bacteria (spherulites/ooids), actinobacteria and saprotrophic fungi (*Microcodium),* fungi (calcified filaments), other indeterminate soil microbes (micrite), and invertebrates (pellets/peloids/micrite).

Metabolic activity within the microbial community (biofilm) colonizing the embryonic tissue facilitated calcium carbonate precipitation leading to exceptional preservation through calcite permineralization (microbial autolithification) of the embryonic soft tissue. The pathway of events driving this included: 1) microbial colonization of embryonic tissue following drowning and sediment burial under anaerobic conditions limiting autolysis, 2) embryonic tissue consumption leading to formation of biofilms that pseudomorphed the embryo form and structurally supported the soft tissue, and 3) microbially-mediated calcite biomineralization of the embryonic soft tissue pseudomorph by growth of and infusion with calcite crystals (permineralization). This process does not require preservation of endogenous soft tissue components, but rather only replication of original embryonic tissue as a biofilm pseudomorph entombed within calcite.

Technical Session XV (Saturday, November 5, 8:45 am)

DICYNODONT (THERAPSIDA, ANOMODONTIA) ASSEMBLAGES FROM THE LUANGWA BASIN, ZAMBIA: TAXONOMIC UPDATE AND IMPLICATIONS FOR BIOSTRATIGRAPHY AND BIOGEOGRAPHY

ANGIELCZYK, Kenneth, The Field Museum, Chicago, IL, USA; STEYER, J. Sébastien, CNRS-Museum, d'Histoire Naturelle, Paris, France; SIDOR, Christian, University of Washington, Seattle, WA, USA; SMITH, Roger, Iziko: South African Museum, Cape Town, South Africa; WHATLEY, Robin, Columbia College of Chicago, Chicago, IL, USA

Dicynodonts were among the first tetrapod fossils discovered in the Luangwa Basin in the late 1920s. As part of our ongoing research in Zambia, we conducted a comprehensive taxonomic revision of Permian and Triassic dicynodonts reported from the basin, incorporating new data from our 2009 field season. We recognize 14 dicynodont species in the Permian upper Madumabisa Mudstone, including two new, endemic species; reports of *Lystrosaurus* from this formation are in error. In addition, we found no significant partitioning of dicynodont taxa in the northern and southern parts of the basin, despite substantial differences in preservation, indicating the presence of a single faunal assemblage in the Upper Permian. The Madumabisa dicynodont assemblage is best correlated with the *Cistecephalus* Assemblage Zone of South Africa. The shared presence of *Dicynodon huenei* and *Katumbia* in the Luangwa Basin and the Ruhuhu Basin of Tanzania suggests that the Tanzanian Usili Formation also can be correlated with the *Cistecephalus* zone. Interestingly, the Madumabisa assemblage from Zambia is more similar to the coeval assemblage from South Africa, despite its closer geographic proximity to Tanzania. The Karoo and Ruhuhu basins also include more endemic species in the Permian than the Luangwa Basin. The Triassic Ntawere Formation preserves four dicynodont species, which occur at two stratigraphic levels. The lower Ntawere assemblage resembles the Omingonde Formation of Namibia in the presence of *Kannemeyeria lophorhinus* and potentially *Dolichuranus*. The upper Ntawere assemblage shares the genus *Sangusaurus* with the Manda beds of Tanzania, and includes the endemic *Zambiasaurus*. Comparisons of these assemblages to the Omingonde and Manda suggest both are best correlated with the *Cynognathus* C subzone. When combined with data on other tetrapod taxa, our revised dicynodont assemblages contribute to an emerging picture of broad faunal similarity in southern and eastern Africa during the Late Permian, and increasing differentiation between the South African and other Karoo basins following the end-Permian extinction.

Poster Session IV (Saturday, November 5)

DEPOSITIONAL ENVIRONMENT OF ISOLATED SKELETAL ELEMENTS FROM THE FAIRMEAD LANDFILL LOCALITY (PLEISTOCENE, IRVINGTONIAN), MADERA COUNTY, CALIFORNIA

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Extensive horizontal exposures of fossiliferous strata at the Fairmead Landfill locality have provided an opportunity to evaluate interpretations of the fossils' depositional environment (fluvial deposition in or near alluvial fans) and provide insight into taphonomic pathways for the fossils' preservation. In the summer of 2007, 39 out of 57 *in situ* isolated skeletal elements were recovered from a reddish-brown argillaceous siltstone facies that contains mudcracks and burrows. The siltstone facies is cross-cut by 3 red to light tan, silty sandstone to coarse sandstone channel-fill facies, each 5-10 meters wide. The channel-fill facies extended from the northeast to the southwest across the landfill cell. The northeast-southwest orientation of the sand-filled channel facies supports previous interpretations of a southwest paleocurrent direction.

The siltstone facies represents deposition in an overbank environment with an attritional assemblage of isolated vertebrate skeletal elements. Observations of bone breakage and weathering prior to burial indicate exposure of the skeletal elements prior to burial. The development of mudcracks and extensive burrowing in the overbank siltstone facies is consistent with exposure and weathering of skeletal elements prior to burial. Continued discoveries of bone breakage support previous interpretations that invoked trampling of bones by large herbivores.

Poster Session I (Wednesday, November 2)

CHANGING OLD VIEWS WITH NEW TECHNOLOGY: USING XRF TO COMPARE BONE CHEMISTRY OF BIRDS WITH OTHER VERTEBRATES

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The rehabilitation of birds with broken bones, both wild and domestic, is problematic due to the tendency of bird bones to shatter on impact rather than fracture. In the veterinary literature, this characteristic is attributed to either elevated amounts of calcium within the apatite structure or a higher ratio of bone apatite to collagen within the skeleton. However, it has not been demonstrated which of these can be attributed the brittle behavior of bird bones. Alternatively, this characteristic may not be a result of differences in bone chemistry at all, but rather differences in the mechanical properties of bird bones caused by the pneumatization of much of the skeleton (in flight birds). Although recent studies have shown that bird bones are denser than bones of other vertebrates, the reason for this greater density is unknown. In this study, I use a ThermoScientific Niton XL3t XRF Analyzer to examine the chemistry of fish, reptile, mammal, and bird bones to test whether levels of calcium are elevated in birds compared to other vertebrate groups. Specimens consisted of the following areas of the skeleton: skull (fish, reptile, bird, and mammal), vertebrae (bird, reptile, and mammal), long bones (bird and mammal), and limb girdles (reptile, bird, and mammal). The samples included representatives of both wild and domestic species, as well as normal and pathologic bone tissue. Calcium was measured in overall parts per million (ppm).

Birds were found to have lower ppm of calcium in their bones compared to reptiles and mammals, with values closer to those seen in fish. These XRF data suggest that the brittle behavior of bird bones in response to trauma is not caused by elevated levels of calcium in the bones; however, further testing is necessary to assess whether apatite to collagen ratios differ in birds compared to other vertebrates.

Poster Session I (Wednesday, November 2)

PLESIOSAUR STRUCTURAL EXTREME FROM THE MAASTRICHTIAN OF ANGOLA

ARAÚJO, Ricardo, Southern Methodist University, Museu da Lourinha, Dallas, TX, USA; LOUIS, Jacobs, Sourthern Methodist University, Dallas, TX, USA; POLCYN, Michael, Southern Methodist University, Dallas, TX, USA; MATEUS, Octávio, Universidade Nova de Lisboa, Museu da Lourinhã, Lourinhã, Portugal; SCHULP, Anne, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands

An elasmosaurid plesiosaur (PA103) was recovered from the Mucuio Formation, Bentiaba, Namibe Province, southern Angola, and preserves the pectoral and pelvic girdles, cervical and dorsal vertebrae, and ribs. However, it is the pectoral girdle that shows several unique adaptations that are unparalleled in other plesiosaurs, including a highly atrophied dorsal process of the scapula, long longitudinal pectoral bar with extensive contacts between the coracoids anteriorly and posteriorly and between scapulae, presence of a left-right asymmetry of the coracoid ventral process, and widely expanded posterior portions of the coracoids. The reduced dorsal process indicates that the muscles required for terrestrial

locomotion atrophied during elasmosaur evolution. To test this hypothesis, pectoral girdle muscle topology and maximum-attachment areas were determined within a squamate and archosaur phylogenetic bracket, and the evolution of the pectoral girdle musculature among Sauropterygia was traced and homologized. A Catalano-Goloboff phylogenetic morphometrics analysis (one landmark character, 14 landmarks) of forty Eosauropterygia taxa retrieved the Bentiaba specimen as derived among Elasmosauridae and supported the general tree topology reported previously from phylogenetic analyses based on anatomical characters other than landmarks. The myological reconstruction determined in this study serves as a basis for determining boundary conditions involved during muscle action. These results allowed construction of finite-element models derived from laser-scan data of the Bentiaba specimen. The Bentiaba specimen model results were contrasted with other basal plesiosaur pectoral girdles to determine the functional significance of the unique skeletal structure of the Angolan fossil. The Bentiaba specimen is a structural extreme; a compromise between the undesired consequences of having a large muscle attachment area and a geometry that minimizes stress within bones by also taking advantage of arthrological relationships with contiguous bones.

Poster Session I (Wednesday, November 2)

A MORPHOMETRIC ANALYSIS OF THE MANDIBULAR PREMOLARS AND MOLARS OF SOUTH AFRICAN *AUSTRALOPITHECUS*

ARBOR, Tafline, Des Moines University, Des Moines, IA, USA

Considerable debate has focused on whether there are high levels of variation in size and morphology in *Australopithecus africanus*, current taxonomic attributions of a variety of South African australopithecine specimens, the number of species represented within the Makapansgat and Sterkfontein samples of *A. africanus*, and the phylogenetic relationships of currently recognized South African australopithecine taxa. Analyses of mandibular premolar and molar shape variation are presented in order to assess the patterning and degree of size and morphological variation in the dentition of currently recognized South African australopithecine taxa.

Dental landmark coordinates were digitized in TpsDig2 using occlusal photographs of the mandibular premolars and molars of South African taxa from Kromdraai, Swartkrans, Sterkfontein, Taung, and Makapansgat. Landmarks were recorded for the cusp tips for unworn specimens and semi-landmarks were recorded for the overall occlusal outlines for both moderately worn and unworn specimens. These coordinate data were imported into Morphologika where generalized Procrustes analysis and principal components analysis were performed. Analyses of the overall occlusal shape of the mandibular premolars and molars and cusp tip positioning were executed on the samples of unworn teeth. Analyses were repeated for the entire sample of worn and moderately worn specimens, excluding cusp tip landmarks, in order to further examine results with larger sample sizes. Analyses of both worn and unworn samples indicate that the occlusal morphology of mandibular premolars and molars does not pattern well with current taxonomic attributions of South African australopithecines and reflect considerable overlap in size and morphological variation among currently recognized species. These results suggest that confident assignment of isolated mandibular premolars and molars of South African australopithecines to a particular species is problematic and may further confound efforts to reconstruct the phylogenetic relationships of these taxa on the basis of dental morphology.

Poster Session IV (Saturday, November 5)

TAPHONOMIC FILTERS OF AGE GROUPS OF THE ANKYLOSAURID DINOSAUR *PINACOSAURUS*

ARBOUR, Victoria, University of Alberta, Edmonton, AB, Canada; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

The ankylosaurid *Pinacosaurus* is known from several bonebeds from Mongolia and China. These specimens largely represent juveniles, based on their small size, lack of body osteoderms other than cervical rings, and unfused neurocentral sutures. The individuals in each of these sites probably died and were buried in a short interval of time. At Bayan Mandahu in China, the skeletons are preserved upright with limbs tucked under the body, and were buried during a sandstorm or by a dune-sourced alluvial fan. The presence of aligned, closely associated articulated skeletons suggests that this represents a social group. The Alag Teeg bonebed in Mongolia exhibits characteristics associated with miring, including plunging limbs and preferential preservation of limb elements. Although this could represent an accumulation of individuals independently drawn to the same resource, the Bayan Mandahu bonebed supports the interpretation that the Alag Teeg bonebed also represents a group. A new review of the Alag Teeg material shows that an individual more than twice the size of the juveniles, with closed neurocentral sutures, was present in the bonebed. This adult may have been part of the group of juveniles, may have been independently drawn to the same resource, or may have been mired at a later time. Drought assemblages, with many animals drawn to a dwindling water supply, tend to have trampled, disarticulated elements, unlike the taphonomy of Alag Teeg. Modern examples show that social groups can be preserved in short periods of time via miring. It is likely that the adult *Pinacosaurus* was mired at the same time as the juveniles, and was probably part of the group. Comparison with the extant phylogenetic bracket suggests that parental care can explain the presence of the adult with multiple juveniles. Ostriches form juvenile groups guarded by adults, and extant crocodilians guard large groups of offspring for about one year. Juvenile *Pinacosaurus,* lacking osteoderms and a fully-developed tail club, may have benefited from the presence of an adult. The absence of an adult at Bayan Mandahu may indicate that the adult(s) were able to escape the catastrophic accumulation of sand.

Symposium 2 (Wednesday, November 2, 11:00 am)

FAUNAL REMAINS FROM *EL FIN DEL MUNDO* ARCHAEOLOGICAL SITE, SONORA, MEXICO

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At present, the Sonoran Desert is one of the driest regions in North America. However, within the last 20,000 years, accounting for the maximum last glacial and warming events, conditions varied significantly, allowing for permanent water ponds and running water. Those conditions, then, supported a mammal community that included tapirs (*Tapirus bairdii*), mylodonts (*Paramylodon harlani*), and gomphotheres (Gomphotheriidae), among others. Such evidence has been found at the archaeological site of El Fin del Mundo (The End of the World), a Clovis site located in the central portion of the State of Sonora, in the Sonoran Desert. Two major bone beds were exposed: one around 12,000 years BP (upper bone bed), which included the human occupation and parts of two juvenile gomphotheres, plus tapir and mylodont, buried by diatomaceous lake sediments; and a second, older level (lower bone bed), characterized by sandy spring-derived alluvium, and which included temperate animals, such as bison (*Bison* sp.), camels (*Camelops* sp.), and horses (*Equus* sp.). Those two faunules are clearly separated in time. The upper one may indicate a warm, humid forested habitat. The lower stratum must have formed under different climatic conditions, indicated by animals from cold, dry habitats, such as grasslands, including bison, camels, horses, hare, and woodrat. Further analyses are warranted to support the preliminary inferences about faunules composition, and to document the taphonomic history of the site.

Poster Session II (Thursday, November 3)

***EQUUS* FROM THE MIDDLE IRVINGTONIAN FAIRMEAD LANDFILL LOCALITY, MADERA COUNTY, CALIFORNIA**

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The middle Irvingtonian Fairmead Landfill site in Madera County, California preserves a diverse fauna collected from fluvial channel, overbank, and lacustrine deposits of the upper unit of the Turlock Lake Formation. The age of the locality is 0.78 Ma to 0.55 Ma. The fauna is dominated by large herbivorous mammals, with *Equus* representing two-thirds of identified specimens. The horses include individuals of all ontogenetic ages, from juveniles to aged adults. The considerable Fairmead Landfill collection provides ample material for comparison to other Pleistocene horses throughout North America. Metatarsals from the Fairmead Landfill were measured and compared to *Equus* from the following sites: *Equus* sp., Irvington, California; *E.* "*occidentalis*", McKittrick and Rancho La Brea, California; *E. scotti*, Rock Creek, Texas; *Equus* sp., Dalhart Horse Quarry, Texas; *E. conversidens*, San Josecito Cave, Mexico; *E. ferus*, Natural Trap Cave, Wyoming; and *Equus* sp., Natural Trap Cave, Wyoming. Horses from the Fairmead Landfill site fall in the low end of the *E.* "*occidentalis*" / *E. scotti* distribution and in the upper end of the *E. conversidens* / *E. ferus* range. In addition to postcranial metrics, mandibles were examined for the presence or absence of infundibula, a character useful in distinguishing among horse species. The presence of infundibula in lower incisors of *Equus* at Fairmead Landfill indicates that these horses are neither *E.* "*occidentalis*" nor *E. conversidens*, since both these species lack infundibula in the lower incisors. This suggests the horse species from Fairmead Landfill may be either *E. scotti* or *E. ferus*, both of which possess infundibula. The infundibulum of the right 3rd incisor is open posteriorly, which also occurs in both *E. scotti* and Pleistocene North American *E. ferus*.

Technical Session XII (Friday, November 4, 2:00 pm)

PHYLOGENETIC MAPPING OF TRAITS OF THE AVIAN ALTRICIAL-PRECOCIAL SPECTRUM, AND ITS IMPLICATIONS FOR INFERRING EARLY AVIALAN LIFE HISTORY

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Extant birds can be classified according to development of offspring along an altricial-precocial spectrum, with fully-functional, feathered individuals at one end (precocial) and helpless, blind, naked chicks at the other (altricial). However, evolution of the various reproductive strategies along this spectrum has been difficult to understand because few studies have placed these data in phylogenetic context. I separated the common division of the precocial-altricial spectrum into seven character states to map life-history data onto both molecular and morphological avian phylogenies. The two trees imply different results: the former suggests that altriciality was evolved independently at least four times (by Passeriformes, Coraciiformes, Cuculiformes, and Apodiformes), while the latter implies a single origin. Both outcomes underscore the need for an avian phylogeny that integrates morphological and molecular data.

I also tested the distribution of avian investment in locomotor modules (pectoral limb, pelvic limb, and tail) and its correlation when mapped against the precocial-altricial spectrum as seen in a phylogenetic context. Taxa on the precocial end tend to invest more highly in the pelvic limb module, and taxa at the altricial extreme invest more highly in the pectoral module. This correlation suggests that an emphasis on a particular locomotor module may provide one proxy for developmental mode in extinct birds. However, these results suggest that early avialans should not be assumed to have shared all the life-history characteristics of living ratites and galloanseriformes, merely because the latter are the earliest-diverging groups of crown-group birds.

Symposium 2 (Wednesday, November 2, 11:45 am)

TOPOGRAPHIC AND CLIMATE CHANGE DIFFERENTIALLY DRIVE PLIOCENE AND PLEISTOCENE MAMMALIAN BETA DIVERSITY OF THE GREAT BASIN AND GREAT PLAINS PROVINCES OF NORTH AMERICA

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The Great Basin of the western United States has elevated beta diversity compared to other parts of the continent, a pattern that could be caused by Pleistocene climatic cycling or tectonically-driven topographic change. Previous results using the MIOMAP database suggested an increase in beta diversity by the Pliocene, supporting the tectonic-driver hypothesis. We test this hypothesis using the FAUNMAP II database. We focused on non-flying land mammals from the Late Miocene to Recent of the Great Basin, using the central Great Plains of the United States as a control. We partitioned faunal lists from FAUNMAP II into NALMA intervals and estimated richness- and evenness-based beta diversity for each time-slice. Great Basin richness-beta ranged from 8.9 to 11.8, while Great Plains values ranged from 5.3 to 9.0. While Great Basin richness-beta was greater in each interval, no differences were significant. The evenness-beta results were, on the surface, clearer, with a significant difference in each interval. Great Basin values were all around 0.11, and Great Plains values were between 0.06 and 0.09 for all intervals except the Holocene. The Great Plains evenness-beta value of 0.14 for the Holocene was unexpectedly high, significantly higher than the Great Basin value for that time. Beta diversity, in terms of both richness and evenness, is higher in the Great Basin than in the Great Plains at all Plio-Pleistocene intervals except for the Holocene, supporting our hypothesis that Great Basin beta diversity has primarily been driven by tectonic change. We explored the Great Plains Holocene evenness-beta spike, hypothesizing it was driven by the megafaunal extinction or by fine sampling of the interglacial transition. We clustered Great Plains Holocene sites by taxon relative abundance, but did not find any clear reason to support or reject either of these hypotheses. We also re-analyzed the data after removing all sites containing megafauna, but the Great Plains Holocene was still significantly higher than the Great Basin, allowing us to reject the megafaunal extinction as cause of the elevated beta diversity.

Preparators' Session (Thursday, November 3, 11:15 am)

DEFORMATION IN SILICONE MOLDS AND ITS EFFECT ON THE ACCURACY OF CASTS

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Fossils are molded and cast to produce near-perfect copies of specimens for research, display, trade, or sale. There are two basic types of multi-part silicone molds: block molds and glove molds. Block molds have thick silicone walls and are self-supporting. Glove molds are thin walled molds that are supported by a rigid mother mold. The two halves of a mother mold can either be in contact along the seam line, or they can be separated by an extension of the silicone mold, forming a gasket.

A phytosaur tooth was cast in a one-part mold and re-molded using all three kinds of the multi-part mold. A grid pattern was carved into the surface of the tooth cast to provide points for measuring the amount and type of distortion. The resulting block mold and glove molds were tested to determine how the molds deform during the process of casting. The molds and casts were produced with a platinum-cured silicone rubber and polyurethane plastic. During the casting process, two-part molds were bound together using a variety of techniques: rubber bands, plywood with c-clamps, and shrink-wrap.

All three types of molds can consistently produce accurate casts when used properly. If block molds or gasket-type mother molds are bound together too tightly, the casts will compress along the seam line. Contact mother molds initially produce high quality copies of fossils, but later casts are often distorted after plastic leaks between the silicone mold and mother mold. This problem can be solved by separating the mother mold from the silicone mold with a single layer of plastic wrap and changing the wrap between pours. Molds should be bound tight enough to prevent leaks but not enough to deform the silicone surface. The greatest amount of deformation typically occurs where a thin layer of silicone surrounds a large void within the mold. To avoid this problem, a silicone mold can be opened, filled with plastic resin, and allowed to cure before combining the two halves.

Poster Session I (Wednesday, November 2)

NEW FIND OF ENIGMATIC PIPID FROGS IN THE UPPER PLEISTOCENE OF THE SOUTH AMERICAN PAMPAS

BÁEZ, Ana, CONICET - Departamento de Ciencias Geológicas, FCEN, UBA, Buenos Aires, Argentina; GÓMEZ, Raúl, CONICET - Departamento de Ciencias Geológicas, FCEN, UBA, Buenos Aires, Argentina; TAGLIORETTI, Matías, CONICET - Centro de Geología de Costas y del Cuaternario, Universidad Nacional de Mar del Plata, Mar del Plata, Argentina

Pipids are odd-looking frogs with a derived morphology that has been considered to be the result of a successful adaptation to a fully aquatic lifestyle. This monophyletic group comprises 33 extant species arranged in 3 clades mainly distributed in tropical regions of northern South America (*Pipa*) and sub-Saharan Africa (Xenopodinae and Hymenochirini). Their fossil record, however, documents greater diversity and wider distribution in South America in the Cretaceous and Paleogene. Recently, isolated postcranial bones bearing distinctive pipid features were discovered in an Upper Pleistocene locality in Argentina, nearly2000 km farther south from their present distribution in the continent. The recent find of a well-preserved ilium that might represent the same taxon in a Late Pleistocene locality of the Pampean Region confirms the intriguing presence of this group in southern South America. Comparisons with a broad sample of extant (*Xenopus*, 9 species; *Pipa*, 4 species; *Hymenochirus*, 1 species) and extinct (e.g., *Avitabatrachus*; *Eoxenopoides*; *Saltenia*; *Shelania*) pipids indicate that the Pleistocene material represents a new taxon. It is characterized by some presumably plesiomorphic features unknown in living taxa, such as the absence of dorsal crest and a moderate lateral exposure of the dorsal acetabular expansion. A preliminary phylogenetic analysis of pipoids combining morphological and molecular data places the new pipid as a stem xenopodine in an unresolved polytomy that also includes "*Xenopus*" *romeri* from the Upper Paleocene-Lower Eocene of Brazil as well as two taxa from the Eocene of Patagonia. The discovery indicates that stem-group xenopodines, once thought to have become extinct toward the end of the Eocene, survived in South America into the Quaternary implying an ample gap in the fossil record and posing interesting questions with regard to their evolutionary history. Finally, the available evidence is not sufficient to determine whether this archaic lineage survived in southern South America throughout this period or, conversely, whether it reoccupied higher latitudes from the north during an interglacial after their extinction in Patagonia.

Poster Session IV (Saturday, November 5)

EARLY OSSIFICATION AND CALCIFIED TISSUES IN THE SKULL OF *HYPACROSAURUS STEBINGERI* (ORNITHISCHIA, LAMBEOSAURINAE): A PRELIMINARY STUDY.

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From a histological perspective, the early phases of dinosaur skull development remain poorly understood. Here we describe the different calcified tissues present in craniofacial elements from a perinate *Hypacrosaurus* from the Upper Cretaceous of Montana. Every element is highly vascularized and mostly composed of primary woven bone trabeculae, indicating rapid growth due to brain development and metabolism. Despite the early ontogenetic stage of this specimen, secondary reworking has already begun. Four cartilaginous bones, already ossified, show remnants of primary cartilage on their sutural edges: the basisphenoid, the prootic, the quadrate and the supraoccipital. The chondrocyte lacunae are rounded, hypertrophic and organized into nodules or cartilage canals. The other cartilaginous bones (i.e the basioccipital, the exoccipital, the laterosphenoid and the orbitosphenoid) are completely ossified at this stage and do not show remnants of cartilage. These observations provide information about the timing of ossification in an ornithischian dinosaur. In addition, some membrane bones show a peculiar tissue, morphologically intermediate between bone and cartilage: a calcified extracellular matrix with numerous cellular lacunae showing the appearance of non-hypertrophic chondrocytes. This "chondroid-like" tissue is present on the sutural edges of the surangular, the frontal and the parietal, but also in the alveolar process of the dentary. Although extant avian and mammalian membrane bones possess secondary cartilage in their sutural areas, no secondary cartilage was found on any of the membrane bones of the study specimen. Nevertheless, further investigation of other specimens should be made to determine the ability (or inability) of dinosaurs to form secondary cartilage. This study sheds light on the early craniofacial histogenesis of a dinosaur and emphasizes the importance of investigating the bone microstructure of skulls, in parallel with the more widely studied postcranial elements.

Poster Session IV (Saturday, November 5)

BIOGEOGRAPHIC IMPLICATIONS OF A PARTIAL CERATOPSID SKELETON FROM THE LOWER TWO MEDICINE FORMATION (CAMPANIAN), MONTANA

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In 1985, the partial skeleton of a large ceratopsid (Dinosauria: Ornithischia; MOR 390) was collected from the lower Two Medicine Formation (Campanian) in northwestern Montana. This previously undescribed specimen represents one of the oldest known ceratopsids from North America, having been found in a horizon slightly above an ash bed radiometrically dated at ~80 Ma. *Diabloceratops eatoni* (~80.1 to 79.5 Ma), from the Wahweap Formation

of Utah, and *Albertaceratops nesmoi* (~77.5 Ma), from the Oldman Formation of Alberta, are of comparable age. Ceratopsid material has also been reported from the Foremost Formation of Alberta (~79 to 78 Ma) and the Menefee Formation of New Mexico (~82 Ma). MOR 390 was found in the same stratigraphic zone that produced the holotype of the basal neoceratopsian *Cerasinops hodgskissi*. Much of the post-cranial skeleton is preserved, including a humerus, scapulocoracoid, sacrum, ilia, fibula, partial femur, vertebrae, and ribs. Several of the ribs exhibit pathologies. The ilia are narrow with an accentuated sigmoidal curve, consistent with referral to the centrosaurinae. MOR 390 demonstrates that ceratopsids were present in the Two Medicine ecosystem prior to the late Campanian transgression of the Bearpaw Sea. The quarry roughly correlates with the maximum transgression of the Claggett Sea and thus supports the hypothesis that the presence of ceratopsids in the Two Medicine ecosystem was linked to the coastal environments produced by marine transgressions.

Poster Session I (Wednesday, November 2)

ENDOCRANIAL MORPHOLOGY OF LIVING AND EXTINCT PENGUINS: TRANSITIONS ASSOCIATED WITH THE EVOLUTION OF UNDERWATER "FLIGHT"

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The evolution of underwater flight within penguins correlates with a number of dramatic morphological rearrangements. A reorganization of integumentary structures, the musculature, and the skeleton has been well documented, yet the nature of neuroanatomical transformations that occurred along the stem lineage leading to modern penguins remains poorly understood. We generated digital endocranial casts of crown and stem penguins as well as several closely related outgroup taxa in order to document in detail the anatomy of the brain and sensory organs and to infer any transformations that may have occurred. The endocasts yield functional data and phylogenetically informative characters correlated with the brain, carotid arteries, pneumatic recesses of the skull, and semicircular canal system. Some features that can be associated with visual acuity and proprioception retain a plesiomorphic morphology in spheniscids that is similar to the morphology apparent in extant, volant birds. In addition, we observe volumetric changes in the total endocranial space and the isolated cerebrum within the spheniscid lineage. Volumetric data support a brain morphology that is more consistent with closely related volant taxa rather than the morphology of more distantly related taxa that also lack the ability to fly. Overall, the endocranial morphology within the spheniscid lineage displays a unique mosaic of plesiomorphic and derived features that can be closely associated with their unusual mode of locomotion.

Preparators' Session (Thursday, November 3, 10:30 am)

HIGH-RESOLUTION X-RAY COMPUTED TOMOGRAPHIC SCANNING FOR PREPARATION: LOGISTICS AND LIMITATIONS

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Paleontological application of high-resolution X-Ray computed tomography (HRXCT) has exploded in the last decade. Literally hundreds of papers and abstracts have implemented HRXCT technology. Data from HRXCT scans may be used to create three-dimensional models of specimens with magnification allowing easy viewing of specimens without the risks of repeated, manual manipulations. Internal anatomy of enclosed structures (e.g., the inner ears of fossil rodents) may be documented for the first time. This might lead one to ask the question: Is this the end of physical specimen preparation? The answer is: No. Like any other medium which puts steps between observers and the observed, HRXCT introduces potential for data loss and error. Importantly, digital scans are not photographs of objects, but reconstructed images produced from overlapping tomogram slices. Some of the finest structures (e.g., pterygoid teeth of the tiny gekkonomorph AMNH FR 21444) may be lost in these reconstructions, and soft-tissue impressions may be completely invisible. Instead, HRXCT is a powerful complementary tool for use in conjunction with traditional tools and procedures for specimen observation (preparation, microscopy, photography, etc.). I will discuss specimens offering the biggest challenges to HRXCT, such as those in highly lithified sediments and those with low fossil/matrix density differentials and offer several case studies. Among these are a new chinchillid rodent from the Chilean Andes, two notoungulate basicrania encased in volcanic ash, and a Jurassic lizard from China. Each case offers specific applications for HRXCT and distinct limitations of such approaches based on mechanical capacities, software, and logistics of even the best HRXCT scanners. Materials, settings, raw and reconstructed data, and fully prepared specimens will be compared. Further application of lower-cost, quicker scans may allow a quick 'triage' of backlogged specimens, allowing researchers and preparators to prioritize specimens for processing. Finally, although technology offers spectacular ways to further study specimens, there is still no replacement for an in-hand original specimen.

Poster Session IV (Saturday, November 5)

CYCLING OF VERTEBRATE ALPHA DIVERSITY PRECEDING THE CRETACEOUS MASS EXTINCTION: EVIDENCE FROM THE LATEST MAASTRICHTIAN OF CENTRAL CANADA

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Vertebrate microsites are an invaluable tool in the study of paleoecology, as they allow for the quantification and description of temporal and spatial paleobiodiversity trends. When coupled with paleoclimate indictors such as stable isotope analyses and plant macrofossil data, insight may be gained as to how climatic factors influenced biodiversity in both time and space. Here we examine the relationships between climate, area and biodiversity during the last half million years of the Cretaceous period in central Canada. Data from thirty vertebrate microsites, together containing some 7500 vertebrate microfossils, were collected from the base of the latest Maastrichtian (65Ma) Upper Frenchman Formation to the K-T boundary clay in Grasslands National Park, Saskatchewan. Stratigraphic level surveys were performed to assess the relative stratigraphic position of each microsite, as well as the depositional environment. The stratigraphic surveys, in combination with chemostratigraphic data, allow for a sequence of stratigraphically corrected microsites from the base of the Upper Frenchman Formation through to the K-T boundary to be established. Once sampling and collection biases have been accounted for and microsite diversities are compared, a temporal pattern of alpha diversity cycling emerges. Diversity appears to peak in at least three stratigraphic horizons, with horizons of lower diversity situated between them. Both the number of sites and the diversity within the sites decreases dramatically in the last 10m below the K-T boundary. The alpha diversity cycles may be associated with the large-scale, repetitive depositional cycles of ironstone, mudstone and sandstone observed throughout the study area. Ongoing work on isotope and plant macrofossil data will also determine what influence paleoclimate had on these cycles. This study demonstrates that local vertebrate alpha diversity may have been fluctuating with local environmental conditions until just prior to the Cretaceous mass extinction, and suggests that alpha diversity may have been waning just prior to the extinction event itself.

Technical Session VI (Thursday, November 3, 2:00 pm)

GEOCHEMICAL AND MORPHOLOGICAL EVIDENCE OF MELANIN PRESERVATION IN THE FEATHERS OF THE EARLY CRETACEOUS BIRD *GANSUS YUMENENSIS*

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Recent high profile studies have purportedly demonstrated the presence of pigment containing organelles, melanosomes, within fossilised soft tissues using predominantly morphological evidence. This study combines both morphological and geochemical analyses to examine the potential preservation of melanin pigment and melanosomes within two exceptionally preserved isolated *Gansus yumenensis* feathers from the early Cretaceous of China. Environmental scanning electron microscopy (ESEM) reveals elongate structures consistent with those identified as eumelanosomes (containing the dark pigment eumelanin) in previous studies. These structures were restricted to visibly dark areas of the feathers and were absent from both the lighter areas of the feathers as well as their respective sedimentary matrices. Fourier transform infrared spectroscopy (FTIR) of these visibly dark areas demonstrates the presence of functional groups indicative of eumelanin comparable to those found in extant *Sepia officinalis* eumelanin, including carboxylate, ketone, hydroxyl and secondary amine groups; such groups were again absent from lighter areas of the feathers and the matrix as shown by an infrared map of the ketone group in the barbules of one of the feathers. Different organic free radical signals between one feather and its matrix are demonstrated using electron paramagnetic resonance spectroscopy (EPR), however the technique was unable to resolve the eumelanin signal within the feather. Pyrolysis gas chromatography mass spectrometry (Py-GCMS) shows a similar distribution pattern of aliphatics in both the fossil feathers that differed from that of their respective matrices, however melanin breakdown products were not observed. These techniques in combination strongly suggest the presence of endogenous organic material in the fossil feathers, however only FTIR was successful at identifying melanin derived breakdown products. This is the first time that Py-GCMS and other organic geochemical methods have been used in conjunction with traditional morphological techniques to provide clear evidence of the preservation of original melanic pigmentation in fossil feathers.

Technical Session I (Wednesday, November 2, 8:45 am)

POSTCRANIAL SKELETAL PNEUMATICITY AND THE EVOLUTION OF ARCHOSAUR RESPIRATORY SYSTEMS

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Extant archosaurs (birds and crocodilians) possess lungs that permit unidirectional airflow. Consequently, it has been hypothesized that unidirectional flow might have been present in the common ancestor of crown-group archosaurs and potentially present in many extinct taxa (including non-avian dinosaurs, pterosaurs, 'rauisuchians', aetosaurs, and other pseudosuchians). Although the soft tissues are not fossilized, they leave traces as characteristic pneumatic fossae and foramina in the postcranial skeleton. The distribution of this postcranial skeletal pneumaticity (PSP) can be used to determine the extent of invasive air sacs (and potentially avian-like respiratory systems) in extinct archosaurs. Here, we summarize results from a project that used micro-CT scanning to document the presence/absence of PSP in all major Triassic-Jurassic archosaur lineages. These results support previous suggestions that avian-like respiratory systems were present in at least non-avian saurischians and pterosaurs.

Conclusive evidence of PSP is not present in any of the ornithischians, pseudosuchians, or basal ornithodirans examined, but some of these taxa exhibit features (e.g., the possession of deep, non-invasive fossae bounded by prominent vertebral laminae) that might be correlated with the presence of less well-developed avian-like respiratory systems in which air sacs were present, but not ramifying within postcranial elements. These data suggest the possibility that the 'avian' respiratory system might have originated earlier than is commonly accepted, and may have been present, in either an incipient or secondarily reduced state, in other archosaurs. It seems likely that each major archosaur lineage acquired their own respiratory specializations, and that these may have been variations on a primitive archosaur system that might have included the development of some non-invasive air sacs and unidirectional lung airflow.

Poster Session II (Thursday, November 3)

FEEDING ECOLOGY OF THE LATE PLEISTOCENE EQUIDS FROM EL CEDRAL, SAN LUIS POTOSI, MEXICO, AS EVIDENCED BY DENTAL WEAR

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Three equid species have been proposed for the late Pleistocene deposits from El Cedral, Mexico, based on cranial and postcranial material: *Equus mexicanus*, *E. conversidens*, and *E. tau*. The evidence indicates that these species were sympatric and it has been suggested that they partitioned their trophic resources. We analyzed a sample of upper and lower cheek teeth with the objective of testing this hypothesis, using the extended mesowear and low magnification microwear methods. Both methods use a data set of living ungulates with known diets to infer the dietary behaviour of extinct species. A discriminant function analysis of the mesowear variables placed the three horse species within the typical grazers (e.g., *Ceratotherium simum* and *E. grevyi*) separate from the variable grazers (e.g., *Alcelaphus buselaphus* and *Kobus ellipsiprymnus*). The mesowear score for *E. mexicanus* (1.75 ± 0.14) is lower than that for *E. conversidens* (2.08 ± 0.16) and *E. tau* (2.11 ± 0.16) suggesting a less abrasive diet; however, these differences are not statistically significant. In contrast, a discriminant function analysis of the microwear variables classified *E. mexicanus* within the meal-by-meal mixed feeders (e.g, *Ovibos moschatus*), whereas *E. conversidens* and *E. tau* were classified within the grazers. *E. mexicanus* differs from the other equids in having a statistically higher average number of pits, but the average number of scratches is not significantly different. The discrepancy between the mesowear and microwear results for *E. mexicanus* might indicate seasonality in its diet. This could account for the stable isotope patterns reported in a recent study which indicated a mixed C3-C4 diet. If this is the case, however, the degree of mixed feeding must not have been substantial as the long term dietary signal (mesowear) clearly corresponds to a grazer. Also, the incorporation of some C3 grasses in the diet of this and the other species (particularly *E. tau*) cannot be ruled out, according to the results obtained here and those from stable isotope analyses. This study supports the hypothesis that the equids from El Cedral partitioned, to some degree, their trophic resources.

Poster Session III (Friday, November 4)

SPHEROOLITHID EGGS FROM THE CRETACEOUS TIANTAI BASIN, ZHEJIANG PROVINCE, CHINA

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Fossil eggs are abundant in the mid-Cretaceous Liangtoutang and Chichengshan formations of Tiantai basin in Zhejiang Province, China. Most previous descriptions, however, are brief and lack scanning electron microscopy. For this study we measured 196 previously undescribed eggs cataloged at the Natural History Museum of Zhejiang Province and sampled four partial eggs in order to ascertain their parataxonomic affinities. The round to subrounded eggs range in size from 7.24 to 13.6 cm. Examination of radial thin sections by scanning electron microscopy and light microscope reveals that the 0.81 to 1.36 mm-thick eggshell consists of a single structural layer of calcite. The inner eggshell is deeply eroded and the slightly undulating outer eggshell surface lacks ornamentation, possibly due to recent weathering. Pores are sparse and often difficult to identify in radial section; however, they appear irregular in shape and distribution and more prevalent in the inner half of the eggshell. Shell units comprising the eggshell are narrow, slightly flared at the outer shell surface, and display straight accretion lines that extend across shell units. The shell units exhibit a sweeping extinction pattern under cross polars. The outer one-third of the eggshell displays parallel banding that likely results from diagenetic alteration. Differences in shell thickness among the eggs may result from intraspecific or interspecific variation, diagenetic alteration, or measurement technique. We assign the Zhejiang eggs to the oogenus *Spheroolithus* oosp. within the oofamily Spheroolithidae on the basis of their size, shape, microstructure, and shell thickness. This study provides a basis for future assessments of the diversity of fossil eggs in the Tiantai basin, contributing to the understanding of the evolution and range of reproductive strategies within Dinosauria. Additionally, this knowledge may facilitate biostratigraphic correlation between basins.

Poster Session II (Thursday, November 3)

EVIDENCE FROM MORPHOLOGICAL VARIATION IN LARGE SAMPLES ON THE NUMBER OF SPECIES OF *EQUUS* IN THE LATE PLEISTOCENE OF NORTH AMERICA

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Remains of horses (*Equus*) are among the most common large mammals recovered from terrestrial Pleistocene deposits. Approximately 60 North American species have been named. The currently accepted number of North American species ranges from two to 10, with some single faunas reported to contain as many as seven species. DNA evidence suggests only two species in North America during the Pleistocene, albeit from a somewhat restricted geographic area. This study uses large, single-quarry samples from South Texas, the Texas Panhandle, northern Mexico, southern California, and Alaska. Measurements were plotted using univariate, bivariate and multivariate methods to investigate morphological variation and to determine the number of species present and which species names to assign to them. Two smaller caballines (*Equus conversidens*, *E.* "*occidentalis*"), a larger caballine (*E. scotti*), and a smaller (*E. francisci*) and larger (*E. calobatus*) stilt-legged species are recognized in the mid-lattitudes; *E. caballus* is present at high latitudes. Many of the local faunas examined have at least both a smaller and a larger caballine and one stilt-legged species present.

Poster Session III (Friday, November 4)

THE DIETARY PREFERENCE OF *HYAENODON* (HYAENODONTIDAE, MAMMALIA) USING STEREOMICROWEAR WITH NEW INSIGHTS REGARDING ITS ECOMORPHOLOGY

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Hyaenodon has long been considered to have occupied a hyena-like niche in its time. This is based on the fact that *Hyaenodon* premolars (especially in old individuals) are often worn down to a plateau similar to what is seen in *Crocuta* and also due to the extreme wear on the m1 which is often completely worn down to its stumps. The dietary preference of *Hyaenodon* was tested using microwear analysis, which classifies and quantifies food scars etched into dental enamel. Enamel microwear features of select extant carnivores and the creodont *Hyaenodon* were assessed via standard light stereomicroscopy to discern differential refractive properties of enamel scar features at low magnification. Extant Carnivora with different diets occupy different parts of a dietary microwear morphospace. *Hyaenodon* obviously consumed relatively coarse food items in its diet based on microwear results which also indicate a broader dietary niche than that seen in many modern carnivores. The most surprising result is that a different ecomorphological pattern is seen for the taxa on different continents. The North American species occupied more of a lion-like niche, whereas the European species preferred a diet similar to the hyena *Crocuta*.

Technical Session X (Friday, November 4, 12:00 pm)

UNDER PRESSURE: HOW MUCH DO FOOTPRINTS TELL US ABOUT FOOT MOTION AND PRESSURE?

BATES, Karl, University of Liverpool, Liverpool, United Kingdom; BENNETT, Matthew, University of Bournmouth, Bournmouth, United Kingdom; LEI, Ren, University of Manchester, Manchester, United Kingdom; RUSSELL, Savage, University of Liverpool, Liverpool, United Kingdom; CROMPTON, Robin, University of Liverpool, Liverpool, United Kingdom

Fossilized footprints are an important primary source of evidence about locomotor mechanics in extinct vertebrates. In particular, track topology is routinely hypothesized to be directly indicative of foot pressure, which in turn is integrally linked with overall limb motion of the trackmaker. However, the extent to which foot motion and pressure are recorded in footprints remains poorly understood. Is track relief indicative of maximal or time-integrated pressure? How is limb motion, and its expression in footprint relief, influenced by sediment rheology? In an attempt to address these fundamental issues we have adopted an interdisciplinary approach that integrates laboratory and field experiments and computational modelling of track formation. An integrated Zebris pressure sensitive treadmill/12-camera Qualysis MOCAP system has been used to synchronously record dynamic foot pressures and whole-body and limb segment kinematics. This provides a baseline for understanding correlations between foot morphology, motions and pressures on non-compliant substrates. This kinematic and foot pressure database can subsequently be quantitatively compared with gaits and footprints recorded in naturally occurring compliant substrates. Initial results from studies carried out in beach sediments on NW coast of the UK emphasise variation in footprint form due to sediment consistency. Statistical analysis of footprint relief within individuals demonstrates great disparity and swamps the still-large inter-subject variation present in treadmill pressures. To support these experiments, a parametric computer model of footprint formation has been employed using Finite Element Analysis. The model allows parameters of interest (e.g. foot geometry, pressure, sediment strength) to be manipulated quantitatively so that their individual effects on footprint form can be assessed. Results from simulations with different foot shapes, sediment properties and dynamic pressures again emphasize variation due to substrate rheology. We discuss the implications of our results for tracking the evolution of foot form and function in hominid footprint record.

Poster Session IV (Saturday, November 5)

TRICERATOPS AND TOROSAURUS SYNONYMY: AN EVALUATION OF TWO LARGE SPECIMENS FROM BRIGHAM YOUNG UNIVERSITY

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Due to the recent controversy surrounding the synonymizing of *Torosaurus* and *Triceratops*, two skulls from the Brigham Young University Museum of Paleontology have been evaluated. BYU 12183 initially appeared to maintain typical *Triceratops* morphology, and did not possess mature *"Torosaurus"* features despite its exceptionally large size. However, examination of the original specimen shows extensive restoration bias, obscuring the original morphology. A second large, un-restored *Triceratops* frill (BYU 19974) possesses dorso-ventrally compressed epiparietals and episquamosals, a sign of ontogenetic maturity. Significant thinning of the parietal occurs in areas that correspond to the parietal fenestrae observed in "*Torosaurus."* These features indicate that it is an ontogenetically transitional form between *Triceratops* and *"Torosaurus."*

Technical Session VII (Thursday, November 3, 3:45 pm)

PALEOBIOLOGICAL IMPLICATIONS OF THE EARLY EOCENE RODENT *TUSCAHOMYS* BASED ON AN EXTRAORDINARY NEW FAUNAL ASSEMBLAGE FROM THE GREAT DIVIDE BASIN, WYOMING, USA

BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA; DAWSON, Mary, Carnegie Museum of Natural History, Pittsburgh, PA, USA; ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA

The cylindrodontid rodent *Tuscahomys* is a dominant component of earliest Wasatchian faunas from the United States, where its range is known to have extended from Mississippi to Wyoming. Earliest Wasatchian faunas containing *Tuscahomys* play a pivotal role in documenting how North American ecosystems responded to the dramatic, yet short-lived episode of global warming known as the Paleocene-Eocene thermal maximum (or PETM). Here, we report an extraordinary new sample of *Tuscahomys* currently consisting of 400 identifiable specimens representing at least 63 individuals from the newly designated Smiley Draw local fauna (l.f.) in the Great Divide Basin, Wyoming. To our knowledge, this is the largest sample of a rodent species ever collected from an early Cenozoic locality in North America, and possibly worldwide. The Smiley Draw l.f. correlates with the lower part of the Wa-4 faunal zone on the basis of the biostratigraphic record of the primate *Tetonius*. Although the new assemblage of *Tuscahomys* is substantially younger than those previously documented from Mississippi and the Bighorn Basin, it maintains a similar pattern of faunal association. Along with *Tuscahomys*, the most common mammals in the Smiley Draw l.f. are *Haplomylus* and *Meniscotherium*. The Smiley Draw l.f. therefore mimics the unusual faunal association that characterizes the earliest Wasatchian Wa-M faunal zone in the Bighorn Basin. Based on the extraordinary abundance of *Tuscahomys* and its association with *Meniscotherium*, a taxon that is well known for its patchy spatiotemporal distribution, the Smiley Draw l.f. apparently samples an ecosystem that was characterized by some of the same unusual conditions that prevailed during the PETM in the Bighorn Basin. *Tuscahomys* appears suddenly in the North American fossil record at the base of the PETM, alongside a suite of other immigrant taxa including Perissodactyla, Artiodactyla, Primates, Hyaenodontidae and Hapalodectidae. The affinities of Cylindrodontidae are debated, but new data from *Tuscahomys* suggest that Cylindrodontidae dispersed into North America at the base of the PETM rather than evolving *in situ* from Clarkforkian paramyid ancestors.

Technical Session IX (Friday, November 4, 8:15 am)

DEATH, DECAY AND DISARTICULATION: RECONSTRUCTING TAPHONOMIC HISTORIES OF TRIASSIC MARINE REPTILES FROM MONTE SAN GIORGIO, SWITZERLAND

BEARDMORE, Sue, University College Dublin, Dublin, Ireland; ORR, Patrick, University College Dublin, Dublin, Ireland; FURRER, Heinz, Paläontologisches Institut und Museum der Universität Zürich, Zurich, Switzerland

Three marine reptile taxa from Monte San Giorgio, Switzerland, were used to develop and test a new method of evaluating taphonomy: the morphologically similar pachypleurosaurids *Serpianosaurus* and *Neusticosaurus* and the protorosaur *Tanystropheus*. Although the *Neusticosaurus* originate from a younger horizon, individuals of all three taxa are preserved in similar successions of alternating black shale and dolomite, representing normal background sedimentation and event beds respectively. Skeletal taphonomy was assessed for nine anatomical units (the head, neck, dorsal, tail, ribs and four limbs) scored independently for two characters (articulation and completeness). All taxa vary in their state of preservation, however the patterns of articulation and completeness indicate individuals reached the sediment-water interface shortly after death and while still largely intact. Episodic deposition of event beds buried individuals at various stages of decay. Where decay reached increasingly advanced states, carcasses became progressively affected by weak bottom currents, resulting in removal of skeletal elements. Removal is most pronounced in *Serpianosaurus* and limited in *Neusticosaurus* indicating subtle differences in the environmental conditions of the basinal setting across two successive units. Interpretations of *Tanystropheus* as having a fully or partly terrestrial lifestyle in near-coastal settings are not supported. Disarticulation is often entire, however completeness remains relatively high, which could not be achieved during the extended interval of transport necessary to reach the marginal intra-platform basin, into which individuals were deposited.

Technical Session XIII (Friday, November 4, 4:00 pm)

DENTAL MESOWEAR AND LONG-TERM PALEODIETARY TRENDS IN HORSES AND OTHER UNGULATES FROM THE EARLY MIOCENE-EARLY HOLOCENE OF FLORIDA

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Dental mesowear is a macroscopic measure of apical cusp morphology that serves as a proxy for the relative amounts of abrasive and attritive dental wear. Recent mesowear studies show that dietary abrasion in North American ungulates broadly tracks paleoenvironmental change. We recorded mesowear data for the entire Florida Museum of Natural History fossil ungulate collection and documented Floridian trends in dietary abrasion from the early Miocene-early Holocene, including Equidae, Rhinocerotidae, Protoceratidae, Camelidae, Palaeomerycidae, Antilocapridae, Moschidae, Gelocidae, Cervidae, and Bovidae. The mesowear trends were compared with those from other regions of North America, mostly from the Great Plains and western United States. Mesowear data from 1342 Florida horse specimens follow a trend consistent with that of horses from other regions, suggesting increasingly abrasive diets during later half of the Cenozoic. Prior to the Clarendonian NALMA, Florida horse diets show abrasion levels most consistent with extant browsers. Thereafter, horses show a more disparate array of mesowear patterns, indicating a mixture of high-abrasion and low-abrasion diets. Low abrasion diets became increasingly rare and by the Pleistocene, all equid diets show high levels of abrasion consistent with extant grazers. Pleistocene horses from Florida appear to have had more abrasive diets than Pleistocene horses from other regions. The significance of higher dietary abrasion to our understanding of Florida paleoenvironment is not yet clear but may indicate that horses consumed greater amounts of incidental sand, soil, or dust. Data from several thousands of other specimens representing other types of ungulates consistently indicate low abrasion diets prior to the Late Miocene. In the Late Miocene / Early Pliocene, camelids develop moderately more abrasive diets perhaps indicative of mixed feeding, though not as abrasive as contemporaneous horses. In Florida, the horse mesowear data show strong and predictable responses to broad paleoenvironmental changes, whereas the mesowear from other ungulates show perplexingly weaker and less predictable paleodietary trends.

Poster Session IV (Saturday, November 5)

TAPHONOMIC INFORMATION FROM LABORATORY EXCAVATION OF A NEW MICROVERTEBRATE LOCALITY IN THE OWL ROCK MEMBER OF THE CHINLE FORMATION, PETRIFIED FOREST NATIONAL PARK, ARIZONA

BEHRENSMEYER, Anna, Smithsonian Institution, Washington, DC, USA; WHATLEY, Robin, Columbia College, Chicago, IL, USA; PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA; MCINTIRE, Suzanne, Smithsonian Institution, Washington, DC, USA

The Upper Triassic Chinle Formation in the Petrified Forest National Park is well known for its fossil trees and for vertebrates representing a wide range of body sizes and ecological niches. The fossil record of the uppermost Owl Rock Member of the Chinle Formation, dated at ~208 Ma, is less well known than that of the lower members. The Owl Rock Member is exposed in the northern wilderness area of the Park and is approximately 130 m thick, consisting of mudstones, mud-clast conglomerates, pedogenic carbonates (caliches), gypsum layers and sandstones. A new locality in the upper part of the Owl Rock Member has yielded abundant microscopic vertebrate remains, which vary from delicate, pristine teeth and fish scales 0.5 - 5.0 mm in length to abraded teeth and bone fragments up to 10.0 mm in length. Some elements have black, manganese oxide halos in the surrounding clastic matrix that may indicate the presence of decomposing organic components after burial. Few if any of the delicate remains would survive dry or wet screening of the sediment; preparation consists of careful breaking and excavation of small matrix blocks under a microscope followed by stabilization of exposed teeth or bones with hardener (Butvar) after they are exposed. Recovery of meaningful taphonomic and paleoecological information from this deposit is only possible using this micro-excavation protocol. The conglomeratic matrix is a relatively well-sorted mix of rounded mud pellets, carbonate clasts, angular to rounded rock fragments, and medium to fine sand. This lithology is laterally continuous over hundreds of meters and may represent fluvially reworked dessicated pond deposits. The fauna from this locality includes fish (teeth and scales), small amphibian pectoral elements, a theropod, phytosaurs, and unknown archosauromorphs. The wide range of bone and tooth preservation states within a single sedimentary unit indicates multiple cycles of erosion, deposition, and input of vertebrate remains. The fauna thus represents a time-averaged sample of aquatic and terrestrial animals that inhabited a Late Triassic depositional system with seasonally variable (possibly ephemeral) fluvial and lacustrine environments.

Symposium 2 (Wednesday, November 2, 8:00 am)

TAXON-BASED PALEOECOLOGICAL RECONSTRUCTIONS: CAUTIONARY NOTES ON THE PULL OF THE RECENT

BELL, Christopher, The University of Texas at Austin, Austin, TX, USA

Taxon-based paleoecological reconstructions remain common in the literature for Neogene faunas and floras. Those reconstructions ultimately are based upon known or inferred data derived from studies of extant taxa. The unexpressed operational assumptions that accompany those reconstructions are tied to the notion that ecological tolerances (sometimes interpreted as 'preferences') of an extant taxon are understood adequately and can be inferred for

paleontological occurrences of that taxon. More importantly, those reconstructions assume that evolution does not occur in the system under study; the ecological parameters of the extant taxon are simply applied to the fossil record. In many cases such assumptions are expressed as untested assertions, although they can, in principle, be tested. Application of an extant phylogenetic bracket, or corroboration from independent data sources (e.g., sedimentary context, isotopes), are possible ways to test taxon-based paleoecological reconstructions. Those issues are well illustrated by the fossil record of mammals in the Great Basin. Paleoecological reconstructions of pikas (*Ochotona*) in the Great Basin were tested by use of an extant phylogenetic bracket, which revealed that assumptions of habitat specificity are unwarranted. Northern bog lemmings of the genus *Mictomys*, however, represent a 'worst-case' scenario, and illustrate the limitations of both phylogenetic bracketing and traditional practices. The extant species has a limited temporal depth, and for most (perhaps all) of its history *Mictomys* was monotypic. Its independent evolutionary trajectory following a long separation from its extant sister taxon (*Synaptomys*) results in uninformative paleoecological reconstructions based on a phylogenetic bracket. Traditional taxon-based reconstructions using *Mictomys* necessarily involved application of data from the extant taxon to extinct forms, and sometimes relied upon incomplete consideration of the published ecological tolerances of the extant species. Independent tests of the stability of ecological tolerances through time are essential in the context of interpreting vertebrate responses to climate change.

Poster Session III (Friday, November 4)

SHARING ICHNOLOGICAL DATA: FROM THE THEORETICAL MODEL TO THE DEVELOPMENT OF ICHNOBASE

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Since its beginning vertebrate ichnology has based the sharing of data and morphologies on outline drawings and qualitative descriptions of tracks. Though these methods are fundamental for the definition and the understanding of vertebrate tracks, they introduce a high level of subjectivity, due both to the drawing ability and to the sharing methods (e.g., copies from old journals), which do not allow a precise quantitative approach to ichnology, as, e.g., shape analysis.

During the last decade, several research groups have started using new methods for the documentation of footprints (laser-scanners, photogrammetry) that brought to the diffusion of three-dimensional models. However, their sharing is still related to direct contact among authors, thus preventing that jump towards a quantitative approach that ichnology needs.

The ICHNOBASE project thus aims to create the first comprehensive online database on trace fossils, allowing to organize, store, and retrieve large amounts of ichnological information. The project bases on a relational database controlled by a web-interface for data input and retrieval. The architecture of ICHNOBASE consists of three interconnected levels, corresponding to bibliographic, taxonomic and morphological data. Morphological data will include updated pictures of holotypes and specimens as well as downloadable 3D models achieved through lasers-canner or photogrammetry methods.

ICHNOBASE will also include detailed stratigraphical and sedimentological data of the site/surface bearing the traces, and will introduce a quantitative estimation of the preservation rate generated by answering some simple questions directly on the website.

Once compiled and tested, the ICHNOBASE would became the reference database for ichnologists, easing the exchange of information and 3D models, and enlarging the chance for each researcher to access new objective data, thus improving the shift toward a more quantitative ichnology.

Poster Session III (Friday, November 4)

MORPHOLOGICAL CONSTRAINT IN THE METATHERIAN CRANIUM

BENNETT, C. Verity, University College London, London, United Kingdom; GOSWAMI, Anjali, University College London, London, United Kingdom

In contrast to placental mammals, in which all cranial bones are ossified at birth, marsupials have only ossified the bones of the oral region in order to commence suckling. Here, we test whether this heterochronic shift in the timing of cranial ossification has constrained cranial diversity in marsupials relative to placentals. Taxa were sampled from 12 extant placental orders and 4 extant marsupial orders and included extinct representatives such as Oligo-Miocene diprotodontians (*Ekaltadeta* and *Namiladeta*) and peremelomorphs (*Galadi*), and Pleistocene diprotodontians (*Simosthenurus* and *Thylacoleo*). Morphology was quantified and compared using type I 3D coordinate landmarks collected using an Immersion MicroScribe G2X digitiser. Two sets of landmarks were used for the extant material, maximising either number of homologous landmarks (18) or the number of taxa, which necessitated use of fewer (11) landmarks, due to issues of homology. A third landmark set (15) was used for the inclusion of fossil taxa. The coordinate data was subjected to Procrustes superimposition, to remove differences in size and orientation, followed by Principal Components Analysis. Results showed that the extant marsupial taxa investigated here occupy a much smaller area of morphospace than the placental taxa, with a significantly ($p < 0.01$) smaller overall variance. The inclusion of fossil taxa did not significantly increase the variance of metatherian cranial shape. Fossil forms plotted close to or within the realm of their extant relatives, except for the peramelemorph *Galadi speciosus* which plotted more closely to the extant dasyuromorphs and diprotodontians. No significant difference in the variance of placentals and marsupials was found for the neurocranial region. A significantly greater variance is displayed in the viscerocranial region of placentals than in marsupials. Furthermore, there is no more difference in variance within the oral region between placentals and marsupials than within the remainder of the viscerocranium. This result may suggest that it is the marsupial viscerocranium as a whole that is developmentally constrained, not just the early ossifying oral region.

Poster Session III (Friday, November 4)

FIRST EVIDENCE OF A CRANIAL CREST IN THE PTEROSAUR *RHAMPHORHYNCHUS MUENSTERI*

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Many pterosaurs had sagittal cranial crests that are generally interpreted as inter- and intraspecific display structures because they had varied shapes, developed late in ontogeny, and in some cases are known to have been sexually dimorphic. In recent years cranial crests have been identified in several non-pterodactyloid pterosaurs including *Austriadactylus, Darwinopterus, Harpactognathus, Pterorhynchus,* and *Raeticodactylus*. Mapping the possession of cranial crests onto a pterosaur phylogeny results in a distribution that suggests that *Rhamphorhynchus* probably had a crest; however, to date no cranial crest has been identified in *Rhamphorhynchus*. Examination of the skull roof of a large specimen of *Rhamphorhynchus muensteri*, which is interpreted as fully mature based on size-independent characters reflecting the ossification and fusion of the skeleton, revealed a series of previously overlooked median features that could have formed the base of a soft tissue sagittal crest similar to that of *Pterorhynchus*. The anterior end of the series is a small bony crest about 2 mm high. It is followed by a median sulcus that is about 1 mm wide and bounded by low ridges, which in turn is followed by another small bony crest about 4 mm high. The overall length of the series of features is roughly 25 percent of skull length. It is surmised that the sulcus held the bottom of a sheet of fibrous and/or cartilaginous tissue that formed the core of a soft tissue crest, and that the small anterior and posterior bony crests anchored the ends of the core and crest. The fact that similar series of median features have not been found in other specimens of *Rhamphorhynchus* despite the fact that the taxon is represented by more than 100 specimens in museum collections presumably reflects the fact that most specimens are immature based on size-independent characters.

Poster Session II (Thursday, November 3)

A TAPHONOMIC AND PALEOECOLOGICAL COMPARISON OF ISOLATED CROCODYLIFORM TEETH FROM THE WOODBINE FORMATION OF TEXAS AND THE HELL CREEK FORMATION OF MONTANA

BENNETT, III, George, Shenandoah Valley Discovery Museum & George Mason University, Winchester, VA, USA; MAIN, Derek, Scotese Museum of Paleontology, University of Texas at Arlington, Arlington, TX, USA; PETERSON, Rachell, Scotese Museum of Paleontology, University of Texas at Arlington, Arlington, TX, USA; ANDERSON, B., Scotese Museum of Paleontology, University of Texas at Arlington, Arlington, TX, USA

The Arlington Archosaur Site (AAS) is a Cenomanian locality in the Texas Woodbine Formation containing a diverse fauna of sharks, bony fishes, turtles, crocodyliforms, and dinosaurs. It represents a marginal marine environment ranging from a brackish or fully marine coastal shelf to a low lying delta plain. At least two crocodyliforms (*Woodbinesuchus* sp. and Crocodyliformes n. gen. n. sp.) are present at the AAS, although two additional taxa are known from the Woodbine Formation. AAS teeth were obtained by either surface collection over a wide area or excavation from the Crocorama quarry that contains isolated skeletal material belonging to a large, undescribed crocodyliform. Both datasets were analyzed independently for taphonomic reasons. Two crocodilians (*Brachychampsa montana* and *Borealosuchus sternbergi*) are present in the fluvial deposits of the Hell Creek Formation study area. The Hell Creek teeth were either surface collected or screen washed. All teeth (n=332) were measured in three dimensions and the size distributions compared with two additional datasets of teeth quarried from the Oligocene Lake Enspel and the Miocene freshwater molasse of Langenau, southern Germany. The Hell Creek screen washed sample shows a similar distribution to modern *Alligator mississippiensis* population structure based on body size, and is interpreted to be the least taphonomically biased dataset because the screen washing process is able to sample the smallest size category of teeth from hatchling or nestling individuals. Quarry excavated teeth show a similar distribution to the screen washed sample, except that the smallest size class is underrepresented. The surface collected samples incorporate the greatest collection bias and were most likely transported, thus are the least accurate approximation of the thanatocoenose. The Crocorama quarry trend toward larger teeth is likely both ontogenetic (larger body size) and collection based in nature. Surface collecting at the AAS has not revealed the range of tooth sizes seen at the quarried locality, suggesting that smaller taxa were more common than the large undescribed taxon.

Symposium 4 (Friday, November 4, 8:30 am)

THE COLONISATION OF LAND: POOR SAMPLING OF EARLY AMNIOTES AND SUSTAINED HIGH EVOLUTIONARY RATES IN THE ORIGIN OF THERAPSIDS

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Tetrapods originated in the Late Devonian (~360 Ma), but were tied to aquatic environments until the appearance of amniotes in the Late Carboniferous (~310 Ma). Amniotes, primarily basal synapsids, rapidly filled terrestrial niches, ultimately freeing vertebrate ecosystems from their dependence on aquatic productivity, and culminating in the taxonomically and ecologically diverse therapsid faunas of the Middle-Late Permian (270-252 Ma). Amniote origins are a classic example of adaptive zone invasion. Based on a new phylogeny of basal synapsids drawing strongly on both cranial and postcranial data, this invasion was characterised by the explosive appearance of higher clades and ecotypes in the latest Carboniferous (~304 Ma), resulting in sudden increases in taxonomic diversity. This was accompanied by apparently elevated rates of morphological character evolution. However, a number of observations suggest caution interpreting this result. (1) Temnospondyls, a diverse clade of non-amniote tetrapods show a similar diversity increase that is clearly linked to a sudden increase in fossil record sampling in the latest Carboniferous; (2) stratigraphic fit of Carboniferous basal synapsid nodes is poor, and phylogenetic ghost lineages are abundant, suggesting extremely poor lineage sampling and systematically underestimated branch durations; (3) evolutionary rates measured 'per branch' do not show the same elevated Carboniferous rates as those divided by time. Thus it is likely that amniote diversification occurred more gradually, originated prior to their first fossil occurrences, and is currently masked by poor sampling and sparse preservation of appropriate facies. By contrast, the Permian amniote record is sampled well. Early Permian synapsids show a phylogenetically co-ordinated pattern of evolutionary rates. The branch leading to the bizarre, herbivorous caseids shows relatively high numbers of state changes. However, maximal sustained rates are evident between successive nodes on the line leading to Therapsida (i.e., within the clade Edaphosauridae + Sphenacodontia), and were key to the evolutionary diversification of early amniotes.

Symposium 4 (Friday, November 4, 8:45 am)

TETRAPOD EVOLUTION THROUGH THE PERMIAN AND TRIASSIC: ROCK RECORD, SUPERTREES, AND DETECTING EVENTS

BENTON, Michael, University of Bristol, Bristol, United Kingdom; RUTA, Marcello, University of Bristol, Bristol, United Kingdom

Studies of macroevolution depend on an adequate fossil record, and investigators should ensure that their data are sufficient to test relevant hypotheses. In such studies it is therefore appropriate to assess the data for error, whether from geological (incomplete rock record) or human (variable study effort) failings. Error is relevant only to the question in hand, so a fossil record that works well for one study may be inadequate for another; so, a statement that, the dinosaur fossil record is good or bad is meaningless. Some studies of vertebrates through the Permian and Mesozoic have applied inappropriate sampling proxies (SPs) that do little to reveal whether the record in question is *good, bad, or adequate*. This is because many popular SPs are redundant with the signal they seek to assess or correct (e.g. 'number of formations' is often correlated with 'number of contained fossils' because the measures are linked).

A key macroevolutionary theme is clade diversifications, whether following a mass extinction, the evolution of an important novelty, or some other cause. In exploring the greatest mass extinction of all time, at the end of the Permian, some investigators have assumed that the tetrapod fossil record is inadequate. However, preliminary studies have shown that the times of lowest diversity in the Early Triassic were times of most intense sampling. Taking this further, we present new evidence on the mass extinction and the recovery from three sources: biodiversity through time; ecosystem or alpha diversity; and disparity (= morphological variance), to explore pre- and post-extinction models. SPs, including number of formations, number of specimens, and specimen completeness are deployed at regional and global scale to monitor error and evenness of sampling in these cases. Recovery from the mass extinction occurred in three phases, with rapid initial filling of ecospace by putative 'disaster' taxa, then building ecosystem complexity, and finally addition of top carnivore taxa, some occupying entirely novel niches. Generally, disparity races ahead of diversity, as taxa explore morphospace and then fill in the gaps.

Poster Session I (Wednesday, November 2)

MAMMALIAN FEMORA FROM THE CRETACEOUS-PALEOGENE BOUNDARY OF NORTHEASTERN MONTANA

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Multituberculates are an extinct group of nontherian mammals that lived for ~120 million years (Late Jurassic to Eocene) and are found on nearly every continent. Assumed to be ecological analogs and potential competitors of early rodents based on dentition and overall size, multituberculates have been inferred to possess postcranial adaptations for a wide range of locomotion (e.g., terrestrial, arboreal, and saltatorial) based largely on the exceptional preservation of skeletons from Asia. Whereas mammalian teeth and jaws are common in the latest Cretaceous (Lancian North American Land Mammal Age, NALMA) and earliest Paleocene (Puercan NALMA) faunas of North America, postcranial bones are relatively rare and usually found as isolated elements. This material however remains the only way to test hypotheses of differential extinction and recovery based on locomotion, and has the potential to contribute to the taxonomic and ecological picture as indicated by the dental record. This study describes select femora from the Cretaceous-Paleogene (K-Pg) boundary of northeastern Montana from the Hell Creek Formation (upper Cretaceous) and Tullock Member of the Fort Union Formation (lower Paleogene). These strata represent some of the best sampled and stratigraphically constrained deposits in the world for studying the K-Pg mass extinction, and these specimens are among the first femora from this area to be described outside of the temporally-mixed (latest Cretaceous-earliest Paleocene) fossil assemblages of the Bug Creek Anthills in McCone County, Montana. Based on an intertrochanteric fossa divided into the more proximal trochanteric fossa and more distal posttrochanteric fossa, and the presence of a subtrochanteric tubercle in nearly all specimens, the femora are attributable to Multituberculata. A preliminary analysis of functional morphology suggests the specimens tend towards terrestriality. Body mass was inferred from cortical cross-sectional area for specimens preserving diaphyses, and results suggest body masses of < 2 kg.

Poster Session I (Wednesday, November 2)

A SECOND, NEW SPECIES OF TREMATOPID AMPHIBIAN FROM THE LOWER PERMIAN BROMACKER LOCALITY OF CENTRAL GERMANY

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Until recently the amphibian Trematopidae was represented at the well-known Lower Permian Bromacker locality of central Germany by a single species, *Tambachia trogallas*, based on a large portion of the skeleton, including the skull. A second, new species, based on the greater portion of the skull with attached mandibles and associated, loosely articulated postcranial elements has been discovered from the same locality. Both species represent the only trematopid occurrences known outside of North America.

The Bromacker specimen is unique among trematopids in having the entire length of the nasolacrimal canal exposed as a smooth, uniform channel in which the anterior half coincides with maxillary-lacrimal suture. A combination of cranial synapomorphies distinguishes it also from all other well-known members of the family. A cladistic analysis of Trematopidae utilizing only cranial characters of those members of the family well represented in this field of inquiry resolves the Bromacker specimen and the North American Upper Pennsylvanian *Fedexia* as sister taxa of a terminal dichotomy of a clade containing the successively more basal *Tambachia* and the North American Upper Pennsylvanian *Anconastes*. This in turn forms the sister clade to that consisting of the sister taxa *Phonerpeton* and *Acheloma* from the North American Lower Permian. The cladogram conforms to previous analyses in recognizing the same two basal sister clades. The Bromacker specimen, however, is interesting in possessing a couple of characters that represent parallel acquisitions to those defining the *Phonerpeton-Acheloma* clade.

Technical Session IV (Wednesday, November 2, 3:45 pm)

HIGHER-LEVEL OF EARLY CAVIOMORPHA (RODENTIA: HYSTRICOGNATHI), PALEOGEOGRAPHY, AND EVOLUTION OF HYPSONDONTY

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The origin and initial diversification of Caviomorpha, South America's "original" rodents, are debated. Given that the closest relatives of Caviomorpha are African phiomorphs (Hystricognathi) and South America was an island for most of the Cenozoic, mid-Cenozoic arrival via "rafting" from Africa is widely assumed. Study of the oldest reported caviomorphs, from the Tinguiririca Fauna of Chile (earliest Oligocene, 33-31 Ma), prompted our broader investigation of early caviomorph phylogeny. We carried out an extensive morphological phylogenetic analysis of fossil and living taxa from all 4 major caviomorph subclades. We analyzed 222 craniodental characters: 129 dental (79 lower, 46 upper, 4 general), 7 enamel, and 86 cranial. These were coded for 102 taxa: 20 Old World (4 extant,16 extinct) and 82 New World (18 extant, 64 extinct).

Our analysis confirms that the Tinguiririca taxa are a dasyproctid and a chinchilloid. Most taxa traditionally classified as erethizontoids form one of the two basal clades within Caviomorpha. Caviids, †eocardiids and octodontids are monophyletic, while 7 other "families" are not (e.g., fossils traditionally assigned to one group instead ally with another, although support for their placement or for non-monophyly is weak in some cases). Cavioidea is monophyletic, but Octodontoidea and Chinchilloidea, as traditionally conceived, are unnatural. Indeed, three †cephalomyids, usually considered chinchilloids, are instead allied with various octodontoids; a dinomyid is placed among cavioids; and five taxa widely considered octodontoids instead group with chinchilloids. The monophyly of crown clade Caviomorpha, Erethizontoidea, and Cavioidea are confirmed in our analysis, consistent with molecular results. Cavioids form the outgroup to a clade encompassing "octodontoids" plus "chinchilloids." These results indicate a single dispersal event of hystricognaths from Africa to South America, probably during the mid-late Eocene (judging from early Oligocene caviomorph diversity). Hypsodonty originated at least three times independently in Caviomorpha (among chinchillids, caviids, and octodontoids), probably in response to environmental changes.

Poster Session III (Friday, November 4)

A NEW SPECIES OF HERPETOTHERIINAE (MAMMALIA, MARSUPIALIA) FROM THE TORREJONIAN OF NEW MEXICO

BEZOLD, Samuel, A.T. Still University of Health Sciences, Kirksville, MO, USA; KONDRASHOV, Peter, A.T. Still University of Health Sciences, Kirksville, MO, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

An extensive collection of isolated dental remains of small mammals was obtained from the Torrejonian interval of the Nacimiento Formation at Tsentas Quarry (San Juan Basin, New Mexico) using screen-washing. The specimens are housed at the New Mexico Museum of Natural History. Among these remains are dental specimens of a new marsupial species represented by multiple isolated M1-M4/m1-m4. The new species is characterized by dilambdodont upper molars with a W-shaped ectoloph and a well-developed stylar shelf. An enlarged metaconule is present on M1-M4; the metacone is taller than the paracone (and both express concave labial faces) on M1-M3. The bases of paracone and metacone on M1-3 are entirely separate. The M2-M3 have well-developed, deep ectoflexi. The m1-m4 metaconid is taller than the paraconid, and the cristid obliqua meets the posterior trigonid wall lingual to the protocristid notch. The trigonid angle, measured on all lower molars from entoconid to protoconid with the metaconid as a vertex, is obtuse. Twinning between the entoconid and hypoconulid is well-expressed, but there remains a distinct notch between these cusps. Cladistic analysis placed the new taxon in subfamily Herpetotheriinae close to *Swaindelphys cifellii*, known from the Swain Quarry in Wyoming. The new taxon differs from *S. cifelli* in having better developed ectoflexi on M2 and M3 (even some M1 specimens show lingual incursion), a more labial termination of the centrocrista, a more obtuse trigonid angle, and larger size. The occurrence of this new marsupial documents a first record of a representative of Herpetotheriinae in New Mexico and suggests that a diversity of marsupials existed at that time in this region, but has been poorly documented due to the surface collection bias.

Technical Session II (Wednesday, November 2, 4:00 pm)

UNITING MICROEVOLUTION AND MACROEVOLUTION IN DEEP TIME: THE ZONE OF VARIABILITY IN ARCHOSAUROMORPHA

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Variation is the raw material for Darwinian evolution, and it has recently been recognized that evolutionary theory predicts a zone of variability (ZOV) within a clade before an apomorphy becomes fixed. The ZOV provides a snapshot of the mechanisms of evolution in action and can be detected in the fossil record both indirectly and directly. Indirectly, when large numbers of individuals are not available for single taxa, a ZOV is implicated if character states that are fixed in a particular clade experience a significant amount of lability proximal to that clade along its phylogenetic stem. Directly, a ZOV is indicated if a single taxon, hypothesized to represent a single species, demonstrates variation in the characters in question. Here we show that both types of evidence exist for several classically important autapomorphies that are fixed above the level of Archosauriformes along the archosaurian stem -- notably the absence of a parietal foramen and supratemporals and the completion of the lower temporal bar. Using a new phylogenetic hypothesis for Archosauromorpha based on an extensive morphological dataset, we demonstrate that these characters show considerable phylogenetic lability in the form of apparent homoplasy during early archosauromorphan evolution. Moreover, there is direct evidence for a ZOV in that the characters vary independently within the abundantly known single taxon *Prolacerta broomi*, with several presence/absence permutations and intermediate states represented in individual specimens. These data represent compelling evidence for the presence of a ZOV for key archosaurian features during early archosauromorph evolution and a novel way to demonstrate the mechanisms of evolution in ancient vertebrates with limited sample sizes. They have implications both for the evolutionary biology of ancient organisms and for the reliability of potentially variable morphological characters in phylogeny reconstruction.

Poster Session III (Friday, November 4)

PALEOENVIRONMENTAL CHANGE IN EASTERN AFRICA THROUGH THE FOSSIL RECORD OF BOVIDAE

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Living bovids (antelopes, caprines, and bovines) are environmentally sensitive, with many clades functionally adapted for life in habitats ranging from forests to deserts. Fossil bovids are regularly used as a source of paleoecological information, figuring centrally in studies of stable isotopes, tooth wear, ecomorphology, community structure, and analyses of taxonomic presence/absence and relative abundances.

We here explore paleoenvironmental changes at multiple scales of resolution through the eastern African late Neogene by way of a correspondence analysis of the frequency of bovid tribes at fossil sites spanning the early Pliocene to the early Pleistocene. Given a context of global cooling and drying through the late Neogene, we seek to determine first: the range of environments represented by different fossil assemblages through the Plio-Pleistocene, and second: whether both large (continental) and small (regional) scale environmental changes can be discerned via changing relative proportions of fossil bovids through time.

We explore mainly datasets from the Middle Awash and Omo Shungura sequences, in addition to published sources (e.g. Laetoli, Koobi Fora). Using the number of identified specimens (NISP) of bovids from the smallest collected area available for analysis (the site/locality where available), and accounting for taphonomic influences, we reconstruct the diversity of environments represented by different fossil assemblages, particularly those at 5–4Ma and 3–2Ma. Our correspondence analysis allows for both chronological and geographical comparisons of African fossil localities at multiple scales of resolution. The associations of different hominid species to the environmental contexts reflected by the fossil bovid assemblages is also explored.

Poster Session I (Wednesday, November 2)

***IN VITRO* SYNTHESIS OF ANCESTRAL VISUAL PIGMENTS AND ITS IMPLICATION FOR NOCTURNALITY IN EARLY MAMMALS**

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It has long been proposed that mammals were ancestrally nocturnal and that this life style was instrumental in the evolution of endothermy and the origin of this clade. Despite recent discoveries of early mammalian fossils, information for inferring visual capacities is still limited. Here, we used an integrative approach using selective constraint analyses and ancestral gene resurrection to investigate rhodopsin, the only visual pigment in the tetrapod eye which is responsible for vision under low light conditions.

Hypothetical ancestral rhodopsin protein sequences were inferred for the nodes Amniota, Mammalia, and Theria using Maximum Likelihood estimates. Biochemical analysis of the successfully synthesized visual pigments tentatively suggests that the mammalian and therian ancestral rhodopsins were particularly adapted for vision at night or under dim-light conditions, supporting the assumption that nocturnality was a novelty in early mammals.

In addition, a high rate of synonymous substitutions acting on the rhodopsin was detected along the branch leading to Mammalia. A high number of synonymous substitutions is said to affect translation efficiency, resulting in an increased amount of rhodopsin molecules in the retina. Furthermore, our previous work has shown that the rhodopsin experienced adaptive changes along the therian branch, possibly resulting from ecological diversification of Mesozoic mammals into various modern habitats, as indicated by recent improvements of the early mammalian and therian fossil record. These results describe a scenario in which early mammals had increased the number of rhodopsin molecules in order to adapt to scotopic vision, followed by adaptive changes in the therian rhodopsin possibly due to exploring novel habitats at different light levels.

Poster Session II (Thursday, November 3)

IT'S COMPLICATED: CHANGES IN *CANIS DIRUS* TEETH AND LIMBS AT RANCHO LA BREA GIVE SIMILAR EVIDENCE OF OPPOSING TRENDS OVER TIME

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The Rancho La Brea tar seeps have been known for their unusually large collection of well-preserved carnivore fossils; trapped herbivores attracted abundant numbers of carnivores which were then trapped in the asphalt themselves. These late Pleistocene large carnivores have been documented to have had significantly higher tooth fracture than found in modern analogs, suggesting a high cost of carnivory, including higher carcass utilization and more intense food competition in the past than at present. When studied temporally it was found that tooth fracture and wear were higher in Pit 13 (about 15,000 years before present) than in the younger Pit 61/67 (about 12,000 years before present). Pit 61/67 dates right before the late Pleistocene megafaunal extinction (approximately 11,000 years before present), and this trend suggests a reduction in feeding stress and competition as the extinction horizon approached. In this study, limb bone changes were examined in the major fore- and hindlimb bones before and during this time period to see how limb size and cursoriality changed in the 20,000 years before the extinction of *Canis dirus*, the most abundant carnivore found in these deposits. Bones were measured from a number of pits allowing for a temporal comparison. Limb lengths were longer in earlier pits (between 31,000 – 25,000 years before present) than in the more recent pits. Most limb bones from Pit 13 were significantly shorter than those in the older pits, however, they were also shorter than those of the more recent Pit 61/67, showing an increase in length between 15,000 and 12,000 years before present, just before the megafaunal extinction. These results demonstrate that cursoriality appears to follow an unambiguous trend over time as does tooth morphology. This indicates that at the time of Pit 13 not only was there high competition and carcass utilization, but selection for smaller individuals as well, both of which were reversed as the extinction horizon approached.

Poster Session I (Wednesday, November 2)

NEUROCENTRAL SUTURE CLOSURE IN *ALLOSAURUS* (SAURISCHIA: THEROPODA): SEQUENCE AND TIMING

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Growth dynamics among theropods, particularly *Allosaurus*, is a widely studied topic but few studies discuss the sequence or ontogenetic stage of neurocentral suture closure. The timing and progression of neurocentral suture closure could determine the ontogenetic stage while assisting in the study of growth dynamics and phylogenies.

An associated *Allosaurus* sp. from the Cheryl's Blind (CB) Quarry of Thermopolis, Wyoming, is presented to discuss the sequence of suture closure. Currently, 20% of a single Allosaurus skeleton has been recovered, including several cervical vertebrae, a nearly complete dorsal column, one-third of a tail, and assorted appendicular bones. Of the distal caudal vertebrae, the neural arches are fully fused with no indication of a suture line (closed). Approximately mid-way on the tail, a suture line appears on the vertebrae and anterior to this the arches are completely separated (open) prior to the sacrum. The rest of the vertebral column remains open. The humerus measures 37 cm; comparable in size to the larger humeri found in the Cleveland-Lloyd Dinosaur Quarry (CLDQ).

A literature study of similarly sized allosaurs seem to follow a similar pattern of neurocentral suture closure as well. Specimens from the CLDQ commonly have fully fused distal caudals but remain unfused or partly fused from the proximal tail forward. USNM 8367 has fused posterior caudal vertebrae but unfused anterior caudal vertebrae and WDC-DMP-02 has fully fused dorsal and caudal vertebrae but lack full fusion in the cervical vertebrae. This information provides a very general neurocentral suture closure pattern from posterior to anterior. Vertebral fusion appears to begin early in ontongeny but anterior progression of the neurocentral closure starts later in life as the animal approaches adult size. To date, there is no evidence of concurrent neurocentral suture closure, such as cervical and caudal suture closure, in *Allosaurus*.

Poster Session III (Friday, November 4)

THE REINTERPRETATION OF AN EARLY JURASSIC DINOSAUR TRACKSITE IN WARNER VALLEY, WASHINGTON COUNTY, UTAH

BIRTHISEL, Tylor, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; MILNER, Andrew, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; HURLBUT, Melinda, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA

The Warner Valley Dinosaur Tracksite was discovered in 1982 and was origianlly assigned a Late Triassic age and placed it in Dinosaur Canyon Member of the Moenave Formation. The WVT is actually located in the Early Jurassic rocks of the lower Kayenta Formation, at the interface between the Springdale Sandstone Member and lowermost "silty facies". The original study also incorrectly identified the producers of *Eubrontes* and *Grallator* tracks at the site as basal sauropodomorphs, based on the idea that these taxa could hyperextend digit one backward to produce a tridactyl footprint identical to *Eubrontes*. Subsequent studies demonstrate that *Eubrontes* tracks, based on foot morphology, were likely created by medium-sized theropods similar to *Dilophosaurus*. Coelophysoid theropods probably produced *Grallator* tracks, but there is no morphological evidence to connect these traces with *Coelophysis* (from the Late Triassic), or any other particular coelophysoid taxon.

The Bureau of Land Management opened the site to the public as an interpretive locality soon after its discovery. Recent improvements to the site include updated signage, range fencing around the site to prevent off-road vehicles from entering, increased road maintenance, and an improved parking area. In association with the St. George Dinosaur Discovery Site at Johnson Farm and the Utah Friends of Paleontology, we remapped the entire locality in detail identifying approximately 470 dinosaur tracks as compared to the original count of 161. Our reanalysis indicates that tracks at the site can be assigned to *Grallator*, *Eubrontes*, *Anomoepus*, and possibly *Kayentapus*, on four stratigraphic horizons within a ~1 meter interval. Other paleontological localities in the region and stratigraphic data show that the lower part of the Kayenta "silty facies" represents shallow lacustrine facies becoming more arid toward the top of the formation, eventually transitioning into the Navajo erg. This new data broadens the paleoenvironment of the region from what has previously been suggested and assists in the correlation between tracks and their possible producers.

Poster Session II (Thursday, November 3)

NEW INFORMATION ON THE SAUROPODOMORPH FAUNA OF THE UPPER TRIASSIC CATURRITA FORMATION, SOUTH BRAZIL

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Unambiguous sauropodomorph remains from the Upper Triassic Caturrita Formation, Rio Grande do Sul, Brazil, include only the putative plateosaurid *Unaysaurus tolentinoi*. Yet, a preliminary study of three additional specimens collected from distinct levels of that stratigraphic unit reveals a higher sauropodomorph diversity than previously recorded. These include an articulated pubis and ischium collected in the Botucaraí Hill area; an isolated ilium and a pair of femora unearthed from the type-locality of the silesaurid *Sacisaurus agudoensis*; and pelvic and hind limb remains recovered a few kilometers from Água Negra, where the holotype of *U. tolentinoi* was found. The former shows a combination of traits shared only by the early sauropodomorph *Saturnalia tupiniquim*, including a wedged lateral opening of the ischio-acetabular groove, a hatchet-shaped obturator process of the pubis, and a subtriangular outline of the distal ischium. The *Sacisaurus* site material belongs to a gracile animal, also sharing with *Saturnalia tupiniquim* a deep acetabular medial wall with straight ventral margin, an elongated postacetabular ala with a wide dorsocaudal rugose area continuous with the dorsal iliac crest, and a stout and asymmetrical fourth trochanter. Both specimens are, therefore, suggested to represent basal sauropodomorphs. The ilium of the third material has a short triangle-like preacetabular ala with a mounded dorsocaudal margin, as also seen in the genera *Plateosaurus* and *Riojasaurus*, suggesting a more derived position relative to the two other specimens. A close relationship between *Unaysaurus* and *Plateosaurus* is seen in all phylogenetic hypotheses that include both taxa. However, *Unaysaurus* resembles *Sarahsaurus*, from the Early Jurassic of North America, for its cranial trunk vertebrae with prezygodiapophyseal laminae and narrow proximal margin of metacarpal I, raising doubts on its phylogenetic position. The presence of basal sauropodomorphs and derived "prosauropods" in the Caturrita Formation suggests that its strata may encompass a longer timespan than previously thought.

Technical Session III (Wednesday, November 2, 2:00 pm)

DETERMINING THE ERUPTION RATE AND DEVELOPMENTAL TIME FOR ADULT CANINES IN THE SABER-TOOTH CAT, *SMILODON FATALIS*, USING MICROCT AND STABLE ISOTOPES

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The timing of development of morphological features has great importance in many aspects of the biology of taxa. For example, slight changes in developmental times can have severe effects on life history. If different growth stages are available, determining the relative developmental timing of features is generally straightforward in ancient species. In contrast, knowing when certain features developed in actual time is more complicated. An intriguing example of knowing the relative developmental timing of a feature rather than the actual time to develop is with taxa that have saber-tooth canines. Even though this feature evolved at least five separate times among mammals, there is no modern analog that can serve as a model for how such teeth developed. Comparing individuals at different growth stages, previous studies have illustrated the relative timing and pattern of tooth development in saber-tooth taxa, such as *Smilodon* and *Barbourofelis*. While the general developmental pattern might be known, determining how long these teeth took to develop and become functional in actual time seems crucial if the aim is to get a complete understanding of species that display this morphology.

The goal of this study was to determine the eruption rate and duration of eruption of the adult canine in *Smilodon fatalis*. By comparing the mineralized canine tooth length with the length of the canine erupted out of the alveolus in individuals at different growth stages, the calculation of eruption rate and eruption duration for these teeth is possible. Previous analyses of stable isotope values in adult *S. fatalis* canines reveal an enamel mineralization rate of about 6mm/month. To calculate the mineralized tooth length specimens at different growth stages were analyzed using MicroCT. Current results show an eruption rate and total eruption duration about the same as the mineralization rate and duration of mineralization. The results were then used to back calculate the actual eruption times for the other teeth in this species. This study provides a model for analyzing actual timing of development of morphological features in ancient species.

Poster Session I (Wednesday, November 2)

NEW SPECIES OF EARLY DEVONIAN ISCHNACANTHID ACANTHODIANS FROM THE MOTH LOCALITY OF NORTHERN CANADA

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The MOTH fossil assemblage from the MacKenzie Mountains of Canada is remarkably diverse. At least 70 species of primitive vertebrates from several groups have been recognized, many based on articulated skeletons. Previously, all ischnacanthid acanthodian specimens from MOTH were assigned to the genus *Ischnacanthus*. The form of the dentigerous jaw bones and teeth suggest instead that they represent three new genera and four new species. All ischnacanthids from MOTH possess medial cuspules on each lateral tooth, separating them from *I. gracilis*. Specimens assigned to one new genus and species are large ischnacanthids with a single row of few long, conical, caniniform teeth with vertical grooves on their medial surfaces. They also possess a denticle-covered ridge on the medial surfaces of the dentigerous jaw bones. Specimens assigned to a second new genus and species are large ischnacanthids with a single row of many short pyramidal teeth and no medial ridge on their unusually robust dentigerous jaw bones. A third new genus comprises two new species, united by the presence of a ridge bearing one or more rows of tricuspid teeth on the medial surfaces of the dentigerous jaw bones. One new species in this genus is represented by very small to medium-sized specimens that possess a lateral row of long, curved, caniniform teeth, and one or more medial rows of large, robust, and blunt tricuspid teeth. The second new species is represented by small to medium-sized specimens that possess a lateral row of short, curved teeth, and one row of very small, blunt, tricuspid teeth. Specimens of ischnacanthid from MOTH display a variety of types of dentition, including dentigerous jaw bones and tooth whorls. Three distinct suites of lip and cheek scales can also be recognized that are morphologically intermediate between external head scales and tooth whorls. The association of the new species of ischnacanthid from MOTH described from jaw bones and

teeth with the different types of tooth-like scales deepens our understanding of ischnacanthid diversity as well as of the development and origins of early vertebrate teeth.

Technical Session III (Wednesday, November 2, 4:00 pm)

FIRST RECORD OF A LARGE IMMIGRANT BEARDOG (MAMMALIA, AMPHICYONIDAE) FROM THE EARLY MIOCENE OF PANAMA

BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; HUNT, Robert, Department of Earth and Atmospheric Sciences, University of Nebraska, Lincoln, NE, USA; RINCON, Aldo, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA

Prior to the formation of the Isthmus (ca 3.5 mya), North and South America were separated by a broad seaway that connected the Atlantic (Caribbean Sea) with the Pacific. The Las Cascadas Formation, a volcaniclastic and tuffaceous sequence outcropping in the southern part of the Panama Canal area, is the first evidence of aerial exposure of land at the southern tip of North America, in what is now Panama. The terrestrial fauna recovered so far includes the oldest records of carnivores, rodents, bats, peccaries, equids, anthracotheres, protoceratids, and camelids from the Panama Canal. Here we report the first record of a relatively large amphicyonid carnivore, represented by a distal humerus and an upper first molar. The molar shows occlusal morphology similar to that of the amphicyonine *Cynelos* that first appears in deposits of Oligocene and early Miocene age in western Europe and the early-middle Miocene of North America. Specifically, the proportions suggest a Central American species paralleling late Aquitanian *Cynelos lemanensis* from France and southern Germany. The unassociated distal humerus preserves sufficient anatomical detail to permit identification as an amphicyonid carnivore, and to place it in the subfamily Amphicyoninae. Among North American amphicyonines it is nearly identical to those of *Cynelos* and to examples of *C. lemanensis* from Europe. If associated with the previously documented North American Large Carnivore Turnover Event, the occurrence of a relatively large-bodied amphicyonine, the southern-most occurrence of Amphicyonidae in the New World, would constrain the age of the mammal-bearing portion of the Las Cascadas Formation to approximately 20-23 million years. Alternatively, it is possible that it represents a previously unrecognized late Oligocene or early Miocene amphicyonine that reached Panama at the extreme of its biogeographic range.

Symposium 2 (Wednesday, November 2, 11:15 am)

BIOME SHIFTS WITH PALEOCLIMATE CHANGE: RECONSTRUCTING PAST BIOMES USING MAMMALS

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Global biome maps for the Last Glacial Maximum (LGM) and mid-Holocene have been developed from fossil pollen and plant-macrofossil records, but the resultant maps have gaps in areas where such records are sparse. Fossil mammal assemblages are a promising source of information about past biome distributions and they might fill these gaps. However, it is unclear which mammal species are good predictors of biome distributions, given that some associations between mammals and vegetation types today appear to be stable while others appear more variable.

For mammals, we adapted the biomization procedure of the BIOME 6000 working group for mapping past biome distributions from paleoecological data. This approach allows globally consistent definitions of biomes as assemblages of functional types, with regionally varying species composition. With a focus on North American non-volant mammals, we created a set of mammal functional types (MFTs) based on combinations of three traits: body size, locomotion, and trophic group. Taxa were assigned to a particular MFT, and MFTs were assigned to biomes. Next, the taxa x MFT and MFT x biome matrices were cross-multiplied to generate lists of taxa associated with each biome. This procedure allowed the affinity of a fossil assemblage to a biome to be calculated based on the ecomorphological attributes of taxa in the assemblage.

Using this approach, we mapped past North American biome distributions using faunal data from the NEOTOMA database. We tested the reliability of our methods using data for the Late Holocene, a time of relative biome stability and similarity to today, before applying mammal biomization for several time periods back to the LGM. Integrating the new mammal biome maps with existing plant-based maps provides more reliable documentation of past biome distributions. It also extends reconstructions to places where pollen data are scarce, particularly in arid, heterogeneous environments of western North America. In some times and places, plant-based and mammal-based biome maps are in strong agreement, but in others there is low concordance, raising new interesting questions.

Technical Session XIII (Friday, November 4, 3:45 pm)

RECONSTRUCTING THE DIETS AND MICROHABITATS OF FOUR LATEST EOCENE - EARLIEST OLIGOCENE PERISSODACTYLS (MAMMALIA) BASED ON STABLE ISOTOPES, DENTAL MESOWEAR, AND DENTAL MICROWEAR TEXTURE

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We present diet and habitat reconstructions for four perissodactyls from the White River Group of northwestern Nebraska based on carbon and oxygen stable isotopes from tooth enamel carbonate, dental mesowear, and microwear texture analysis. This study is the first to apply a multiproxy approach to determining the diets and habitats for a group of White River mammals, providing a more robust reconstruction than any single proxy. Carbon isotopes help to determine habitat preference based on models of modern mammal and plant δ13C values. Mesowear measures total dietary abrasion by assessing cusp relief and shape. Fossil taxa are classified into dietary groups by comparison with extant ungulates of known “lifetime” diet using principal component and cluster analyses. Microwear texture provides a characterization of surface wear via confocal microscopy and scale-sensitive fractal analysis, reflecting the “last supper”.

We examined the equid *Mesohippus bairdii*, the rhinocerotoids *Hyracodon nebraskensis* and *Subhyracodon occidentalis*, and the brontothere *Megacerops coloradensis*. δ13C values of teeth ranged from -12.3‰ to -6.6‰ (vPDB) indicating pure C3 diets for all taxa assuming an atmospheric δ13C value of -5.5‰ at this time. *M. bairdii* appears to have been a browser/mixed-feeder based on mesowear and microwear, inhabiting more open woodland areas based on δ13C (-8.3‰) and δ 18O (24.0‰ vSMOW) mean values. *H. nebraskensis* appears to have been a browse-dominated mixed-feeder based on mesowear and microwear; inhabiting woodland areas based on δ13C (-9.8‰) and δ18O (25.0‰) mean values. *S. occidentalis* appears to have been an abrasion-dominated mixed feeder based on mesowear and microwear, that inhabited woodland areas based on δ13C (-9.8‰) and δ 18O (22.0‰) mean values. *M. coloradensis* appears to have been a generalist browser based on mesowear and microwear, and inhabited riparian areas based on δ13C (-11.8‰) and δ 18O (23.0‰) mean values. This multiproxy approach suggests that these species were partitioning dietary resources and occupied a range of microhabitats, from riparian to woodland areas.

Poster Session III (Friday, November 4)

COMPOSITION OF *TYRANNOSAURUS* AND *BRACHYLOPHOSAURUS* SOFT TISSUES AT HIGH SPATIAL RESOLUTION: NEW INSIGHTS INTO PROTEIN DIAGENESIS

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Soft tissue ‘vessel’ structures recovered after demineralization of long bones from *Tyrannosaurus* (MOR 1125) and *Brachylophosaurus* (MOR 794) were subjected to chemical analysis to further investigate their composition and to elucidate possible pathways of ancient protein preservation and diagenesis. Demineralized ostrich blood vessels and ostrich vessels bathed in hemoglobin were also analyzed. Micro-focused X-ray fluorescence (XRF) mapping revealed micron-scale distribution and relative concentrations of S, Ca, Mg, Fe, Zn, and As. X-ray absorption near-edge structure (XANES) spectroscopic analyses at K-edges were performed on isolated vessel and cell regions to determine chemical speciation. Micro-focused X-ray diffraction (XRD) of these isolated regions was also performed. All X-ray microprobe analyses were completed at the Advanced Light Source of the Lawrence Berkeley National Laboratory. Sub-micron spatial distribution of the elements of interest was analyzed with scanning electron microscopy and energy-dispersive X-ray spectroscopy (EDS).

XRF maps and EDS revealed high spatial correlation of Mg, Fe, Zn, and As with vessel structures. In particular, Mg, Zn, and As were enriched in the fossil tissues versus the ostrich suggesting their presence reflects postmortem diagenesis. Calcium exhibited low spatial correlation with structures of interest and is likely an artifact of bone apatite demineralization. In both ostrich samples, S was of methionine character but in fossil samples S was not detected, suggesting that cleavage of S-containing functional groups from amino acid residues may be a consequence of diagenesis. K-edge XANES fitting analyses indicated that Fe in the soft tissues was primarily of oxyhemoglobin character in ostrich and entirely goethite in fossil tissues. XRD confirmed the expected amorphous character of the ostrich vessels and demonstrated the extensive crystalline goethite character of the fossil tissues.

Technical Session XI (Friday, November 4, 3:00 pm)

COMPARATIVE SHAPE ANALYSIS OF THE NECK IN EXTINCT AND EXTANT ARCHOSAURS: IMPLICATIONS FOR VERTEBRAL EVOLUTION IN SAUROPOMORPH DINOSAURS

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Archosaurs represent one of the most morphologically diverse groups of tetrapods. The variation in the axial skeleton alone displays a wide range of morphologies and vertebral

formulae. Particularly, comparisons of the neck vertebrae yield striking numerical and osteological differences in archosaurs. Crocodiles have 9 cervical vertebrae, whereas chicken possess 14 and some sauropod dinosaurs even reach a number of 19 neck elements.

Here, we analyse the intraspecific variation in the morphology throughout the cervical column of different archosaurs applying landmark-based geometric morphometrics. Equal predefined homologous points were digitized on the neck bones of crocodilian, avian, and dinosaurian taxa to capture important morphological characteristics. The relative warps analysis summarizes the distribution of the vertebral shapes in each morphospace. Independently from the number of neck elements in the different taxa, it is possible to distinguish between at least three morphological groups (atlas-axis complex, anterior, and posterior vertebrae). When the neck is elongated by the addition of vertebrae, the shape analysis reveals that the anterior cervical region expands and an additional distinct morphological group of middle segments forms that likewise expands further on.

The first two cervical vertebrae significantly differ from the other axial bones. They form a functional unit that carries the head. The cervico-thoracic transition represents a unique region in the spine because of its biomechanical properties. The junction from the highly mobile cervical column to the relatively stiff thoracic spine places great demands on the body plan. From a biomechanical point of view the morphological expansion of the anterior and middle segments is the only way to increase the number of neck vertebrae.

The absolute axial formula depends on the number of morphologically very similar somites that give rise to the morphologically different vertebrae. The differentiation of the individual vertebral segments is governed by *Hox* genes. The variation in the morphological subregions of the neck seem to be the result of an expansion of *Hox* gene activity.

Technical Session XVI (Saturday, November 5, 9:15 am)

INSIGHTS ON THE EVOLUTION OF THE PELVIC GIRDLE OF EARLY GNATHOSTOMES FROM THE DEVELOPMENT OF THE ELEPHANT SHARK (*CALLORHINCHUS MILII*) AND PRESERVED SOFT TISSUE IN DEVONIAN PLACODERMS

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Two sets of paired fins and their supporting girdles are defining characteristics of gnathostomes. However, pelvic girdles have a patchy distribution in early gnathostome phylogeny, lacking altogether in some placoderms, and having an origin that is still poorly understood. Elephant sharks (*Callorhinchus milii*) are extant chimaeroids (Holocephali) with a fossil record extending back to the Devonian. Growth series were obtained from eggs laid in captivity and analysis of the developing girdle was conducted through histology and dissection of adults. The morphology of the pelvic girdle is very similar to that of arthrodire placoderms such as *Incisoscutum* and *Compagopiscis*. Exceptionally preserved material from the Late Devonian of the Gogo Formation (Western Australia), containing three-dimensionally preserved musculature, allows for comparison with *Callorhinchus*. In specimens of *Incisoscutum* and *Compagopiscis*, musculature following most of the length of the posteroventrolateral plate extends transversally relative to the trunk myomeres and extends to the pelvic girdle. This is similar to the condition in adult *Callorhinchus* and suggests that in both groups, these muscles lie ventral to the 'lateral somitic frontier', a region where the interaction of somitically derived tissue is influenced by lateral plate mesoderm to form appendicular bones and muscles, confirming a derived developmental pattern for placoderms. The development of *Callorhinchus* shows that the fins develop first followed by the migration of mesenchymal cells to the region where the pelvic girdle will later develop. Muscles extending from the fin to the girdle migrate dorsally and anteriorly after the formation of the fin, suggesting that the girdles could have originated after paired fins by an extension of the mesenchymal migration field. This suggests that true fins could have originated prior to their supporting girdles.

Poster Session I (Wednesday, November 2)

FROG TAPHONOMY IN A HIGH ELEVATION LAKE BASIN ON THE NEVADAPLANO, LATE CRETACEOUS TO EOCENE, SHEEP PASS FORMATION, EAST-CENTRAL NEVADA

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Here we report on differential preservation of frog remains of the Sheep Pass Formation type section in the south Egan Range, Nevada. A diverse fauna is known from other sections of the formation; however in the Sheep Pass type section the only vertebrate identified to date are frogs.

The Sheep Pass Formation represents sedimentary units of the Sevier retroarc hinterland. The formation is divided into 5 members. Of interest to this study are members B and C. Member B represents a calcareous lacustrine system, while Member C represents a lacustrine fan delta. Absolute age control from the base of member B is latest Cretaceous, while member C straddles the Paleocene-Eocene boundary. Results of a recent stable isotope paleoaltimetry study support a high elevation setting for the Sheep Pass basin.

Member B frogs are preserved in 3 taphonomic modes. Mode 1 is frogs fully articulated and accumulated under attritional processes, as no two frogs are in close association. These frogs settled on microbial mats, as evidenced by crinkle fabric of the limestone. Mode 2 frogs also accumulated as a result of attritional processes, as no two frogs are found in close association. These frogs are found mostly articulated. Some of these frogs, especially those partially disarticulated, are thought to have been scavenged. Possible scavengers are gastropods, ostracods, and decapods. Mode 3 is the isolated reworked remains of frogs as a result of storm activity, supported by the association of elements with disarticulated bivalves and mud rip-up clasts.

Member C preserves frogs in 2 taphonomic modes. Mode 1 is articulated frogs accumulated under attritional processes. Mode 2 is a frog bonebed. Given similar preservation of elements we interpret that the organisms died in a short period of time (perhaps a single season). Massive, irregular matrix, and lack of orientation of elements suggests transport by a debris flow. Variability in size of elements suggests this was a non-selective event. Modern examples of frog die-offs, mostly the result of pathogens, exist.

Poster Session IV (Saturday, November 5)

BOVID HORNS AS MODELS FOR CERATOPSID CRANIAL HORNS

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The functional significance of the prominent cranial horns of ceratopsid dinosaurs remains poorly understood. They have been hypothesized to have been weapons, used in predator defense or intra-specific combat, or both, or to have been signalling structures that functioned in species recognition or signalled the attainment of sexual maturity. The horns of bovid mammals have often been considered as potential analogues of the horns of ceratopsids. The factors that influence horn form and dimorphism in extant bovids can be studied, and bovid horn morphology has been shown to be correlated with function and with the intensity and nature of selection pressure. However, bovids show a wide range of sexual dimorphism in horn form, something that has not been observed or demonstrated for ceratopsids. We have performed a comparative morphometric study of bovid and ceratopsid horncores. Measurements relating to horn dimensions and skull size were recorded from several *Centrosaurus apertus* and *Triceratops horridus* specimens in collections at eight institutions. Suites of similar measurements were also recorded from large samples of two sexually dimorphic bovids, the mountain goat (*Oreamnos americanus*) and North American bison (*Bison bison*), as well as the pronghorn (*Antilocapra americana*). Morphological variation related to sexual dimorphism and ontogeny was demonstrated in the bovid horncores, and then assessed in a comparative manner in the ceratopsid samples. This revealed high variability in horncore form in ceratopsids and did not demonstrate informative signals attributable to sex or function. Extended 2D Eigenshape analysis was demonstrated to successfully distinguish sexual differences in horn sheath, but not horncore, shape in *O. americanus*, and then applied to investigate the points of greatest variation in horn curvature in *Triceratops*. With reference to our bovid dataset, we also discuss the power of the ceratopsid fossil record for demonstrating intraspecific variation in horncore form.

Technical Session XVII (Saturday, November 5, 2:00 pm)

ENVIRONMENTAL INFLUENCES ON THE EVOLUTION AND GEOGRAPHIC DISTRIBUTION OF CAMELIDAE (ARTIODACTYLA, MAMMALIA)

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The effects of climate change on organismal populations is an important issue facing conservation efforts concerning endangered species. By studying the effects of climate change on extinct populations, the ecology of current populations can be better understood. The emergence of C4 grasses during the Cenozoic brought about a shift in habitats, from closed, wooded areas to open, flat expanses. Due to this change in habitat cover, organisms evolved cursorial morphologies through elongating, fusing and reducing bones in their distal limbs. In addition, geographic distributions of populations may have been altered due to the appearance of new ecological niches. The family Camelidae was selected for this study because it consists of a total of 43 genera, but only three are extant (e.g. *Lama*, *Camelus* and *Vicugna*), with one species, *Camelus ferus,* critically endangered. In order to understand extant camelid morphology and distribution, the effects of Cenozoic grasslands on extinct camelids are analyzed using phylogeny, genus diversity, PCO limb clustering, fossil occurrence data and ecological niche modeling. The data show that although camelid diversity does not appear to be affected by cooling events, as indicated by oxygen 18 isotopic levels, both limb morphology and genus diversity are affected by the appearance of C4 grasses. Limb morphology patterns of the last half of the Cenozoic change from earlier Cenozoic patterns. Camelid genus diversity decreases during the interval when grasslands emerged. Current ecological niche models and models projected into the future, with carbon dioxide levels twice that of today, demonstrate that potential niches for *Camelus ferus* do not exist outside of Asia, while *Vicugna* and *Lama* have potential niches on other continents.

Technical Session III (Wednesday, November 2, 3:00 pm)

CRANIAL VARIATION IN "CREODONT" AND IMPLICATIONS FOR CONVERGENCE IN PLACENTAL AND MARSUPIAL CARNIVORES

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Carnivory has evolved independently in multiple lineages of mammals. Three-dimensional geometric morphometric techniques were used to explore the relationship between cranial morphology, diet and dentition in a broad sample of carnivorous mammals and their closest relatives. Seventy-five landmarks were collected from the dorsal and ventral aspects of the skulls of extant carnivorans, and extant marsupials. In contrast to previous analyses, this dataset also included an extensive sample of the two extinct “creodont” families Hyaenodontidae and Oxyaenidae, diverse eutherian carnivores that filled terrestrial carnivore niches across the Northern Hemisphere and Africa during the Paleogene. A principal components analysis was used to identify major axes of variation in the sample. A MANOVA using the first five PCs as independent variables and group membership as the dependent variable was used to compare variance between groups. Post-hoc tests were used to evaluate significant differences between groups on each PC axis. The results indicate that cranial variation in hyaenodontid creodonts and marsupials is not significantly different on PC1. Hyaenodontid and marsupial skulls, with long rostra and posteriorly-placed temporomandibular joints, occupy one end of the carnivorous mammalian morphospace, with species of Carnivora occupying the opposite end of the axis, with shorter rostra and more rostrally-placed temporomandibular joints. Oxyaenids are placed in an intermediate position, near taxa with moderately shortened rostra including *Crocuta crocuta* and *Sarcophilus harrisii*. A canonical function analysis demonstrates that the second and third principal components, describing palatal and zygomatic breadth, basicranial flexion and temporal crest height, are more significantly correlated with diet than PC1. The CFA also demonstrated that Hyaenadontidae and Oxyaenidae fall within the variation expected for extant carnivorous mammals. Hyaenadontidae and carnivorous marsupials share a similar carnassial arrangement and occupy similar areas of morphospace, suggesting that cranial morphology is more directly influenced by dental morphology than development.

Poster Session I (Wednesday, November 2)

DISTAL FIBULAR REDUCTION AND ITS REVERSION IN EVOLUTION AND DEVELOPMENT

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A narrow fibula evolved several times in the Archosauria, often related to bipedal posture, and was the ancestral condition for Ornithodira. Within at least four different clades of Ornithodira, (Pterosauria, Alvarezsauridae, Oviraptorosauria and Aves), the fibula lost its distal epiphysis and became shorter than the tibia, losing its articulation to the tarsus. Remarkably, reversion to a fibula as long as the tibia and articulated distally to the tarsus has occurred in some modern birds such as the Pelecaniformes. Parallelism and reversal reinforces the importance of understanding the developmental factors involved in the evolution of the avian crus. Here we present evidence that the reduction of the distal fibula is related to the disruption of a molecular feedback between the diaphysis and the distal epiphysis. In chicken embryos the distal end of the fibula is in contact with the tarsus until day 7, expressing typical epiphyseal genes such as Sox9 and PthrP. At embryonic day 8 the distal end of the fibula loses the expression of epiphyseal genes and expresses markers of chondrocyte hypertrophy usually found near the diaphysis such as collagen type X and Indian hedgehog. We demonstrate that the loss of the distal epiphysis can be avoided by application of Cyclopamine, a down-regulator of Ihh signaling, resulting in a long fibula that articulates with the tarsus and closely resembles that of non-avian theropods.

Technical Session II (Wednesday, November 2, 3:15 pm)

OSTEOHISTOLOGY OF TRIASSIC ARCHOSAUROMORPHS FROM THE KAROO BASIN OF SOUTH AFRICA

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The South African non-archosauriform archosauromorph *Prolacerta* and the archosauriforms *Proterosuchus*, *Erythrosuchus* and *Euparkeria* were important constituents of the Early to Middle Triassic Karoo ecosystem following the end-Permian mass extinction. We present new data on the osteohistology of these stem archosaurs and provide insight into their paleobiology. Bone tissues of the Early Triassic *Prolacerta* contain a poorly defined fibro-lamellar complex, with parallel-fibered bone in some regions, whereas the contemporaneous *Proterosuchus* exhibits rapidly forming uninterrupted fibro-lamellar bone early in its ontogeny, which becomes slow and cyclical with increasing age. The early Middle Triassic *Erythrosuchus* deposited highly vascularized, uninterrupted fibro-lamellar bone throughout ontogeny, whereas the growth of the contemporaneous *Euparkeria* was relatively slow and cyclical. When our data are combined with those of previous studies, preliminary results reveal that Early and Middle Triassic non-crown group archosauromorphs generally exhibit faster growth rates than many of those of the Late Triassic. Early rapid growth and rapid attainment of sexual maturity are consistent with life history predictions for taxa living in the unpredictable conditions following the end-Permian mass extinction. Further research with larger sample sizes will be required to determine the nature of the environmental pressures on these basal archosaurs.

Technical Session XII (Friday, November 4, 2:30 pm)

***GASTORNIS* IS A TERROR BIRD: NEW INSIGHTS INTO THE EVOLUTION OF THE CARIAMAE (AVES, NEORNITHES)**

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Gastornis (which includes the junior synonym *Diatryma*) comprises several species of giant ground birds from the Lower Paleogene of Europe and North America. This enigmatic taxon of flightless birds has been considered as related to various groups, including Ratitae, Gruiformes and the extinct South American Phorusrhacidae. More recently, it was proposed that *Gastornis* is sister to the Anseriformes, but this conclusion was reached on the basis of a very limited sampling.

Here we present a new phylogenetic analysis to assess the phylogenetic position of *Gastornis* within modern birds (Neornithes). The character/taxon matrix includes representatives of most neornithine clades and is based on morphological characters. Our results strongly reject the hypothesis that *Gastornis* is related to anseriforms. We provide the best evidence so far that living seriemas (Cariamidae) are related to terror birds (Phorusrhacidae). Most importantly, we show that *Gastornis* is nested within the Phorusrhacidae. The small long-legged *Psilopterus* is basal within the Phorusrhacidae, and *Gastornis* is regarded as a highly specialized phorusrhacid, closely related to the giant graviportal species included in the Brontornithinae.

The inclusion of *Gastornis* within the terror birds is based on postcranial as well as cranial features including a stout, high and laterally compressed maxilla and a very long mandibular symphysis. Most features shared between *Gastornis* and Brontornithinae are linked to the massive, graviportal hindlimb. *Gastornis* differs from all other phorusrhacids in the non hooked maxilla and in the stronger reduction of the flight apparatus. Unlike most Phorusrhacidae, known as ferocious cursorial predators, *Gastornis* was not a strong runner and was likely a scavenger or an herbivore.

The crown position of *Gastornis* implies that the age of diversification of the Cariamae is older than Late Paleocene and that this clade originated in the Late Cretaceous, as has been hypothesized for major neornithine divergences. It is compatible with the hypothesis that Cariamae originated and diversified in South America and expanded to North America, and then Europe, in the Paleogene.

Technical Session XIV (Saturday, November 5, 9:15 am)

COMPUTER MODELING OF NASAL AIRFLOW IN TWO EXTANT AVIAN DINOSAURS (TURKEY AND OSTRICH), WITH IMPLICATIONS FOR MODELING AIRFLOW IN EXTINCT THEROPODS

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Dinosaur respiratory anatomy has received a great deal of attention recently, which is appropriate in that it can provide insight into metabolic status and activity levels. Much of this recent work focused on reconstruction of hypothetical lung and air sac conformations, while the upper respiratory tract—specifically the nasal cavity—has been relatively unexplored. The conformation of the nasal cavity affects respired air on its way to the lungs. The degree of convolutions in the nasal cavity, coupled with the extent and placement of vasculature, will affect the conditioning of the air field, which in turn plays a key role in systemic heat and water balance. As an initial step in assessing how this soft-tissue anatomy would affect dinosaurs, we turned to their extant avian descendants. 3D models of a turkey (*Meleagris gallopavo*) and an ostrich (*Struthio camelus*) were reconstructed from microCT scan data using Avizo 6.3. Models were then input into the computational fluid dynamic (CFD) software Fluent. Results of these analyses were compared to our prior CFD work on *Alligator mississippiensis*. Although shorter in relative length than that of the alligator, airflow through the nasal capsules of the birds exhibited notable spiraling due to the presence of the extensive nasal conchae. This cyclonic motion increased the amount of time that air remained in the nasal passage, as well as the amount of surface area with which the air came in contact. Physiological data have shown that the extensive vasculature in the nasal conchae allow this area of the nasal cavity to function as a counter-current heat exchanger associated with reducing respiratory evaporative water loss in endotherms. The role of conchae on airflow was assessed by digitally removing the conchae and re-running the CFD analyses, resulting in a dramatic effect on the dynamics of the airfield. Results from these comparative analyses were incorporated into a 3D model of the nasal capsule for the Cretaceous abelisaurid theropod *Majungasaurus* to ascertain possible flow regimes based on varying nasal conchae conformations.

Poster Session III (Friday, November 4)

QUANTIFYING HISTORICAL TRENDS IN THE COMPLETENESS OF THE AVIAN FOSSIL RECORD

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Estimating the completeness of the fossil record has long been a central area of research in paleontology. Improvements in the perceived completeness of the fossil record may be driven both by new discoveries and by reinterpretation of known fossils, but the impact of these processes on our understanding of the fossil record has never been quantitatively explored. Here, we evaluate trends in observed patterns of relative completeness of the avian fossil record over the past century using a new methodology that clarifies the differential impact of the discovery of new fossils versus phylogenetic revision of known material. Dates of discovery and recognition for the oldest fossil representatives of 75 major avian lineages were collected for the historical period between 1910 and 2010. Using a comprehensive phylogeny, we calculated minimum implied stratigraphic gaps (MIG) across these lineages. Our results show a reduction in global MIG values of ~50% over the past century in avian paleontology. A pronounced increase in the average rate of global MIG reduction is noted post 1970s compared to pre 1970s (290.5 Ma versus 31.9 Ma per decade, respectively). While the majority of improvement in the avian fossil record has come from new discoveries, substantial improvement (~22.5%) has resulted from restudy and phylogenetic revision of previously described fossils over the last 40 years. A minimum estimate of MIG indicates that at least 1.38 Ga of gaps remain to be filled between the predicted and observed first appearances of major lineages of crown Aves, implying much progress is needed. However, a notable tapering of the rate of global MIG reduction occurs between 1990 and 2010, suggesting we may be approaching an asymptote of oldest record discoveries for birds, though only future observations can determine whether this is a real pattern or a historical anomaly. Either way, barring the discovery of fossils that greatly push back the minimum age for the origin of crown clade Aves, new discoveries cannot continue to reduce global MIG values at the average post 1970s rate over the long term.

Poster Session IV (Saturday, November 5)

NEW SKULL AND ASSOCIATED POSTCRANIA OF *IGNACIUS GRAYBULLIANUS* (MAMMALIA, ?PRIMATES) FROM THE EOCENE OF WYOMING

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We report a new specimen of the paromomyid plesiadapiform *Ignacius graybullianus* (UF 260000) from an early Wasatchian (Wa1) freshwater limestone in the Clarks Fork Basin including a largely complete, mostly undistorted neuro- and basicranium, maxillae and dentary preserving all teeth, triquetreum, hamate, sternebra, and vertebra. Compared to the other well-preserved skull of this species (USNM 421608), the new skull is smaller (maximum length = 44 mm), as is its cranial capacity (1.7 cm3). However, encephalization quotients for the two specimens are similar, making them higher than reported for other plesiadapiforms, and above average for archaic mammals. They are further similar in having posteriorly broad nasals, a foramen in the ectopterygoid plate, non-petrosal bullae, and posterior carotid foramina positioned posterolaterally on the bullae. In contrast to previous attempts to estimate relative optic nerve size, measures of optic foramen (OF) area relative to orbital diameter and skull length fall outside the range of diurnal euarchontans. Among plesiadapiforms, the OF is most similar to that of *Microsyops*, while those of plesiadapoids (*Plesiadapis* and *Carpolestes*) are much smaller, as typical of highly nocturnal or visually non-reliant taxa. Newly observable similarities to plesiadapids include a frontal that projects caudally between the parietals (making an "M" shaped suture), a small "suboptic" foramen positioned anteroventral to the OF, and a cochlea measuring 16 mm in length and spiraling 2.125 times. Cochlear length of UF 260000 suggests low-frequency hearing intermediate between extant treeshrews and strepsirrhines. The triquetreum is identical to that of *Phenacolemur*. The hamate differs from those known for plesiadapids in having a cylindrically concave metacarpal surface, more pronounced ulnar-wedging, and in being dorsopalmarly shallow. Wedging described previously in the triquetreum is thus accentuated by the hamate, suggesting an ulnarly deviated manus. The other aspects of the hamate suggest dorsopalmar flexibility at the metacarpocarpal joint. The new specimen contributes to the picture of *Ignacius* as a nocturnal, agile arboreal frugivore.

Poster Session I (Wednesday, November 2)

A REVISED DIAGNOSIS OF *TITANICHTHYS* (PLACODERMI: ARTHRODIRA) FROM THE CLEVELAND SHALE (FAMENNIAN) OF OHIO, USA, WITH IMPLICATIONS FOR ASPINOTHORACID PHYLOGENY

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Although *Titanichthys* is one of the oldest known placoderms, its exact phylogenetic placement has been problematic. Seven species of *Titanichthys* are currently recognized (five from North America; one each from Morocco and Poland) mostly based on very fragmentary specimens (exceptions: *T. agassizi*, *T. clarki* and *T. termieri*). However, even the most complete specimens are missing key elements important for phylogenetic resolution. Large, isolated dermal plates from the productive fossil beds of the Cleveland Shale member (Famennian) of the Ohio Shale Group have often been attributed to *Titanichthys* despite the fact that the anatomy of the taxon has not been fully resolved. A new, nearly complete, articulated specimen (CMNH 50319) of a subadult-sized *Titanichthys* from the Cleveland Shale provides important new information about the taxon, including the first descriptions of the rostral, postmarginal, postsuborbital, submarginal, posterior superognathal plates, and the nasal capsule. A revised diagnosis is provided for the genus and three new diagnostic characters are proposed including a longitudinally elliptical rostral, a reduced posterior superognathal, and a median dorsal that inserts into the posterior dorsal lateral plate. The newly recognized features of this specimen allow for the confident referral of previously problematic specimens to *Titanichthys*. Based on this new data, we present the first comprehensive phylogenetic analysis of *Titanichthys* using a set of 98 morphological characters, 70 of which can now be confidently coded for the genus. *Titanichthys* is found to be an aspinothoracid arthrodire that forms a clade with *Gorgonichthys*, a large arthrodire also known from the Cleveland shale. The resolution of at least part of the aspinothoracid tree formerly referred to the family *Dinichthyidae* adds to the growing understanding of the final diversification of the arthrodire placoderms before their abrupt extinction at the end of the Devonian.

Poster Session I (Wednesday, November 2)

ESTIMATING BENDING MECHANICS OF EXTANT AND FOSSIL PENGUIN? CONTOUR FEATHERS

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The biomechanical behavior of biological structures results not only from the properties of their component materials but also from the spatial organization of those materials. Previous comparative studies have reported that feather rachis keratin is relatively homogenous, meaning that the bending properties of feathers primarily result from differences in rachis geometry. We measured the cross-sectional properties of contour feather rachises in a phylogenetically and functionally diverse set of extant birds. Feathers were embedded in epoxy resin and serially sectioned at approximately 0.5 mm intervals. From thin sections, we measured the following structural parameters: maximum and minimum second moments of area (measures of resistance to bending), ellipticity (a measure of maximum resistance to bending), and polar moment of inertia (a measure of resistance to torsion). We found that ellipticity of the rachis is relatively constant along the rachis in all avian feathers measured but is approximately twenty times greater in penguins. Overall, the rachis of extant penguins is dorsoventrally flattened and ellipsoid in cross-section, in sharp contrast to other avians. Relatively homogenous feather morphology among extant penguins allows us to estimate the cross-sectional area and thus the mechanical properties of contour feathers from extinct stem taxa with similar rachis geometry. In fossils, rachises are modeled in cross-section using the measured diameter and the calculated dorsoventral depth based on regressions from extant birds. We are then able to estimate the same structural parameters for fossil feathers. Our results indicate that contour feathers in the extinct giant penguin, *Inkayacu paracasensis*, may have been approximately twenty times more resistant to torsion at their mid-shaft than similarly sized contour feathers in extant penguins. These results indicate diversity in feather morphology early in the penguin lineage and suggest another transition in feather structure between stem and crown clade penguins in addition to that recently reported in melanosome morphology.

Poster Session IV (Saturday, November 5)

THE ORIGIN AND TAPHONOMY OF CHASMOSAURINE (ORNITHISCHIA: CERATOPSIDAE) DINOSAUR BONEBEDS IN THE UPPER CRETACEOUS KAIPAROWITS FORMATION, SOUTHERN UTAH

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Similarities in depositional and biostratigraphic factors can result in related modes of skeletal accumulation, and provide significant insight into the understanding of the paleoecology, biology and behavior of chasmosaurine ceratopsid dinosaurs in the late Campanian. We investigated the sedimentology and taphonomy of the only two known chasmosaurine bonebeds in the Upper Cretaceous Kaiparowits Formation in southern Utah. UMNH VP loc. 942 is a monodominant bonebed dominated by disarticulated, partial remains of a juvenile, subadult, and adult *Utahceratops gettyi* deposited in a fine-grained sandy fluvial channel. Elements exhibit minimal evidence of post-mortem alteration (e.g., surface abrasion, breakage, loss of smaller less dense elements), though several elements exhibit weathering. These bones are weathered and disarticulated prior to transport, deposition and reworking within a river channel. In contrast, UMNH VP loc. 945 is a multitaxic bonebed containing a disarticulated associated juvenile, a nearly complete, articulated second juvenile skeleton (both probably referable to *Utahceratops*) and a partially articulated crocodylian skeleton in a fine-grained sandy clayey siltstone crevasses splay deposit. Many elements are articulated, but others show significant breakage (i.e., transverse), abrasion, minimal to moderate amounts of corrosion, and evidence of fungal infestation. These skeletons were hydraulically transported to the site and modified after burial. In contrast to these bonebeds, isolated chasmosaurine specimens preserved in fine-grained strata, deposited as overbank or pond deposits elsewhere in the Kaiparowits Fm. are more likely to be disarticulated and decomposed than elements preserved in channel sandstones. This suggests that these bonebeds represent two different but unusual taphonomic modes in the Kaiparowits depositional system. These data compare well with other chasmosaurine bonebeds that preserve *Triceratops* and *Agujaceratops*, where specimens are often disarticulated, dominated by juveniles and/or subadults and

preserved in finer-grained deposits. This suggests a common paleoenvironmental setting for chasmosaurine bonebed formation.

Poster Session III (Friday, November 4)

ECOLOGICAL DIVERSITY OF A LARGE MAMMALIAN COMMUNITY FROM THE LATE PLEISTOCENE OF HIDALGO, CENTRAL MEXICO: A PRELIMINARY APPROACH

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This research describes the ecological diversity of a mammalian community from the late Pleistocene of Hidalgo, central Mexico. The assemblage preserves 17 species from 13 families of large mammals (body mass > 500 g), including Glyptodontidae (*Glyptotherium floridanum*), Mylodontidae (*Paramylodon* cf. *harlanii*), Sciuridae (*Spermophilus variegatus*), Leporidae (*Sylvilagus floridanus*), Canidae (*Canis dirus*), Felidae (cf. *Lynx* sp.), Antilocapridae (*Capromeryx mexicana*, *Stockoceros* sp.), Bovidae (*Bison* sp., *Ovis canadensis*), Camelidae (*Camelops hesternus*, *Hemiauchenia gracilis*), Cervidae (*Odocoileus virginianus*), Equidae (*Equus conversidens*), Elephantidae (*Mammuthus* sp.), and Gomphotheriidae (*Cuvieronius* sp., *Mammut americanum*). The presence of *Bison* is indicative of a Rancholabrean Mammal Age. Ecological diversity was measured as the relative proportion of trophic and locomotor behaviors within the community. These adaptations were assigned on the basis of direct observations, published information and/or electronic databases of extinct and extant mammalian species. The mammalian ecological diversity of the community is characterized by a high percentage of animals with terrestrial locomotion (88.23%), and low percentages of those that move on the ground and/or trees (5.88%) (e.g., cf. *Lynx* sp.), as well as fossorial mammals (5.88%) (e.g., *S. variegatus*). On the other hand, a similar proportion of omnivores (e.g., *G. floridanum*), browsers (e.g., *O. virginianus*), and grazers (e.g., *E. conversidens*) was observed (17.64% for each trophic category). Mixed feeders were well represented (35.29%) and to a lesser extent, carnivores (11.76%). The locomotor adaptation pattern suggests areas dominated by open vegetation and scarce tree coverage, whereas a heterogeneous trophic pattern would be related to the presence and availability of diverse resources. The ecological mammalian diversity of the Pleistocene of Hidalgo is closely comparable with that observed in extant grassland areas of the Serengeti ecosystem. However, further implementation of ecomorphology studies and ecological diversity analysis will lead to accurate reconstruction of vegetation types.

Technical Session XVI (Saturday, November 5, 1:45 am)

THREE-DIMENSIONAL GILL ARCH STRUCTURE IN A STEM GNATHOSTOME REVEALED BY SYNCHROTON TOMOGRAPHY

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Although jaws are considered to have a special anatomical relationship to gill arches, remarkably little is known about the branchial skeletons of crownward members of the gnathostome stem. What is known of articulated gill skeletons in these taxa is incomplete owing either to disarticulation or the absence/incompleteness of mineralization. Variation in gill arch structure has had a critical role in the placement of fossil fishes (e.g., *Acanthodes*) on either the chondrichthyan or osteichthyan stems. However, the polarities of these characters are difficult to assess, owing to the lack of knowledge of corresponding structures in stem gnathostomes. To address this issue, we have targeted the exceptionally preserved, but phylogenetically enigmatic gnathostomes of the Hunsrück Slate of Germany. These fossils have a record of preserving soft tissue structures and, due to pyritization, are highly amenable to x-ray studies. To acquire high-resolution, three-dimensional data, we used powerful synchrotron light tomography at the Diamond Light Source in Oxfordshire, UK, with considerable success. Here we report on the endocranium and branchial arch anatomy and associated structures of *Paraplesiobatis heinrichsi*. We compare it with preliminary results on the anatomy of so-called 'stensioellids', to which it has sometimes been assigned. Our data on the endocranium support petalichthyid relationships for *Paraplesiobatis*. The branchial arch data positively refute earlier shark-like reconstructions of petalichthyid pharynx morphology, in favor of an agnathan-like organization of the branchial chamber beneath the braincase and orbits. The data have several implications for early gnathostome phylogeny. First, we provide additional corroboration for a stem gnathostome placement of placoderm-grade vertebrates. Second, the data provide rich character data that can be used to inform hypotheses of character transformation within the gill arches of the gnathostome crown. Finally, and perhaps not unexpectedly, we confirm that the 'stensioellids' are a polyphyletic wastebin assemblage whose putative relationships should not be debated as a whole, but rather individually. From a technical side, this work serves as a valuable proof of concept for the power of x-ray tomography to yield significant new anatomical data from even very flattened specimens.

Poster Session III (Friday, November 4)

MORPHOMETRICS OF THE MOOSE TRIBE, ALCEINI: *CERVALCES* VS. *ALCES*

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Cervids are the primary ruminants of the Americas and Eurasia. Their systematics have been and continue to be a source of contention, and this is reflected in the numerous revisions and nomenclatural inconsistencies found in the group. Cervid evolution is tied to Eurasia, with multiple dispersals to North America beginning in the Miocene and continuing through the late Pleistocene. Though the appearance of other cervid and cervoid groups is fairly well evidenced in North America, the history of the moose tribe (Alceini) is more enigmatic and requires work to determine which characteristics are more significant than others for use in systematics. Morphometric approaches have successfully provided a phylogenetic signature in other extant deer groups, and linear ratios have suggested that quantifiable differences exist between the dentaries of modern moose (*Alces alces*) and *Cervalces* spp. of Pleistocene Europe. To date, no statistically robust morphometric analysis has been performed on North American Alceini skeletal material. Here, an expanded sample of *A. alces* cranial and postcranial skeletal morphometry provides a framework for morphospace comparison with other North American members of the tribe, including species of the genus *Cervalces*.

Preparators' Session (Thursday, November 3, 8:15 am)

PHOTOGRAMMETRIC ICHNOLOGY: STATE-OF-THE-ART DIGITAL DATA ANALYSIS OF PALEONTOLOGICAL RESOURCES IN NORTH AMERICA, EUROPE, ASIA, AND AFRICA

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Vertebrate trace fossils reflect the complex interrelationship between an animal and the substrate. Digital data collection provides an excellent tool for capturing an incredible wealth of information provided by ichnofossils. Close-range photogrammetry is one of the easiest and most cost-effect digital data collection techniques and forms the basis for photogrammetric ichnology. Three-dimensional image datasets created from digital photography can provide a permanent digital record of fossil tracks (including the creation of digital type specimens) and tracksites and is a non-invasive method to obtain 3D data for assessment. Photogrammetry is an objective recording and analysis method, which provides a visual, quantifiable baseline to evaluate track-bearing surfaces. It has been especially useful in remote locations of Korea, Tanzania, and the United States. Not only do these datasets support accurate visualization of the fossils, they can also be used to make accurate measurements, as well as highly accurate solid, three-dimensional models of the surface. As 3D terrain surfaces or point clouds created from photogrammetric documentation may contain thousands of very accurate x, y, and z coordinates, researchers can measure various track and trackway dimensions at a submillimeter level. In addition to traditional ichnological measurements, higher-level mathematical analyses may be conducted on the 3-D data. These calculations can automatically quantify areas of surface curvature, roughness, slope and other morphometric characteristics. Because these calculations are conducted by algorithms within the software, human bias is greatly removed if not eliminated. Utilizing this type of data analysis, unbiased morphological correlations of various ichnofaunas (e.g., Jurassic tracks from Wyoming, Utah, Scotland, and England) can be made and footprint data normalized (e.g., converting convex hyporelief forms to concave epirelief) for comparison purposes. Digital datasets are stored easily, provide a permanent record, are readily shared, and are currently helping to unravel numerous ichnological complexities in Permian-Pliocene sites throughout the world.

Poster Session III (Friday, November 4)

THE EFFECTS OF VARIOUS ENVIRONMENTS AND SEDIMENTS ON THE DECAY OF SOFT TISSUE WITHIN *ODOCOILEUS VIRGINIANUS PHALANGES*

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Recent discoveries proposing the persistence of soft tissue in Late Cretaceous fossils challenged long-held views concerning the persistence of soft tissues and mechanisms of fossilization and biomolecular degradation. An alternative hypothesis proposes that biofilm production within vascular cavities and lacunae has more recently generated organic tissues. There is a wealth of knowledge to be gained from bacteria endogenous to the fossil environment – an environment yet unexplored by microbiologists. A distinct lack of noticeable taphonomic data on the molecular level of the internal structures of bones has largely led to the ambiguity of the origin of the proposed soft tissue structures found. This project has worked to establish a foundation in the taphonomic processes that occur within the bone's intravascular cavities at the tissue level in modern deer (*Odocoileus virginianus*) bone in different environments, each with varying sediment types. Two deer phalanxes were sampled from each environmental sediment type. The analysis consists of an in depth review of Field Electron Microscope images taken over the period of twelve months and the relationship between the observed decay and the potential for original soft tissue to survive in fossils. While it was concluded that decay needs to be assessed over a longer period of time for more conclusive results, surprising evidence of early mineralization and the occurrence of an unknown parasite, illustrating evidence of invertebrate activity at the microscopic level, provide insight into new avenues of still more undiscovered aspects of how tissues decay and fossils form. Such tantalizing beginnings warrant further analysis and attention by a broader interdisciplinary scientific community.

Technical Session XV (Saturday, November 5, 8:15 am)

ONTOGENY AND TAXONOMY OF A NEW SPHENACODONTID SPECIMEN FROM THE EARLY PERMIAN OF TEXAS

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Sphenacodontids are the most speciose and abundant non-mammalian synapsids recognized from the Early Permian of Texas, known from hundreds of specimens. However, the ontogeny of sphenacodontids remains poorly understood and morphologic variation as a result of growth may confound the delineation of discrete characters useful for taxonomic and phylogenetic identification. Here, we describe a juvenile skull and vertebral column of a sphenacodontid (MCZ 2028) from the Archer City Formation, Texas, with an unusual combination of features present in both *Dimetrodon milleri* and *Secodontosaurus obtusidens*. The cranium is typically sphenacodontid, with a well-developed supracanine buttress and maxillary precaniniform step. Characters shared between this new specimen and *D. milleri* include a laterally expanded frontal orbital process, an extensive postorbital-squamosal contact, spatulate marginal teeth, three premaxillary teeth, and elongate neural spines that are nearly circular in cross section. Characters shared between this new specimen and *S. obtusidens* include the absence of ectopterygoid teeth, no expansion of the caniniform tooth root into the choana, jaw articulation above the level of the dentary tooth row, a low axial neural spine, and an elongated skull. A new phylogenetic analysis of Sphenacodontidae recovers *Secodontosaurus* as the sister taxon to an unresolved clade of short-spined sphenacodontids (*Sphenacodon*, *Ctenorhachis*, *Ctenospondylus*), *Dimetrodon*, and MCZ 2028. Based on this result, we can interpret MCZ 2028 as a juvenile of *D. milleri*, suggesting that many of the synapomorphic characters that unite the new specimen to *S. obtusidens* are ontogenetic, and the morphology of juveniles of these two taxa may be convergent. Alternatively, MCZ 2028 can also be interpreted as a new species, intermediate in morphology between *D. milleri* and the younger *S. obtusidens*. This study illustrates the importance of recognizing ontogenetic characters in phylogenetic analyses and the role that juvenile specimens play in understanding the early evolutionary history of synapsids.

Symposium 3 (Thursday, November 3, 9:00 am)

LATITUDINAL DIFFERENTIATION OF FISH ASSEMBLAGES FROM THE LATE CRETACEOUS OF WESTERN NORTH AMERICA—EVIDENCE FROM VERTEBRATE MICROFOSSIL LOCALITIES

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Studies of vertebrate microfossil assemblages from the Late Cretaceous of Alberta, Utah, and Mexico, together with high-precision correlation of formations from these areas, allow patterns of latitudinal distribution of fish assemblages to be recognized and tracked through time. Northern assemblages are characterized by the presence of sturgeon, *Belonostomus*, and unnamed fish referred to as Holostean A and Holostean B, plus a high abundance of the teleost *Coriops*. Southern assemblages are characterized by the presence of the elasmobranch *Lonchidion*, the amiid *Melvius*, plus a high abundance of teleost centra morphotype U3/BvD, which is tentatively identified as an ostariophysan. Taxa that are typically southern occur in Alberta in the late Santonian and late Maastrichtian, times of relatively high temperatures, but do not occur in Alberta or Montana in the Campanian or early Maastricthian. Similarly, taxa that are restricted to more northern regions are more abundant in Alberta in the late Campanian and early Maastrichtian, times of relatively cool temperature. These stratigraphic patterns are interpreted as a result of shifts in distribution pattern in response to climatic change. A Cenomanian-Turonian faunal event is characterized by the first appearance of many taxa that have a southern distribution in North America. This faunal event may be correlated with high global temperatures that have been proposed on the basis of a Turonian occurrence of turtles and other ectothermic mesoreptiles in the high Canadian Arctic.

Poster Session I (Wednesday, November 2)

TAPHONOMY OF COELOPHYSOID THEROPOD BONEBEDS PRESERVED ALONG THE SHORELINE OF AN EARLY JURASSIC LAKE IN THE NUGGET SANDSTONE OF NE UTAH

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The Saints & Sinners quarry in northeast Utah has produced >3000 bones and bone fragments from two ~30 cm thick, superimposed bonebeds in the middle of the Nugget Sandstone. The bonebeds are located within a wet-phase horizon bounded above and below by eolian sandstones. The bonebeds are lateral to 10-20 cm thick lacustrine beds with associated ~10 cm long tridactyl theropod tracks.

With the exception of sphenodontid bones plus teeth of a medium-sized theropod, all bones pertain to a new coelophysoid diagnosed by a splint-like metatarsal II. The coelophysoid assemblage is dominated by juveniles and subadults with rare adults. Plants are limited to probable cycadeoid frond impressions.

Data was compiled separately for the upper and lower bonebeds but differences between the layers are insignificant. Excavation of 5.5 m2 of the lower and 2 m2 of upper bone beds yields a MNI (Minimum Number of Individuals) nine and ten, respectively. Except for fused bones, all bones are disarticulated but associated skulls/skeletons are present and common. Average skeletal completeness is 17%. Individual bone completeness is bimodal with 33% complete and 56% fragmentary (<24% of a bone). Fragmentation is limited to delicate bones. Weathering evidence is rare. Insect/vertebrate traces on bone are absent.

The bones are lying flat and 87% of arcuate bones (e.g., scapulae) are in stable positions. Elongate bones are preferentially oriented NNE-SSW in the upper bed and NNW-SSE in the lower bed. Flow direction indicators (i.e., dorsal ribs, fibulae), however, are randomly oriented within these parameters, indicating that hydraulic action was oscillatory. Shape-sorting data indicates that winnowing was minimal.

The similarity of both bonebeds indicates that they were subject to identical taphonomic conditions. Total disarticulation indicates complete maceration in a wet environment. Breakage is attributed to trampling prior to reworking, while close associations and absence of winnowing and indicates hydraulic action was short-lived. The proximity to lacustrine deposits, combined with strong bone orientation indicates reworking by wave action along the shoreline of an ephemeral lake. The large numbers of individuals is speculated to be due to two episodes of mass death near an ephemeral, possibly non-potable, water source.

Technical Session XVIII (Saturday, November 5, 2:45 pm)

THE MYTH OF THE LIVING FOSSIL: BASAL CROWN GROUP RELATIONSHIPS, REVERSING POLARITIES, AND RESTORATION OF THE ANCESTRAL CROCODYLIAN

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Most living crocodylians have long, broad snouts associated with a wide-ranging diet and habitat tolerance – the so-called "generalized" morphotype. This was presumed to have been ancestral for Crocodylia, with more specialized forms (e.g. tube-snouted or small-bodied) arising from generalized ancestors, but underlying morphological data sets were optimized to express variation within Crocodylia itself. Analyses with expanded sampling from noncrocodylian neosuchians suggests that proximate outgroups of Crocodylia were predominantly small-bodied forms (≤2m total length) with cranial features reminiscent of derived alligatoroids. Depending on how relationships are resolved, ancestral conditions for Crocodylia might approximate the small putatively durophagous alligatorines of the Paleogene. The generalized morphotype appears to have arisen at least five times independently from more specialized ancestors within Crocodylia, generally following a drop in crocodyliform diversity that eliminated earlier unrelated generalized lineages. Living "generalized" forms are actually highly (and independently) specialized, and caution is needed when applying functional or behavioral observations from one lineage to all. It also shows that descriptive terms for crocodylian cranial morphology depend on context; the American alligator *(Alligator mississippiensis)* is not long-snouted when compared with other living crocodylians, but is profoundly long-snouted compared with its closest extinct relatives. Similar patterns can be inferred throughout Mesoeucrocodylia, calling into question the widespread perception that specialized crocodyliforms deviate from a stable generalized phylogenetic core that persisted with little change in overall body or head shape from the Middle Jurassic through the Recent.

Symposium 3 (Thursday, November 3, 11:15 am)

NEW EVIDENCE CONCERNING DIVERSITY AND ABUNDANCE OF SMALL-BODIED ORNITHOPODS FROM THE BELLY RIVER GROUP (CAMPANIAN) OF ALBERTA

BROWN, Caleb, University of Toronto, Toronto, ON, Canada; RUSSELL, Anthony, University of Calgary, Calgary, AB, Canada; EVANS, David, University of Toronto/ Royal Ontario Museum, Toronto, ON, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; BRINKMAN, Donald, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

The diversity of large bodied dinosaurs from the Belly River Group is well established, but that of small bodied taxa remains poorly understood. Small-bodied ornithopods have been recognized from the Oldman (OF) and Dinosaur Park (DPF) formations on the basis of teeth and a few isolated elements, but associated or articulated skeletons have not been reported. Here, we document the first articulated remains of basal ornithopods, as well as the first cranial bones, from these well sampled formations. The oldest specimen, from the middle OF along the Milk River, southern Alberta, consists of the articulated posterior half of skeleton that shares numerous features with the contemporaneous *Orodromeus makelai* from Montana: ossified axial tendons on the dorsal and sacral vertebrae, but not the caudal vertebrae; a strongly down-curved preacetabular process of the ilium. A second, less complete, specimen from the upper OF (time equivalent to DPF) of the same area exhibits morphology distinct from that of any other ornithischian, and likely represents a new taxon. The fibula is flattened distally and fused to the anterior surface of the tibia for the distal third of its length. Numerous elements from the DPF are also of basal ornithischian origin.

Although basal ornithopod material is rare, taphonomic comparison with contemporaneous pachycephalosaurs suggests considerable undiscovered diversity in the former. The two groups are similar in size and taphonomic properties postcranially, but the abundance of basal ornithopod postcranial material from DPF greatly exceeds that of pachycephalosaurs,

although the opposite is true for cranial elements. The record of robust pachycephalosaur frontoparietal domes suggests a diverse assemblage of at least four taxa, with relatively high abundance. Based on comparison of taphomonically-equivalent postcranial elements, basal ornithopods may be more abundant than are pachycephalosaurids in these formations, and may display similar, although currently unrecognized, taxonomic diversity. These findings highlight biases against preservation of small taxa, and suggest that small taxa may have been an important component of the fauna.

Preparators' Session (Thursday, November 3, 11:00 am)

IMPROVING THE SCIENCE OF PALEONTOLOGY THROUGH EFFECTIVE COMMUNICATION IN THE LABORATORY

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The ability to conduct research on fossil vertebrates is typically predicated on exposure of morphology. This exposure often takes place in preparation laboratories, and is conducted by laboratory staff that usually do not have as extensive an understanding of specific morphological features or their relevance as the primary researchers requesting the work. Likewise, laboratory and collections staff may have concerns about long-term effects of treatments that conflict with the goals of short-term research projects. Misunderstandings can have dire consequences due to loss of information through damage to specimens, increased labor costs, and potential risk to specimens. These risks can be mitigated by improving communication between members of the research team. Expectations and concerns must be clearly stated throughout the project, and can be communicated consistently using common technology, e.g., email, digital photos, CT scans, and digital maps, as well as through the use of tools like dual-head teaching microscopes and computer monitors. This information should be maintained, along with detailed records of materials and techniques applied, within the collections database or laboratory archives and included in the methods section of resulting publications.

Poster Session III (Friday, November 4)

FOSSIL EGGS FROM ZHEJIANG PROVINCE, CHINA: EVIDENCE OF A REDUCING ENVIRONMENT FACILITATED BY ORGANIC DECOMPOSITION

BRUNDRIDGE, Krista, Montana State University, Bozeman, MT, USA; BARTA, Daniel, Montana State University, Bozeman, MT, USA; JACKSON, Frankie, Montana State University, Bozeman, MT, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA; JIN, Xingsheng, Zhejiang Museum of Natural History, Hangzhou, China

Fossil eggs from the Middle Cretaceous, Tiantai Basin in Zhejiang Province, China, occur in fine-grained quartz-rich red sandstone, of alluvial fan origin. These rounded to subrounded eggs are referable to the oogenus *Spheroolithus,* within the oofamily Spheroolithidae. Nearly every egg of the 196 specimens examined at the Zhejiang Natural History Museum, exhibits a white halo (0.2-17.8mm in width) immediately adjacent to the eggshell on the interior and exterior surfaces. Similar halos in fine-grained deposits surround Sinornitho?mimus skeletons from an Inner Mongolia bonebed and fossil eggs at the Auca Mahuevo (Argentina) suggesting a common origin.

To investigate these halos, we characterized the mineralogical composition of the halo and surrounding sandstone using light microscopy and X-ray diffraction. Petrographic thin sections show white halos that closely outline the eggshell, and their composition and texture are identical to that of the surrounding red sandstone matrix. Six thin sections of eggshell reveal round dark rimmed spherical structures (160µm in diameter) that occur exclusively in the eggshell. These structures display multiple generations of sparry calcite fill and are interpreted as pedotubules. X-ray diffraction analyses of sediment samples show no quantifiable difference in the overall sedimentology and clay mineralogy between the halos and red sandstone. In contrast, iron staining of a Zhejiang thin section revealed the presence of Fe2+ and Fe3+ associated with the white halo and red sandstone, respectively. The greater abundance of Fe2+ suggests limited dissolved oxygen immediately surrounding the eggshell, therefore, indicating a reduced state immediately adjacent to fossil specimens. Decay of organics associated with the fossils may have decreased the amount of oxygen in sediments resulting in iron reduction. The halos provide potential evidence for interactions between organisms and eggs during early diagenesis. However, halos also occur in secondary rock fractures, therefore alternative explanations may include microbial activity and the capacity of fossils to attract or repel ions as mechanisms for the displacement of Fe2+ and Fe3+.

Symposium 4 (Friday, November 4, 8:15 am)

COPING WITH ROCK RECORD BIAS IN STUDIES OF MORPHOLOGICAL EVOLUTION: NEW METHODS FOR ANALYZING DISPARITY AND EVOLUTIONARY RATES

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The fossil record is imperfect and it is widely recognized that sampling biases (differential preservation and collection of fossils) can distort patterns of taxonomic diversity (species richness) over deep time. Intervals that appear more diverse may merely be better sampled than other intervals, and therefore, quantitative techniques such as subsampling and modeling are used to ameliorate sampling bias in paleodiversity studies. Species richness, however, is only one measure of biodiversity; others include morphological disparity and rates of evolution. Comparatively little work has focused on how these measures are affected by sampling bias, or on the development of methods that may correct these measures for differential sampling. Here we describe two new techniques for assessing morphological rates and disparity over long time scales, which take into account information on the age uncertainty of fossil specimens and help fill gaps in the fossil record. Our rates method uses a likelihood ratio test to determine whether individual branches or clades on a phylogeny have significantly different rates of discrete character evolution from the remainder of the tree. A sensitivity analysis allows rates to be calculated using permutations of the range of possible ages for each taxon. In this way, temporal curves can be constructed by permutations which allow each character change to occur at any point in time along the duration of the branch it is optimized on. Using lungfish as a test case, we find that morphological rates are highly heterogeneous across phylogeny and recover a general slow-down in character change from the Devonian to the present. Our disparity method fills some gaps in the fossil record by including reconstructed ancestral morphologies that are predicted to be present in older time intervals by reference to a phylogeny (analogous to ghost ranges), but are currently unsampled in the fossil record. Using Triassic archosaurs and two mammal clades as test cases, we show that including "ghost morphologies" often results in elevated disparity in earlier time bins, a result that would be unobtainable by taking the fossil record at face value.

Technical Session XV (Saturday, November 5, 12:00 pm)

LOCALIZATION OF THE DIAPHRAGM AND AXIAL PATTERNING IN MAMMALS

BUCHHOLTZ, Emily, Wellesley College, Wellesley, MA, USA; YANG, Jennifer, Wellesley College, Wellesley, MA, USA; BAILIN, Hannah, Wellesley College, Wellesley, MA, USA; LAVES, Susan, Wellesley College, Wellesley, MA, USA; DROZD, Lucie, Wellesley College, Wellesley, MA, USA

The nearly uniform sequence of vertebrae that articulate with moveable ribs in ancestral aquatic vertebrates was replaced by a column with distinct morphological series in tetrapods. Although the column is of somitic origin and therefore patterned primaxially, the borders of its component series occur coincident with the antero-posterior locations of structures with abaxial patterning, suggesting the presence of developmental integration. Chief among these structures are the limbs, which subdivide the column into cervical, dorsal, and caudal units. The secondary subdivision of the dorsal series into thoracic and lumbar subunits in synapsids occurs coincident with osteological proxies for the origin of a muscular diaphragm and mammalian physiology. In living mammals the diaphragm develops by secondary investment of the transverse septum by striated muscle cells of somitic origin, and is anchored to both somitic (vertebral) and lateral plate (sternal) structures. Here we ask if the locations of these anchor points are displaced when the location of the thoracolumbar boundary shifts homeotically, when the total count of the thoracolumbar unit deviates from its conserved count of 19-20, and/or when there is a patterning shift in the location of primaxial relative to abaxial structures. We used dissection and CT scanning to reconstruct the locations of the diaphragm in fluid preserved specimens of *Bradypus variegatus*, *Choleopus didactylus*, *Ornithorhynchus anatinus*, *Dasypus novemcinctus*, and *Anomalurus derbianus*, and a DICOM data set of *Trichechus manatus* provided by the Florida College of Veterinary Medicine's Aquatic Animal Health Program. Our results indicate that the location of the diaphragm travels with changes in the thoracolumbar boundary except in taxa with primaxial / abaxial shifts. In these taxa, the diaphragm retains its traditional lateral plate, but not its somitic, anchor points, supporting molecular studies that identify the patterning of the diaphragm as abaxial.

Poster Session I (Wednesday, November 2)

TESTING FOR TOOTH WEAR RESISTANT MEASURES OF DIET IN PRIMATES

BUNN, Jonathan, Stony Brook University, Stony Brook, NY, USA; ZOHDY, Sarah, University of Helsinki, Helsinki, Finland; KING, Stephen, University of Massachusetts, Amherst, MA, USA; WRIGHT, Patricia, Stony Brook University, Stony Brook, NY, USA; JERNVALL, Jukka, University of Helsinki, Helsinki, Finland

Dental topographic analysis (DTA) is a set of methods for quantifying topographic variables of molar occlusal surfaces to infer dietary adaptations in living and fossil species. DTA offers a number of advantages over other methods of quantifying dental-dietary variation (e.g., shearing quotients) primarily in its ability to quantify shape in both pristine and worn teeth. As fossil assemblages are dominated by worn teeth, the capability to include worn specimens in analyses greatly increases the probability of correctly inferring paleodiets. Relief index (RFI), a topographic variable measuring surface relief, has been shown to separate extant species with different diets in samples of variably-worn molar teeth. Little is known, however, of how RFI changes through the process of wear in an individual animal over time. Further, Dirichlet Normal Energy (DNE), a topographic variable quantifying surface curvature that has advantages over RFI, has never been examined relative to molar wear. Knowing how molar shape, as measured by RFI and DNE, is modified by the process of progressive molar wear may aid our ability to infer diets in fossil species. Here we address these topics by measuring RFI and DNE on a longitudinal sample of second mandibular molars of *Propithecus edwardsi* and *Microcebus rufus* from Ranomafana National Park, Madagascar. This sample consists of repeatedly captured wild animals, allowing examination of molar shape over the lives of individuals. Large dietary differences exist between these species,

with *P. edwardsi* being primarily folivorous and *M. rufus* consuming fruits and insects. RFI and DNE were calculated from 3D digital models of laser-scanned molar casts and compared between species and through wear. Results show that RFI and DNE decrease as teeth wear, consistent with prior non-longitudinal studies. Additionally, RFI and DNE each individually separate these species by diet across a wear gradient. These results suggest that RFI and DNE both capture elements of primate molar shape that are obliterated over time through wear, but that these variables can nonetheless be used to infer diets of extinct species in samples of variably-worn teeth.

Poster Session III (Friday, November 4)

GIANT PTEROSAUR REMAINS FROM THE CAMPANIAN OF THE MORONDAVA BASIN, WESTERN MADAGASCAR

BURCH, Sara, Stony Brook University, Stony Brook, NY, USA; SERTICH, Joseph, Denver Museum of Nature and Science, Denver, CO, USA

The global distribution of pterosaurs during the Cretaceous includes representatives from most Gondwanan landmasses including South America, Afro-Arabia, Australia, and New Zealand. The only putative evidence of pterosaurs from Madagascar is limited to teeth from Middle Jurassic deposits; no pterosaur material has been recovered from Cretaceous deposits despite extensive fieldwork in the Mahajanga and Ambilobe basins of northern Madagascar. Recent fieldwork in the Morondava Basin of Madagascar targeting Cretaceous sediments has yielded the first definitive non-dental skeletal remains of a pterosaur from Madagascar. These remains were recovered from deposits biostratigraphically dated with ammonites (e.g., *Eubostrychoceras otsukai*) to the Campanian. The Morondava Basin is the largest of the three major sedimentary basins of Madagascar, encompassing much of the western and southwestern portions of the island. Extensive transgressive and regressive sedimentary deposits in the basin range in age from the Albian to the Maastrichtian and have remained almost entirely unsampled for vertebrate remains. The new pterosaur material consists of a distal right ulna and radius, both three-dimensionally preserved and uncrushed in a concretion. The ulna has a maximum dorsoventral height of 8 cm and a preserved cortical thickness of less than a millimeter. The distal articular surface possesses a well-defined fovea carpalis and tubercle, with an expansive dorsal articular facet similar to that of *Azhdarcho lancicollis*. The ventral crest is short and low, not elongate as in anhanguerids. The anterior surface is not characterized by a broad, flat surface with a prominent ridge dorsally as in other pterosaurs (e.g., *Anhanguera araripensis*, *Istiodactylus latidens*), but is rounded and possesses a squared protuberance distally, which is situated directly anterior to the tubercle. Based on size and overall morphology, we refer the material to the Pterodactyloidea and tentatively to the Azhdarchidae. These remains present conclusive evidence for the presence of pterosaurs in the Late Cretaceous of Madagascar and expand the known geographic distribution of the clade during the Campanian.

Poster Session III (Friday, November 4)

DIVERSITY, EXTINCTION, AND GAPS: AN OVERVIEW OF THE MAMMALIAN RECORD DURING THE LATE PALEOCENE AND EOCENE IN THE ROCKY MOUNTAIN REGION OF NORTH AMERICA

BURGER, Benjamin, SWCA, Vernal, UT, USA

Temporal data of over 700 mammalian species from the intermountain basins of western North America were compiled to study what effects climate change had on diversity and species richness during the late Paleocene and Eocene epochs (60 to 33.5 million years ago). To mitigate latitudinal/geographic discrepancies in diversity patterns, biostratigraphic ranges were reconstructed from the limited region of eastern Utah, Wyoming and Colorado. The fossil record reveals patterns of diversity that reflect the volatile hyper-thermal climatic events of the late Paleocene and Eocene. In particular, mammalian turnover is strongest at the Paleocene-Eocene Thermal Maximum (55 mya), with many groups either becoming extinct (Carpolestidae, Picrodontidae, Nyctitheriidae) or reduced in diversity (Multituberculata, Plesiadapidae, Pantodonta) after the event. The smaller climatic events of the early Eocene appear to have negligible effects on diversity patterns. However, during the Early Eocene Climate Optimum (50 mya) small arboreal mammals became highly diverse, culminating in the richest primate and rodent diversity (highest species-richness) at the climax of the event. The data does not reveal a strong crash afterward, but stable diversity until about 46 million years ago. At that point, primates become replaced by a sudden proliferation of artiodactyls. The data reflects a strong change in mammalian diversity at 46 million years ago (Bridgerian/Uintan North American Land Mammal Age boundary). This change in mammalian diversity patterns is correlated to a gradual global cooling trend rather than a sudden event. Small insectivore mammals, such the members of the Lipotyphla show low diversity during the Uintan NALMA, indicating this subsequent change might be influenced by sampling bias. Only a handful of taxa are known between 41 and 36 mya indicating a significant gap in the fossil record that will require future discoveries to fill. Toward the end of the Eocene, the Carnivora families Viverravidae and Miacidae are replaced by the modern Felidae and Canidae. Lagomorpha diversity and richness increases, while marsupial species have diminished in prominence by the end of the Eocene.

Poster Session IV (Saturday, November 5)

NEW ASSOCIATED SKELETAL MATERIAL OF A VARANID LIZARD, *SANIWA CF. ENSIDENS*, FROM THE EOCENE UINTA FORMATION OF THE UINTA BASIN, UTAH, USA

BURK, Daniel, Intermountain Paleo-Consulting, Vernal, UT, USA; SANDAU, Stephen, Intermountain Paleo-Consulting, Vernal, UT, USA; ALDERKS, David, Intermountain Paleo-Consulting, Vernal, UT, USA

We report the remarkably preserved skeleton of a varanid lizard from the Uinta B (Upper Wagonhound Member) of the Eocene Uinta Formation of the Uinta Basin, in Eastern Utah. The skeleton was found in 2010 during a paleontological reconnaissance survey in the Natural Buttes Oil and Gas Field, preserved in a block of fine grained light green sandstone in the bottom of a small canyon wash. The specimen closely resembles, in size and morphology, the well documented Bridgerian species *Saniwa ensidens*, from the Eocene Green River Formation of Wyoming. The cranial skeleton is represented by: the right maxilla with two teeth, right dentary, and supraoccipital. The axial skeleton is represented by: two articulated cervical vertebrae, twelve articulated dorsal vertebrae (six of which with articulated ribs), and ten articulated caudal vertebrae. The appendicular skeleton is represented by: a clavicle, left coracoid, articulated right coracoid and scapula, partial right humerus, partial right radius, partial right ulna, right femur, partial right tibia, five right metatarsals, and five phalanges from the right pes. Also associated with the specimen are a number of small, fragmented, and unidentified bones. Other *Saniwa cf. ensidens* material previously recovered from the Uinta Formation consist of three individuals recovered during earlier paleontological reconnaissance surveys in the Uinta Basin. One is represented by a few associated vertebrae belonging to an individual of a size comparable to *Saniwa ensidens*. The other two specimens are much larger individuals, which may represent a separate species. The first is represented by a total of 23 vertebrae (eight articulated) and associated fragments. The second consists of a single partial vertebra.

Poster Session III (Friday, November 4)

NEW FOSSIL BOX TURTLES FROM THE PALEOGENE OF WEST TEXAS: A NEW TAXON WITH CRITICAL INSIGHTS INTO THE EVOLUTIONARY HISTORY OF BOX TURTLES

BURROUGHS, Robert, Jackson School of Geosciences, The University of Texas at Austin, Austin, TX, USA

Two new fossils of functional box turtles from the Vieja Formation of Texas provide insights into the evolutionary history of North American box turtles. The formation is latest Eocene/early Oligocene (Chadronian) in age. The specimens are immediately recognizable as functional box turtles, by the separation of the plastron into two distinct lobes, the presence of a well-developed kinetic plastral hinge, and the reduction of the plastral-bridge to bony projections similar to those seen in the extant box turtle genera *Terrapene* and *Cuora*. These specimens are the most complete specimens of box turtles from the North American Paleogene to date and are slightly younger in age than a previously described extinct box turtle *Planetochelys*. The specimens are mostly obscured by hard matrix. The specimens were scanned with an X-ray Computed Tomography scanner and were digitally prepared. Digital preparation exposed the nuchal bone, which is otherwise completely obscured by matrix and allowed the mostly complete anterior lobe of the plastron to be visualized and studied. The entoplastron of the specimen is roughly oval in shape and more similar to that of extant *Terrapene* than *Cuora*; the entoplastron of *Planetochelys* has never been described. The nuchal bone does not have features of *Cuora*, but does have features similar to those described for *Planetochelys* and *Terrapene*, such as elongate costiform processes and intruded contact of the first neural. The carapace is highly domed, similar to that of extant *Terrapene*, but distinct from *Planetochelys*. The specimens have more neural bones than extant *Terrapene*, but have a suprapygal consistent in shape with that of *Terrapene* and have post neural elements similar to those described for *Planetochelys*. These fossils appear at this time to be more closely related to Emydid turtles than any other group, based on the characters present in the nuchal, plastron, neural and pygal series, and the external shell morphology. These fossils provide insights into the evolutionary history of Emydid and box turtles. I provide the first anatomical description of this material and a discussion of the phylogenetic implications of the fossils.

Poster Session III (Friday, November 4)

DIET CATEGORIZATION FOR DIDELPHID MARSUPIALS USING TOOTH ENAMEL MICROWEAR

BURROWS, Allison, Midwestern University, Glendale, AZ, USA

The purpose of this study was to generate broad categories of diet that can be used to study extinct marsupials. Low magnification microwear studies have been shown to be a reliable medium for studying the diets of mammals both extant and extinct. In this study, 546 specimens representing 10 genera and 25 species of didelphid marsupials have been included for the purpose of studying the relationship between the enamel microwear and diet categories. Marsupial microwear was counted on high dynamic range images using Image J on all specimens. High dynamic range image methods resulted in images with sufficient amount of detail for studying microwear. The diet literature for didelphids provided for a separation of their diets into five diet categories: Carnivore-Invertebrates, Carnivore-Vertebrates, Omnivore-Insects, Omnivore-Fruit, and Omnivore-Generalist. Based on the microwear data obtained in this study, the Carnivore-Invertebrates group has a coarse wear signature of many large pits, coarse scratches, and hypercoarse scratches. A coarse wear signature

of many large pits and small puncture pits is expected for didelphids in the Carnivore-Vertebrate group. The Omnivore-Insectivore group has a mixed microwear signal: high large pit and fine scratch amounts with various small pit and small puncture pit counts, due to the variation of insectivory/frugivory within the group. Didelphid frugivores have a highly pitted microwear signal. Our analysis for the Omnivore-Generalist group indicates that large pits and small puncture pits are the most frequent microwear features for this group; however, the species in this group also have varying amounts of small pits, gouges, and all types of scratches.

Symposium 4 (Friday, November 4, 9:30 am)

THE TAXONOMIC DIVERSITY AND MORPHOLOGICAL DISPARITY OF PTEROSAURS: UNTANGLING SAMPLING BIASES, THE IMPACT OF LAGERSTÄTTEN, AND DIVERSIFICATION TRAJECTORIES

BUTLER, Richard, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; BARRETT, Paul, Natural History Museum, London, United Kingdom; BENSON, Roger, University of Cambridge, Cambridge, United Kingdom; BRUSATTE, Stephen, American Museum of Natural History, New York, NY, USA; ANDRES, Brian, Yale University, New Haven, CT, USA

Recent work on shallow marine invertebrates and both marine and terrestrial tetrapods has highlighted close correlations between observed taxonomic diversity counts and sampling of the fossil record. The interpretations of such correlations and how best to correct for them if they reflect sampling biases remain controversial. Pterosaurs have played a prominant role in this debate among vertebrate paleontologists, with sharply conflicting views as to the extent to which the pterosaur record is biased by sampling and the relative importance of Lagerstätten deposits. Here we present revised comparisons of species-level pterosaur taxonomic diversity and fossil record sampling, based upon an extensive revision of pterosaur distributional data within the *Paleobiology Database* (>550 collections, 145 species). Moreover, we calculate temporal trends in morphological diversity (disparity) for pterosaurs using a new phylogenetic dataset (100 species, 183 characters) and make the first explicit quantitative comparisons between disparity and fossil record sampling. We utilise a variety of sampling metrics, rigorous data transformations to remove trend and autocorrelation, and recently developed multiple regression modelling approaches to 'correct' diversity estimates and explore the effect of uneven bin lengths. For comparisons involving disparity, we find that range-based disparity metrics are strongly influenced by uneven sampling, whereas variance-based metrics are more robust and can be more confidently interpreted as reflecting true biological signals. Our analyses support proposals of a substantial 'Lagerstätten effect' on some biodiversity metrics for pterosaurs. We argue that careful consideration of sampling may allow genuine patterns in pterosaur evolutionary history to be identified, such as a decline in diversity and disparity in the Late Cretaceous.

Poster Session IV (Saturday, November 5)

GEORADAR APPLICATIONS IN VERTEBRATE TAPHONOMY AND ICHNOLOGY

BUYNEVICH, Ilya, Temple University, Philadelphia, PA, USA; HASIOTIS, Stephen, University of Kansas, Lawrence, KS, USA

Ground-penetrating radar (GPR or georadar) is a rapid and effective high-resolution, subsurface imaging technique with promising applications to site prospecting and quantitative analysis of vertebrate remains and traces. Low- to mid-frequency GPR antennas (50-500 MHz) aid in visualizing bounding surfaces, with large (>20 cm) vertebrate fragments and traces producing diagnostic point-source reflections. Imaging of paleochannels in Quaternary sediments and some older semiconsolidated rocks establishes the sedimentary context for locating large bones (channel thalweg) and track surfaces (channel margins). GPR records often reveal sediment deformation associated with buried targets and allow imaging below the water table, where resolution typically increases at the expense of penetration. In the upper 1-2 m of the subsurface, high-frequency antennas (500-2,300 MHz) allow detection and resolution of such decimeter-to-centimeter scale features as individual bones, skeletal accumulations, and decomposing carcasses, as well as large tracks and trampled surfaces. We present examples of identification, mapping, and measurement of vertebrate traces in the field and laboratory using a spectrum of GPR antenna frequencies: unfilled burrows and tunnels in alluvial deposits (diameter: 5-30 cm), excavations in aeolian sands (15-20 cm), and ungulate (equid and cervid) tracks (8-10 cm). Whereas fine-grained material attenuates the electromagnetic GPR signal in unconsolidated sediments and soils, the dielectric contrast with the surrounding sand-rich matrix is sufficient for detecting biogenic structures. In some coastal areas, heavy-mineral concentrations produced during high-energy storm events may also have associated vertebrate remains and traces. Such mineralogical anomalies provide strong dielectric contrast that accentuates subsurface structures in geophysical records. In addition to its application in vertebrate taphonomy and ichnology, our work suggests that caution must be taken when interpreting point-source and irregular reflections as primary (inorganic) physical structures.

Poster Session I (Wednesday, November 2)

BITING OFF MORE THAN THEY COULD CHEW: A GEOMETRIC MORPHOMETRIC APPROACH TO THEROPOD FEEDING ECOLOGY

BYKOWSKI, Richard, Indiana University, Bloomington, IN, USA

Non-avian theropod dinosaurs represent a case of evolutionary tinkering: while the overall body plan is conserved, the amount of skull morphological diversity suggests a possible selective force. In theropods, there is an apparent trade-off between skull robustness and the importance of forelimbs. In extant mammalian predators, there are correlations between skull morphology and the ability to subdue various types of prey. If changes in theropod skull morphology are a direct result of interactions with potential prey, then we should observe a relationship between the different morphologies and the changes in relative abundances of prey. The maxilla is a large bone along the lateral margins of the skull and contains the teeth that would be important in subjugating potential prey and absorbing bite forces needed for predatory behavior. Maxillary shape is quantified across multiple taxa using sliding semilandmarks. Relative abundances of coexisting sauropods, theropods, marginocephalians, ornithopods and thyreophorans are estimated and a multivariate linear regression is performed to test for correlations between maxillary deformation taxa abundances. Preliminary results indicate that a small amount of variation ($r2 \leq 0.2$, $p < 0.05$) in maxillary shape is correlated with the changing abundances of coexisting taxa. The most striking correlation is with the abundance of sauropods, where trends indicate a more elongate skull and flatter ventral border ($r2=0.14$, $p=0.009$) and thicker ascending ramus of maxilla ($r2=0.2$, $p=0.002$). Other trends observed include an elongation of the snout with higher abundances of marginocephalians ($r2=0.1$, $p=0.04$) and thyreophorans ($r2=0.1$, $p=0.03$) and deeper, more robust skulls with higher abundances of other theropods ($r2=0.21$, $p=0.001$) or ornithopods ($r2=0.1$, $p=0.03$). More robust skulls may have been stronger and better suited to biting and holding on while more elongate skulls were better suited to a 'slash and run' technique. This diverse morphology suggests that specific approaches may have evolved in response to the relative abundances of coexisting organisms and potential prey.

Poster Session III (Friday, November 4)

CENOZOIC FOSSIL TURTLES FROM THE PANAMA CANAL BASIN

CADENA, Edwin, North Carolina State University, Raleigh, NC, USA; BOURQUE, Jason, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; RINCON, Aldo, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; JARAMILLO, Carlos, Smithsonian Tropical Research Institute, Panama, Panama

Based on extensive collections made over the past 50 years, three distinct fossil turtle assemblages are recognized from the Panama Canal area that span the Eocene through Middle Miocene. The first, from the middle to late Eocene Gatuncillo Formation, is composed of panpodocnemid pleurodires. The second, from the Early Miocene Culebra Formation, is also composed of panpodocnemids, as well as trionychid and testudinid cryptodires. The third, from the Early to Middle Miocene Cucaracha Formation, is composed of a new species of the geoemydid *Rhinoclemmys*, a new species of the kinosternid *Staurotypus*, a testudinid, trionychid, and panpodocnemids. Analysis of these turtle assemblages indicates an early interaction between North-Central American and South American herpetofauna at the easternmost tip of the Central American Peninsula, before the emergence of the Panama isthmus. Specifically, we document North American cryptodires in the same assemblage with pleurodires in the new world tropics. These fossils further document some of the earliest occurrences of *Rhinoclemmys* in Central America, a wider past distribution for *Staurotypus*, and an earlier occurrence of giant tortoises into the new world tropics than previously known.

Technical Session XIII (Friday, November 4, 3:00 pm)

FRUIT PROPORTION AND CONSUMPTION OF HARD ITEMS IN THE DIETS OF PRIMATES CORRELATE WITH MICROTEXTURES

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The 3D dental microtexture analysis is powerful in reconstructing the diets of extinct primates. This method is based on the comparison of fossils with extant species with known diets. The diets of primates are highly diversified but fruits remain the main component. Two methods of microtexture analysis, the Scale-Sensitive Fractal Analysis (SSFA) and the Dental Areal Surface Texture Analysis (DASTA) are applied. Besides of revealing diets, DASTA is highly useful to describe tooth function. Eight extant primate species (*Alouatta seniculus, Gorilla gorilla, Lophocebus albigena, Macaca fascicularis, Pan troglodytes, Papio cynocephalus, Pongo abelii, Theropithecus gelada*) are included. These species largely differ in the mean annual fruit proportions (from 0 to 90%) in their diet, as well as in their consumption of other hard items (seeds, bark, and insects) and of grass. First we tested if the proportion of fruits consumed can be estimated by microtextures and second how the other components in the diet impact the microtexture. The complexity and its heterogeneity (SSFA) correlate with the proportion of fruits in the diet. However, the ingestion of all hard items (fruits, seeds, bark, and insect cuticles) contributes to an increase in the textural fill volume (SSFA). Moreover, the anisotropy (SSFA) reflects the consumption of grass. ISO/

FDIS 25178-2 parameters (DASTA) valley height, root mean square height, material volume, density of peaks, and closed hill and dale areas refer to specific dental functional characteristics. Combining all six parameters allows for a comprehensive representation of surface microtextures and their functional integrity. Food items containing large hard particles (e.g. fruits) indent enamel facets more heavily producing a surface with more relief, whereas items with comparatively smaller hard particles (e.g. grass) tend to flatten surfaces. Therefore ISO/FDIS parameters (DASTA) provide insights into the functional interface that dental surfaces represent in respect to environment. SSFA and DASTA are thus complementary and can reconstruct diet, function and environment of extinct primates with a higher resolution.

Symposium 1 (Wednesday, November 2, 9:45 am)

380 MILLION YEARS OF TETRAPOD EVOLUTIONARY TRANSFORMATIONS: CONVERGENT EVOLUTION AND THE COUPLING OF AXIAL ELONGATION WITH LIMB AND GIRDLE REDUCTION AND LOSS

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A phylogenetic perspective on the evolutionary history of tetrapods, suggests that the loss and reduction of limbs and girdles appears to have been tightly linked to axial elongation. In otherwords, multiple groups of limbed tetrapods appear to become long and skinny while at the same time displaying loss and reduction of their limb and girdle elements. This apparent linkage between limbloss and body elongation is observed in all major groups of tetrapods throughout the 380 million year history of the group. A threshold number of 35-40 presacral vertebrae appears linked to minor reductions in digit number and phalangeal count. Presacral vertebral counts do not increase gradually, rather, but rather appear to saltate from 35-40 vertebrae to 60-70. At higher vertebral numbers, limb loss is extreme, with the forelimbs being reduced to tiny appendages, or lost altogether. Higher presacral counts (>90) are linked to total forelimb and girdle loss and radical rearlimb reductions culminating in total loss. A pattern of this sort is recognized in Paleozoic lepospondyls and Mesozoic to modern squamates. Less severe modifications are observed in aquatically adapted reptiles (e.g., ichthyosaurs, mosasaurs, plesiosaurs) and mammals (e.g., archaeocetes). A recently proposed developmental genetic models identifies homeobox gene complexes associated with body axis morphogenesis that may be linked homebox-regulated development of the limb. Axial elongation and limb reduction/loss follows regular patterns regardless of the tetrapod lineage and may well reflect underlying constraints on developmental processes and patterns that are common to all vertebrates, including tetrapods.

Technical Session VII (Thursday, November 3, 2:30 pm)

THE LAST SUPPER BEFORE THE IMPACT: MAMMALIAN DIETS ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY

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The Cretaceous-Paleogene (K-Pg) mass extinction that marked the end of non-avian dinosaurs had a critical impact on mammalian faunas. It has been suggested that the K-Pg event triggered an ecological release, in which small-bodied, mostly insectivorous mammals were able to ecologically diversify into a variety of niches during the Paleocene. Previous studies have addressed quantitative changes in taxonomic diversity of the mammalian fauna leading up to and across the K-Pg, but few have quantified changes in ecological diversity across this boundary. We used low-magnification microwear analysis of fossil specimens from the Hell Creek and Tullock formations of northeastern Montana to delineate diets in latest Cretaceous (Lancian) and earliest Paleocene (early Puercan) mammals and test whether the range of diets expanded across the K-Pg boundary, in particular towards increased herbivory.

Lancian metatherians and eutherians show microwear patterns corresponding to insectivores and insect-dominated omnivores. However, *Didelphodon*, which is a large-bodied metatherian, exhibits a microwear comparable to the durophagous North American river otter. Lancian multituberculates show a broad range of microwear patterns, corresponding to insectivorous to omnivorous diets and, among larger-bodied species, diets with an increased plant component. Early Puercan eutherians, in particular archaic ungulates, show microwear patterns indicative of increased plant consumption and possibly browsing behavior. Patterns of early Puercan multituberculates suggest increased herbivory, corroborating results based on gross morphology. Thus, our results in large part support the traditional view: during the latest Cretaceous, most therians were largely insectivorous, though *Didelphodon* and large-bodied multituberculates may have exploited a broader range of food sources; then a distinct shift in mammalian ecology occurred immediately across the K-Pg boundary, when diverse archaic ungulates began to exploit high-fiber plant material as a food source.

Poster Session IV (Saturday, November 5)

FIRST MOLLUSC DATA AND PALAEOENVIRONMENTAL IMPLICATIONS IN "LO HUECO" VERTEBRATE SITE (UPPER CRETACEOUS, CUENCA, SPAIN)

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The 'Lo Hueco' vertebrate site includes a succession in 'Garumn' facies of versicolor marly mudstone levels, partially cut by a sandy channel structure and two sulphated intervals. It contains an exceptional richness and diversity of fossils, and has to date provided more than 8500 macroremains, mainly of vertebrates, such as actinopterygians and teleosteans fishes, amphibians, panpleurodiran (bothremydids) and pancryptodiran turtles, squamate lizards, eusuchian crocodiles, pterosaurs, and euornithopod (rhabdodontids), theropod (mainly dromaeosaurids) and sauropod (titanosaurs, some of them with nearly complete skeletons) dinosaurs, but also of plants and invertebrates. In order to gain a better characterization of the palaeoenvironment of this important site, a detailed analysis of the collected molluscs was conducted here. Nevertheless, due to the extreme urgency of the excavation process (with sampling not focused on sieving molluscs), and to the fact that the preservational scenario was not ideal for the fossilization of carbonated remains, the number of collected specimens is scarce and does not reflect the real abundance and diversity of these invertebrates in the palaeoenvironment. Molluscs are mainly preserved as internal moulds of marly mudstone (bivalves) without hinge details, or of gypsum (most of gastropods), and have been kept in open nomenclature until new data is collected. Bivalves are recorded by freshwater unionids of the families Margaritiferidae (*Margaritifera*) and Unionidae (*Anodonta*), and heterodontids of the families Corbiculidae (*Corbicula*) and Pisidiidae (*Pisidium*). Gastropods are known from at least two species of Melanopsidae (*Faunus*), which suggest some influence of moderately brackish conditions. All bivalves were found disarticulated, a fact that can be related to some energetic flooding episodes in the palaeoenvironment. These systematic and palaeoecologic data on molluscs are in accordance with an upper Campanian-lower Maastrichtian near-coast continental muddy flood plain crossed by distributary sandy channels, exposed intermittently to brackish or marine tidal influx, freshwater flooding, and partial or total desiccation.

Technical Session XV (Saturday, November 5, 9:00 am)

THE TAXONOMY AND CRANIAL MORPHOLOGY OF CHINESE *LYSTROSAURUS*

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The taxonomy of Gondwanan *Lystrosaurus* species has undergone major revision over the past 60 years, with a decrease from 29 to four valid species. Nine additional species have been named in Laurasia, seven of which are found in China. One of these, *L. weidenreichi*, is only known from non-diagnostic postcranial material. The validity of the remaining six, *L. broomi, L. hedini, L. latifrons, L. robustus, L. shichuangouensis*, and *L. youngi,* has only been briefly addressed in the literature and is the focus of this study. Inspection of all available specimens of Chinese *Lystrosaurus* reveals minimal variation between *L. broomi, L. hedini, L. robustus,* and *L. shichuangouensis*. Variable features, such as snout depth and the development of ornamentation, can be attributed to ontogeny. The paratype of *L. latifrons*, though distorted, is also similar to these species. *Lystrosaurus youngi* has a longer snout and minimal ornamentation, giving it a more plesiomorphic appearance such as that observed in the Gondwanan species *Lystrosaurus curvatus*. The size ranges of the *L. broomi-L. hedini-L. robustus-L. shichuangouensis* and *L. youngi* groups overlap and differences are visible in juveniles, making sexual dimorphism unlikely. Geometric morphometric analyses reaffirm these two morphotypes, with *L. youngi* separate from a group consisting of *L. hedini, L. robustus,* and *L. shichuangouensis*. These results support the presence of two species in China: *L. hedini* (=*L. broomi, L. latifrons, L. robustus, L. shichuangouensis*) and *L. youngi*. Additionally, these species are morphologically distinct from Gondwanan *Lystrosaurus* in several ways. Laurasian *Lystrosaurus* have a much higher degree of intraspecific variation in preparietal size and shape. The shape of the lacrimal and expression of the nasal-frontal and transverse frontal ridges also vary geographically. Both Chinese species share these traits, suggesting a single dispersal event from Gondwana to Laurasia in the Late Permian prior to the appearance of *L youngi* in the stratigraphic record.

Poster Session I (Wednesday, November 2)

PLIO-PLEISTOCENE PALEOENVIRONMENTAL CHANGE IN THE CRADLE OF HUMANKIND, SOUTH AFRICA: AN APPLICATION OF MODERN RODENT NICHE MODELS TO FOSSIL BEARING LOCALITIES

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Paleoenvironmental reconstructions utilizing small mammal faunas to assess past conditions are based on the principle of actualism in which the environmental and ecological tolerances of fossil taxa are assumed similar to the modern taxa that they resemble. It follows that an accurate assessment of modern environmental tolerance limits is a prerequisite for any actualistic approach. When the tolerance limits of modern taxa are defined, these parameters can then be applied to fossil-bearing localities where the taxa have been reported. This study utilizes modern rodent niche models developed using a Geographic Information Systems (GIS) based analysis of 19,567 specimens obtained from the electronic databases of the Transvaal Museum, South Africa, and the Division of Mammals, Smithsonian Institution National Museum of Natural History. Genus level ecological and environmental tolerance ranges are used due to difficulties in species level identification and a lack of well-defined dental apomorphies for many rodent taxa. Modern niche model parameters are applied to Plio-Pleistocene fossil-bearing localities within the Cradle of Humankind, South Africa, including the hominin bearing sites of Makapansgat, Sterkfontein, Drimolen, Gondolin, Swartkrans, Gladysvale and Plovers Lake. In doing so, this study examines environmental change for an area of approximately 470 square kilometers over the last 5 million years. Results from this analysis suggest that in the Early Pliocene the study area was more arid than in later times. Subsequently, this model suggests a general increase in precipitation along with more wooded environments during the Late Pliocene. Throughout the Pleistocene a general

trend of reduction in the amount of wooded cover concomitant with an increase in savanna grassland habitats is observed. As most Plio-Pleistocene rodent genera in South Africa have extant representatives, this study provides a conservative analysis of environmental change for the study area. With improvements in species level identification of rodent taxa, greater precision can be obtained through the application of lower level niche model parameters to fossil-bearing localities.

Poster Session II (Thursday, November 3)

OSTEOARTHRITIS IN AN AMPHICYONID FROM THE EARLY BARSTOVIAN, YELLOW HILLS FAUNA, NORTHWESTERN NEVADA

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A disarticulated partial skeleton of an amphicyonid displaying severe osteoarthritis was recovered from the basal portion of a relatively fine-grained lahar that was deposited within the High Rock Caldera in northwestern Nevada. The lahar is part of the High Rock Sequence and hosts the majority of the mammalian taxa of the Early Barstovian Yellow Hills Fauna (~16Ma). The amphicyonid (Sierra College VMC 199) post-cranial elements that show osteophytes are: the axis on the ventral side of the caudal articular surface; interior and exterior surfaces of the distal ends of the tibiae; metacarpals; and possible carpal fragments so distorted by osteophytes that they cannot be identified. Although all of the metacarpals show a varying degree of osteoarthritis adjacent to the proximal articulating surfaces, the 3rd and 4th show the most severe osteoarthritis with osteophyte development adjacent to the distal articulating surfaces. The 4th metacarpal has osteoarthritis growth on the ventral side of the central shaft forming a continuous ridge of osteophytes to each terminus. The type of arthritis shown on these elements is primary osteoarthritis - a condition normally found in older animals. Amphicyonids are believed to be ambush predators that use their front feet to grab and bring down their prey. Thus, it is difficult to comprehend how this animal was able to survive as long as it did in order to develop such an advanced stage of osteoarthritis. Possible hypotheses could be that this animal was supported and protected by a pack, or that it somehow avoided being the victim of predators, and scavenged during its remaining days of life. Since a relatively high percentage of skeletal elements of this animal have been recovered from a localized area and that there is a lack of obvious evidence of scavenging, it may be concluded that there was little disturbance and distribution of the carcass prior to its incorporation into the lahar. One could hypothesize that the animal was too crippled to avoid the flow or that its carcass was protected from scavengers. In any case, it is a rare occurrence within the fossil record to find osteoarthritis in an amphicyonid.

Symposium 4 (Friday, November 4, 10:45 am)

DIVERSITY DYNAMICS IN THE LATE CRETACEOUS OF NORTH AMERICA: SAMPLING AND BODY SIZE BIASES

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The pattern of dinosaur diversity leading up to the end-Cretaceous extinction event is highly debated, and conflicting hypotheses centre on either a catastrophic demise or a gradual decline in the Maastrichtian. However, existing studies employ different sampling bias correction methods on independently derived datasets, making comparisons difficult, and most approach the problem on a global scale, which suffers from highly uneven geographic sampling through time. Here, we compile an up-to-date database of Cretaceous dinosaur species focusing only on North America, an essentially isolated, well-sampled continent. We apply two methods of sampling bias correction (rarefaction and model-based) at two different temporal scales (stage and sub-stage levels). The stage-level analyses suggest that Campanian species richness is unusually high, and therefore support a drop in species richness from the Campanian to the Maastrichtian.

Analysis of the dataset also indicates substantial body size biases in the dinosaur record. Body masses of all taxa were estimated, and species-body-size distribution curves constructed for the well-sampled Dinosaur Park and Hell Creek formations. Both reveal strong negatively skewed distributions, compared to the positive skew seen in extant ecosystems, suggesting that small species are substantially undersampled. We therefore restrict the second, sub-stage scale analysis to large-bodied dinosaurs (> 1000 kg), which are well represented in the fossil record, and provide a higher fidelity of diversity through this time. Results support a significant drop in dinosaur species richness from the early to the late Maastrichtian. The latest Maastrichtian lacks both lambeosaurines and centrosaurines and therefore a drop in taxonomic richness may be associated with a drop in ecological diversity. This drop in diversity is correlated with body size increases in multiple dinosaur clades and suggests a significant reorganization of dinosaur communities in the late Maastrichtian in which fewer but larger-bodied taxa were able to coexist, and may have made these communities more vulnerable to disturbance at the terminal Cretaceous extinction event.

Poster Session II (Thursday, November 3)

STABLE ISOTOPE COMPOSITION OF GLYPTODONT OSTEODERMS: A TOOL FOR INTERPRETING PALEO-ENVIRONMENT

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Glyptodonts were large, herbivorous xenarthrans that inhabited South America for most of the Cenozoic. Like all xenarthrans, glyptodonts lacked enamel, but are still assumed grazers based on the possession of large, hypseledont cheek teeth, which are estimated to have grown fast enough to compensate for the wear of abrasive grasses. Stable isotope analysis offers a means of testing this interpretation, but the lack of enamel makes stable isotope analysis of their dentition less reliable for interpreting paleodiet. An alternative may be analysis of the interlocking osteoderms that form the protective carapace of these animals. Due to the resiliency of osteoderms and their exceptional preservation in the fossil record, we hope to develop a more robust tool for the investigation of paleodiet and ecology from the stable isotope composition of this dense dermal tissue.

Glyptodont osteoderms were collected from multiple levels of the San Felipe Formation in the Angastaco Basin, northwestern Argentina. These Pliocene age fluvial and alluvial fan deposits mark the transition from humid conditions to sustained aridity c.a. 4 Ma associated with the development of a rainshadow. Prior to geochemical analysis, the structure and composition of the osteoderms was assessed by several methods (loss-on-ignition analysis, XRD and thin-sections) to confirm the integrity of the specimens. The average δ18O values of the osteoderm bioapatite is -6.5 ± 0.9‰, suggesting shallow burial conditions for these glyptodont fossils. This is consistent with slow sedimentation rates in the San Felipe Fm. ranging from ~ 0.16-0.2 mm/yr. The δ13C values of enamel from coeval rodent teeth (-3.4 ± 1.0‰) suggest the vegetation cover at the time was mostly C4 or CAM plants, in accordance with the onset of aridity in the region. The average δ13C value of the osteoderm bioapatite is -7.4 ± 1.2 ‰. If osteoderms are archives of unaltered carbon from diet, than glyptodonts were mixed-feeders, incorporating some C3, C4 and potentially CAM plants.

Poster Session IV (Saturday, November 5)

GROWTH PATTERNS AND PALAEOECOLOGY OF PAREIASAURS (PARAREPTILIA, PAREIASAURIDAE) INFERRED FROM LONG BONE HISTOLOGY AND MICROANATOMY

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Fossil bone histology and microanatomy is known to provide insight into various aspects of tetrapod palaeobiology (ontogeny, individual age, growth patterns, and lifestyle). Although bone histology has been extensively applied to the diverse and abundant nonmammalian therapsids from the vertebrate fossil-bearing sequence of the Karoo Basin (South Africa), few studies have been conducted on anapsids, such as the pareiasaurs which were fairly abundant in the Late Permian terrestrial ecosystems.

These herbivorous parareptiles remain enigmatic because of their phylogenetic affinities (hypothesized to be the sister group of turtles), and also in terms of their growth strategies and lifestyle habits. Earlier research based on anatomical and taphonomical studies have suggested that pareiasaurs had a rather short juvenile period as compared to adulthood, and that juveniles and adults occupied different habitats. Moreover, it has been often proposed that these animals were semi-aquatic or at least water-dependent for feeding.

Through an extensive survey of pareiasaurian long bone histology and microanatomy, here we assess these hypotheses. The main sampling method by coring using high pressure water cutting used in this study preserves the overall anatomy of the skeletal elements and provides the opportunity to examine a larger number of specimens compared to the standard cross-sectioning protocol. In order to document growth patterns, palaeoecological adaptations and intra and inter bone histovariability of these animals, our study examines more than 70 long bones (humeri, radii, femora, tibiae, fibulae, ribs) of 35 specimens of different ontogenetic stages. The whole taxonomic and stratigraphic spectrum of South African pareiasaurs is covered by our sample, from the early, large and less armoured genera such as *Bradysaurus* and *Embrithosaurus* (*Tapinocephalus* and *Pristerognathus* assemblage zones) up to the later forms such as *Pareiasaurus* and the dwarf, well armoured *Anthodon* (*Tropidostoma* to *Dicynodon* assemblage zones).

This research present fresh insights about the life history and palaeoecology of anapsid Permian tetrapod communities.

Poster Session II (Thursday, November 3)

MORPHOMETRIC ANALYSIS OF RANCHO LA BREAN FELID ILIA

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We have performed a morphometric analysis on the ilia of the Rancho La Brean *Smilodon fatalis* (n=9), *Panthera (Felis) atrox* (n=4), and *Lynx rufa* (n=4). Our goal was to visualize the ilium shape changes among the three species and to determine if size has an influence on the iliac shape. Generalized Procrustes Superimposition and principal components analysis techniques allowed us to examine the landmark-based variation. PC1 accounted for 33.4% of the total variance to be in the width of the ilium. *L. rufa*, with a positive PC1 score, has a

narrower ilium than *S. fatalis* and *P. atrox*, with negative PC1 scores. There was no significant difference between S. fatalis and P. atrox. The width of the ilium has a major effect on the muscle attachment site areas of gluteus medius and gluteus profundus, possibly influencing their force output and function. There is some positive relationship between size and shape for the ilium inferred by the regression between PC1 and ln centroid size. The ilium becomes wider as body size increases, from *L. rufa* to *P. atrox* and *S. fatalis*. However, *S. fatalis* has a more robust ilium although its body size is considerably less than that of *P. atrox*. This suggests that size is not the only determinant for the ilium shape. More felid species of different sizes should be included in this type of study to come to a better conclusion about the relationship between body size and ilium shape.

Technical Session VI (Thursday, November 3, 1:45 pm)

BLACK FEATHER COLOR IN *ARCHAEOPTERYX*

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Archaeopteryx has been regarded as an icon of evolution ever since its discovery 150 years ago from the Late Jurassic limestone deposits of Solnhofen, Germany. The anatomical mosaic of plesiomorphic and derived traits evidenced by these fossils has prompted a rich scientific literature on *Archaeopteryx* and the origin of birds, yet the color of this animal has remained only speculative. Here we report the first evidence of color from *Archaeopteryx*, based on scanning electron microscopy and energy-dispersive x-ray analyses that reveal the presence of fossilized color-imparting melanosomes in the isolated feather (MB.Av.100). Using a phylogenetically diverse database of 115 extant bird feathers (representing 87 taxa from 27 orders), quadratic discriminant analysis of five properties of melanosome morphology predicts that the original color of the *Archaeopteryx* feather was black, with 95% probability. Furthermore, based on our reexamination of its morphology we interpret the feather to be an upper primary covert. The specimen is also preserved as an organosulfur residue and reveals a barbule microstructure similar to that of modern bird feathers. In modern birds, melanin is also known to increase feather strength, thickness, and resistance to abrasion from the aerodynamic demands of flight, and the extensive melanization observed in the *Archaeopteryx* wing feather may have provided similar mechanical advantages during this early evolutionary stage of dinosaur flight. Ultimately, our results demonstrate how modern imaging techniques and statistical analysis can be coupled to reconstruct and further the understanding of plumage color and function in extinct dinosaurs.

Poster Session IV (Saturday, November 5)

BIOSTRATIGRAPHY OF EARLY HEMPHILLIAN BEAVERS (RODENTIA: CASTORIDAE) FROM THE PACIFIC NORTHWESTERN UNITED STATES OF AMERICA

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Castor is the sole remaining genus of a once diverse group of beavers, Castoridae, which roamed across the northern hemisphere from North America, Europe and Asia since the Oligocene. In the early Hemphillian of western North America three beaver genera are reported; *Castor, Hystricops* and *Dipoides*. *Hystricops* and *Dipoides* are native to North America while *Castor* is an invader. *Castor* appears in the European fossil record after 11.2 Ma and *Dipoides* after 9.0 Ma. The two genera of beavers, *Hystricops* and *Dipoides,* are found together in North America in the early Hemphillian, after 8.5 Ma. However, between 8.0-7.5 Ma, the relationship changes with *Castor* invading North America from Europe, appearing in association with either a medium or small sized species of *Dipoides*. *Castor* appears in the fossil record of Asia at 7 Ma and *Dipoides* a little later at 6 Ma. *Dipoides* beavers of the western United States are similar to specimens from Asia. The oldest North American specimens assigned to *Castor* come from the Hemphillian Chalk Hills Formation of Idaho and southeastern Oregon that contain species of *Dipoides*. No instance of *Hystricops* associated with *Castor* is evident. The youngest reported occurrence of *Hystricops* is from the Hemphillian Bartlett Mountain local fauna of southeastern Oregon that also contains *Dipoides*. *Castor* appears to have displaced *Hystricops* during the early Hemphillian while the other native genus, *Dipoides,* seems to flourish. Changing environmental conditions apparently favored the combination of *Dipoides* and *Castor* over *Hystricops*. A primary difference between the three genera is the development of ever-growing cheek teeth in *Castor* and *Dipoides* and not in *Hystricops*.

Poster Session III (Friday, November 4)

WHY THE LONG FACE? DENTAL MICROWEAR COMPARISON OF *LONGIROSTROMERYX* AND *BLASTOMERYX* (ARTIODACTYLA, MOSCHIDAE)

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The North American Miocene moschid *Longirostromeryx* shows several unique cranial characteristics. *Longirostromeryx* is distinguished from other small North American artiodactyls by an elongate rostrum and dentary symphysis, an increase in the length of the diastema between the canines and the anterior-most premolar, an increase in molar hypsodonty, and a reduction in premolar size. Combined, these characters paradoxically suggest both selective browsing and increased grazing.

Dental microwear analysis was performed on specimens of *Longirostromeryx* and *Blastomeryx* from localities in the Valentine (Barstovian-Clarendonian), and Ash Hollow (Clarendonian) formations of Nebraska. Results yielded mean pit and scratch counts that placed both genera within the range associated with browsing taxa. The difference in mean microwear values between the two genera was tested using Wilk's labmbda and found not statistically significant ($p=0.13$); while the difference in distributions of scratch counts was significant ($p=0.003$) using a two-tailed F-statistic test.

Previous analysis of microwear has focused on comparing mean values between taxa to determine feeding type; however, the difference in distribution of pit and scratch values between *Longirostromeryx* and *Blastomeryx* suggests that statistical analysis of wear value distributions may provide further insight into feeding behavior. The greater range of scratch counts observed in *Blastomeryx* suggests that it had a more varied feeding style, while a narrower distribution of scratch counts observed in *Longirostromeryx* implies that it had a preferred diet with less variety. This is consistent with the elongate rostrum and increased premolar-canine diastema characteristic of *Longirostromeryx* but it does not accommodate the increase in molar hypsodonty or reduction of the premolar row.

Technical Session XIV (Saturday, November 5, 10:30 am)

A COMPARATIVE STUDY OF ONTOGENY BETWEEN DERIVED TYRANNOSAUROIDS: EVIDENCE FOR HETEROCHRONY

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Tyrannosauroids are exemplar fossil taxa, given the excellent quality of their fossils, well-resolved and robust phylogeny, extensive temporal and geographic distribution, and densely sampled fossil record. In particular, the fossil record of the subclade Tyrannosauridae is exceptional, where many species are represented by growth series. Taken together, ontogeny and phylogeny can provide a framework for hypothesizing the developmental processes that produced the character changes during their evolutionary history. The objective of this study was to identify the alterations in the sequence of development (heterochrony) that produced the evolutionary novelties (synapomorphies and autapomorphies) that arose during tyrannosaurid phylogeny. This goal was achieved by first reconstructing growth series using cladistic methods (parsimony analysis) for several species, namely *Albertosaurus libratus, A. sarcophagus*, *Daspletosaurus torosus*, *Tyrannosaurus bataar*, and *T. rex*. Two complementary approaches, "event-pair-cracking" and a novel approach termed "end points" were used to compare the growth series in a cladistic context, where the non-tyrannosaurid tyrannosauroid *Bistahieversor sealeyi* was the outgroup. Evidence of heterochrony was found: for example, the size of the maxillary fenestra had a complex evolutionary history, where the isomorphic process termed pre-displacement produced the enlarged maxillary fenestra seen in derived tyrannosaurine adults. The greatly enlarged condition seen in *Tyrannosaurus* was produced by the peramorphic process of acceleration or hypermorphosis; and, in contrast to *D. torosus* and *T. rex*, the peramorphic process of pre-displacement produced the enlarged condition that is seen in juveniles of *T. bataar*, which is an autapomorphic process (and morphology) seen in that species. Therefore, tyrannosauroids provide an effective case study, in a fossil vertebrate, for identifying the heterochronic processes that produced morphological novelties from their ancestral antecedents.

Symposium 4 (Friday, November 4, 10:15 am)

THE IMPORTANCE OF VERTEBRATE MICROFOSSIL BONEBEDS IN UNDERSTANDING THE FOSSIL RECORD: EXAMPLES FROM THE CLOVERLY FORMATION

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Vertebrate microfossil bonebeds (VMBs) are commonly sought for their ability to preserve elements of small-bodied taxa, often mammals. They have been used more recently to assess paleodiversity and paleoecology, but remain under-utilized as a means to broadly study these features of the vertebrate fossil record. Here, we present the results of eight years of fieldwork in the Early Cretaceous Cloverly Formation of Wyoming and Montana that illustrate the importance of VMBs for intra- and inter-formational studies.

Seventy-five years of fieldwork in the Cloverly Formation has been dominated by traditional prospecting and collection methods, resulting in a numerically significant ($N > 500$) but taxonomically depauperate ($N < 20$) sample of large vertebrates. New VMBs add > 9000 identifiable specimens and > 30 taxa to these totals. Rarefaction curves for these two methods differ significantly at equivalent sample sizes, suggesting that traditional collecting is both impractical and unsuccessful at recovering total available diversity here.

Added taxa include several species of freshwater sharks, crocodilians, and mammals, among others. Bony fishes and crocodilians are the most abundant, followed by dinosaurs, amphibians, and turtles. These patterns remain after adjusting for proportional differences in element numbers between groups. The few taxa not recovered in VMBs are either rare or difficult to identify from isolated elements. Cloverly vertebrate diversity is now much closer in number and content to diversities of coeval neighboring formations (e.g., Antlers). Its fauna has a strong aquatic and semiaquatic component, but dinosaurs are abundant and represented by a dozen species.

These results underscore the critical role of VMBs in recovering the highest possible fraction of available vertebrate diversity. Methodologically, it is important to obtain sufficient, consistent samples in order to maximize potential comparisons. Although it is impossible to

know how accurately any single VMB reflects its original paleoenvironment, VMBs offer a standardizable, statistically supportable benchmark that can be measured across formations and long stretches of geologic time.

Poster Session IV (Saturday, November 5)

IMPORTANCE OF THE JUCHIPILA FAUNA (LATE EARLY HEMPHILLIAN, HH2), STATE OF ZACATECAS, IN THE BIOSTRATIGRAPHIC CORRELATION OF THE HEMPHILLIAN FAUNAS OF CENTRAL MEXICO

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Sedimentary basins located between central México and the Great Plains are crucial to understand the biostratigraphy, dispersal, migration routes, and extinctions of late Tertiary mammals in North America. Most published information is based on vertebrate fossil localities in the San Miguel Allende (SMAB) and Tecolotlán (TB) basins, which contain the most diverse Hh3 & Hh4 and early Blancan faunas in México. Additional information came from other sites. Recent work at the Juchipila basin (JB, Zacatecas) documented the oldest Hh2 mammalian assemblage in México. Based on the youngest record in North America of the merycodontid *Cosoryx* and the occurrence of the megalonichid *Pliometanastes*, the horses *Calippus* (*Grammohippus*) *hondurensis*, *Neohipparion eurystyle*, *Astrohippus ansae* and *Dinohippus mexicanus*, the antilocaprids *Plioceros* and *Sphenophalos,* and the camel *Alforjas taylori,* the JB fauna is considered Hh2. Two ages obtained from interbedded ashes yield a reliable age bracket (U-Pb, zircon, 6.95+0.29 – 5.58+0.10 Ma) consistent with the fauna's NALMA.

The JB fauna is a key in the biostratigraphic correlation among the Hemphillian faunas of México. *Calippus* is also part of Hh2 faunas in Zietla (Hidalgo), La Presa (Guanajuato), and Jalostotitlán and Santo Domingo (Jalisco). Sediments below the Rhino layer of Rancho El Ocote (fission track, zircon, 4.8+0.2 Ma) include an Hh3 fauna with *Nannippus aztecus* and *Megalonyx* associated with *Dinohippus mexicanus, Astrohippus stockii, Neohipparion eurystyle;* these fossils correlate with the Coecillos fauna (SMAB) and with fossils older than 4.89+0.16 Ma (Ar-Ar, sanidine single crystal) from the Santa Maria site at TB. However, the Rinconada (4.4+0.3 Ma, fission track, zircon) and Arroyo Tepalcates localities at the SMAB, which lack *Nannippus aztecus*, are assigned to Hh3 and correlated with La Hacienda locality (TB) as they both are younger than the Rhino layer fauna. El Gigante and El Trapiche (Nayarit) localities are interpreted as Hh3 based on *Teleoceras*, *Megalonyx, Neohipparion eurystyle, Dinohippus mexicanus Taxidea,* indet canidae, *cf. Hemiauchenia,* and Gomphotheriidae remains, and a U-Pb (zircon) age of 5.12 + 0.26 Ma.

Symposium 4 (Friday, November 4, 11:30 am)

COMPARING EXTANT MAMMALIAN SPECIES DIVERSITY TO PALEOSPECIES RICHNESS: PROBLEMS AND SOLUTIONS

CARRASCO, Marc, University of California, Berkeley, Berkeley, CA, USA

Recent analyses of current extinction rates in extant animals have suggested that we may be in the midst of a sixth mass extinction. However, assessment of the true size, rate, and timing of this extinction has been made difficult because of the lack of a comparison between the natural paleodiversity baseline and extant species diversity. Here I use the NEOMAP distributed database of mammalian occurrences to create and compare a baseline, as assessed by species-area curves, for the past 30 million years to modern mammalian species diversity. Species-occurrence data was subjected to rarefaction and other sample standardization techniques and, in combination with the Berkeley Mapper software, was used to derive species-area curves by geographic region for distinct time slices from the late Oligocene through the Modern. Preliminary results indicate that mammalian species diversity, while severely depressed during the Holocene, appears to increase during the Modern time interval. Upon closer inspection, it appears that this rise in diversity is a result of a large increase in the diversity of small mammals (Rodentia, Lagomorpha, and Insectivora), primarily members of the rodent families Heteromyidae, Geomyidae, and Sciuridae – groups whose species are often difficult to diagnose in the fossil record. I suggest that this anomalous modern diversity shift is likely an artifact caused by the different taxonomic standards used by paleontologists and neontologists. Therefore, any attempt to assess the magnitude of the current extinction in mammals needs to account for these fundamental differences by employing alternative methodologies such as more detailed taxonomic studies of problematic fossil groups and reassessments of extant species using paleontological techniques.

Poster Session III (Friday, November 4)

A THIRD AZHDARCHID PTEROSAUR FROM THE TWO MEDICINE FORMATION (CAMPANIAN) OF MONTANA

CARROLL, Nathan, Montana State University, Bozeman, MT, USA; POUST, Ashley, Montana State University, Bozeman, MT, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA

New material of an azhdarchid pterodactyloid pterosaur was recovered from Jack's Birthday Site (JBS) in the Two Medicine Formation of northwestern Montana. With few exceptions (e.g. *Quetzalcoatlus*, *Montanazhdarcho*), reported members of this group are represented by few or partial elements, or, as in the case of *Zhejiangopterus*, are two-dimensionally preserved which prevents evaluation of most morphological and osteological details. Taphonomic modification of the Birthday Site material includes disarticulation, some lithostatic compaction, and possibly trampling-induced breakage. Nevertheless, the new material is generally well-preserved and three-dimensional. The broad range of preserved elements allows evaluation of newly recognized post-cranial characters of the humerus, antebrachium, pelvis, and tarsus. The new form shares several elements in common with the two previously described Montana azhdarchids of similar age (including syncarpals and proximal humerus) and character analysis demonstrates their close relationships. Previous functional arguments for land-based feeding strategies have emphasized the anatomy of the skull and cervical vertebrae. The preservation of the several carpal, manus and tarsal elements now allows consideration of these elements. The robust nature of the carpus and manus and the unique expanded morphology of the proximal phalanges suggests weight-bearing, further supporting the hypothesis that azhdarchids were well adapted to terrestrial locomotion. Jack's Birthday Site represents a small floodplain pond far inland, perhaps 200 km from the Western Interior Cretaceous Seaway. The JBS azhdarchid provides additional evidence for the proposed biogeographic and ecological associations of this group with open environments decidedly far from marine sediments.

Poster Session IV (Saturday, November 5)

EVOLUTIONARY TRAJECTORIES OF EARLY EOCENE PRIMATE EVOLUTION

CARTER, Katherine, Harvard University, Boston, MA, USA

Many Eocene primate radiations show the parallel evolution of many dental features, including the development of a quadrate upper molar and the loss of a paraconid on the lower molar. These innovations have often been linked to expanding dietary niches as an adaptation to the rapid changes in early Eocene floral and faunal composition. However, fossil evidence suggests highly constrained evolutionary pathways where the evolution of novelty is not directly dependent upon the climate. To determine the magnitude of the effect of environment on dental morphology, it is necessary to examine the shape and size of several trajectories of microevolutionary sequences of early Eocene primate groups. Photographs of upper and lower M2s across adapid and omomyid primates were measured using coordinates and linear measurements. The resulting metrics were analyzed using a combination of multivariate multiple regression and pairwise contrasts. Trajectories were generated from the linear measurements, and the covariation between trajectory size, shape and orientation was assessed from a comparison of the data to empirically-derived random distributions. Environmental data was collected from published reconstructions of fossil sites, and standardized into a set of seventeen variables. Trajectory size was highly variable among lineages, likely an artifact of differential evolutionary rate. However, almost no lineage differed significantly in either trajectory orientation and trajectory shape, indicating that the evolutionary pathways were highly constrained. In addition, levels of variability in individual traits corresponded well with position on the evolutionary trajectory, with the protocone increasing in variability over the evolutionary sequence and the distal talonid cusps decreasing in variability. Overall, the correlation between tooth shape and climatic variables was not high, implying that environment is not a large determining factor in Eocene primate tooth morphology. The level of environmental variables previously linked to high seasonality and instability showed the highest level of correspondence with tooth morphology.

Poster Session IV (Saturday, November 5)

ASSESSING THE EFFECTS OF SIZE, ECOLOGY AND PHYLOGENY ON MANDIBLE SHAPE IN SQUIRRELS (SCIURIDAE, RODENTIA)

CASANOVAS VILAR, Isaac, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain; VAN DAM, Jan, Institut Català de Paleontologia, Cerdanyola del Vallès, Spain

Ecomorphology of fossil rodents has traditionally centered on the interpretation of their dentition, although mandibles may provide valuable paleoecological information. Nevertheless, such an approach has been hampered by the lack of a comparative database, as well as a rigorous assessment of the relationship between mandible morphology and ecological preferences. Here we analyze mandible shape in extant squirrels (Sciuridae, Rodentia) using two-dimensional landmark-based morphometrics and further assess its correlation with size, phylogeny and broad ecological preferences. The correlation of shape with size was tested using a multivariate regression of Procrustes shape coordinates on centroid size. Our results show that scaling in the squirrel mandible is generally isometric, and that the different squirrel subfamilies show the same size-related trends in mandible shape. The presence of a phylogenetic signal in the morphometric data was tested using a permutation test, which simulates the null hypothesis of complete absence of phylogenetic structure. In addition, we calculated shape consistency and shape retention indices, which provide a measure of homoplasy in morphometric data. In most cases, the null hypothesis of independence could not be rejected and the indices consistently indicated a low degree of homoplasy, clearly stressing the role of phylogeny. Finally, the relationship between shape and ecology was studied with canonical variates analysis (CVA) using different grouping variables: broad dietary preferences, main habitat and lifestyle. Those squirrels showing the more extreme adaptations (such as those feeding mainly on insects, mosses or grasses) are clearly distinguished, although the discrimination of the most abundant dietary classes, frugivory and granivory, remains problematic. Because of its strong relationship with phylogeny, we conclude that mandible shape is probably not a good proxy for the paleoecology of extinct squirrels, even though some particular adaptations may be easily recognizable.

Poster Session III (Friday, November 4)

RARE EARTH ELEMENT FINGERPRINTING AND 87SR/86SR RATIOS SUPPORT A LATEST MAASTRICHTIAN AGE FOR ANTARCTICA'S FIRST DISCOVERED CRETACEOUS BIRD, *POLARORNIS GREGORYI*

CASE, Judd, Eastern Washington University, Cheney, WA, USA; PATRICK, Doreena, Richard Stockton College of New Jersey, Pomona, NJ, USA; NEZAT, Carmen, Eastern Washington University, Cheney, WA, USA; CLARKE, Julia, The University of Texas, Austin, TX, USA

New evidence from 87Sr/86Sr ratios in fossil bone and Rare Earth Element (REE) analyses of matrix identifies the controversial, first-discovered Antarctic bird, *Polarornis gregorii*, as from the latest Maastrichtian deposits of the Lopez de Bertodano Formation, Seymour Island, Antarctic Peninsula. The 87Sr/86Sr ratios in six samples of bone from the *Polarornis* holotype specimen and REE fingerprinting of the specimen matrix were evaluated. The 87Sr/86Sr ratios are indicative of a latest Maastrichtian age (between 65.8 and 65.5 Ma). Resulting REE values from the analyses were compared to samples from the Late Maastrichtian informal stratigraphic unit Klb 9 of the Lopez de Bertodano Formation and the Telm 2 unit of the Eocene, La Meseta Formation, which are both exposed in the area of collection of the *Polarornis* holotype specimen on Seymour Island. While the recovered values of REE from the fossil matrix samples are consistent with a Klb 9 provenance, these values are significantly different from the La Meseta REE values. The REE analysis also supports previous interpretations on water depths for each formation; the Lopez de Bertodano Formation and fossil samples yield a signature consistent with a deep water, mid-shelf environment, while the La Meseta Formation signature is consistent with a shallow water, near-shore environment.

Preparators' Session (Thursday, November 3, 9:45 am)

LESSONS LEARNED FROM "DEAD SHEEP 148", OR THE FINE ART OF DEALING WITH BIG PLASTER JACKETS

CAVIGELLI, Jean-Pierre, Tate Geological Museum, Casper College, Casper, WY, USA

Because of their size and weight, collecting large dinosaur specimens can be a logistical challenge. From 2005-2007, crews from the Tate Geological Museum at Casper College collected a hadrosaur known as "Dead Sheep 148" from the Lance Formation in eastern Wyoming. The pelvic region of this animal was well articulated and collected as one jacket eight feet long, three feet wide and two feet thick. Over the next few years the jacket was opened in the museum's prep lab and the specimen were prepared by museum volunteers. Since the bones were well articulated, including many ossified tendons, they were left *in situ* in the jacket. The jacket contains a series of 22 articulated vertebrae, much of the pelvis and one femur. After opening the jacket, three cracks developed in the specimen. It is uncertain if the cracking was due to structural issues in the jacket, or to drying out, or to other factors. The cracks were stabilized using glues and epoxy putty. We had planned to move the specimen using a tripod, chain hoist, and two-inch wide nylon webbing, but the cracks were almost exactly above where the nylon straps would be suspending the jacket, raising fears that in moving it, the cracks would re-activate and the specimen would fall apart. We came up with a technique to move the specimen into the museum galleries while minimizing the chances of its breaking. The jacket was lifted using the same tripod set-up plus a scissor jack under each end of the jacket to prevent the jacket from buckling. A custom fit piece of plywood was slid in underneath the jacket, and then the jacket was lowered onto the plywood. While the jacket was still suspended, two-part foam was injected into the space between the jacket and the plywood, making a rigid support for the jacket. This rigid support makes the specimen easily movable in the future should we need to move it again. Many lessons were learned in dealing with a big jacket and unforeseen problems, and will influence how we will deal with future large jackets.

Poster Session II (Thursday, November 3)

A TEST OF THREE SOLVENT-BASED CONSOLIDANTS FOR FIELD USE IN THE RAIN

CAVIN, Jennifer, John Day Fossil Beds National Monument, Kimberly, OR, USA

An experiment was undertaken to determine which of three solvent-based consolidants would hold up best in a field situation wherein a fossil is discovered, consolidated, and left in-situ in a rainy climate for collection at a later date. Locally obtained road gravel was dry sieved and washed to obtain a sample of very coarse sand, between 1 – 2 mm in grain size. The dried sand was glued to wooden dowels using one of the following consolidants: polyvinyl acetate (PVAC, B-15), methyl methacrylate (B-72), and polyvinyl butyral (B-76). The glue was allowed to dry overnight, and the sand encrusted dowels were weighed. Each of the dowels was positioned over a cheesecloth covered sieve and placed in a shower to simulate rain. After one hour, the dowels were removed from the shower and allowed to thoroughly dry. The dried dowels were then weighed to determine the percentage of material that was lost due to the falling water. A quick visual analysis suggested that the consolidants performed similarly, and detailed analysis supported this finding. For all test dowels, approximately 2% of the sand grains were washed away after an hour of simulated rain, demonstrating no significant difference between consolidants. The process was then repeated, with the dowels subjected to two more hours in the shower. Very few sand grains on any of the dowels were washed away in this second wetting, thus showing no significant difference, in this experiment, between PVAC, methyl methacrylate, or polyvinyl butyral. This suggests the consolidants are relatively impervious to precipitation, and weathering may be a result of other factors. Future experiments will include allowing sand encrusted dowels to soak for various periods of time submerged in water and examining the effects of temperature fluctuations. It is suggested that plastic dowels, or PVC pipe, should be used in additional experiments to reduce the drying time required.

Poster Session II (Thursday, November 3)

THE FIRST RECORD OF SAUROPOD DINOSAURS FROM ANTARCTICA

CERDA, Ignacio, CONICET-INIBIOMA, Neuquén, Argentina; PAULINA CARABAJAL, Ariana, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina; SALGADO, Leonardo, CONICET-INIBIOMA, Neuquén, Argentina; CORIA, Rodolfo, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina; MOLY, Juan, Museo de La Plata, La Plata, Argentina

Sauropods were one of the most widely distributed group of dinosaurs for most of the Mesozoic Era, although this clade has not been previously recorded in Antarctica. Here we report the first record of a sauropod dinosaur from Antarctica, represented by an incomplete caudal vertebra from the Late Cretaceous of the James Ross Island (Antarctic Peninsula). The vertebra was collected from marine sediments assigned to the Gamma Member of the Santa Marta Formation (Campanian), constituted mainly by fine-grained to mid-size grained sandstones. The specimen consists of a strongly procoelous middle caudal centrum lacking the neural arch. The centrum length (excluding the posterior ball) is 170 mm and its height is 105 mm. There is no pleurocoels, and a sagittal fracture has exposed the internal bone structure, which is not pneumatized. The morphology and size of the specimen allow it to be identified as a caudal vertebra of a derived sauropod dinosaur. The anterior position of the neural arch indicates referral to Titanosauriformes. The procoely of the middle caudal vertebra has been proposed to have a diagnostic feature of lithostrotian titanosaurs. The biogeographical history of sauropods and the interrelationships amongst titanosaurs from southern landmasses remain obscure and controversial. The specimen is notable for representing the first Antarctic sauropod record, but also the most southern record of the clade, adding new data in the process of resolving the affinities of South American titanosaurs and the understanding of Gondwanan paleobiogeography.

Poster Session I (Wednesday, November 2)

THE VIRTUALIZATION OF A LARGE *TYRANNOSAURUS REX* SPECIMEN (SUE) FROM SOUTH DAKOTA

CHAPMAN, Ralph, New Mexico Virtualization, LLC, Los Alamos, NM, USA; ANDERSEN, Arthur, Virtual Surfaces, Inc., Glenview, IL, USA; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, USA; DECK, Linda, New Mexico Virtualization, LLC, Los Alamos, NM, USA; SIMPSON, William, Field Museum of Natural History, Chicago, IL, USA

The huge size of many dinosaurs and prehistoric mammals can make it very difficult to work on them scientifically. A solution to this is to digitize a skeleton to provide a copy we can experiment with in virtual space, where size is irrelevant. This approach was used to virtualize the large tyrannosaur FMNH PR 2081 often referred to as SUE. The work was done in 3 phases. The first was the 3D capture of the mounted skeleton using an area laser scanner. The construction of a modern museum mount for a large animal uses scientific principals combined with the feedback provided by the skeletal elements. As such, the final product is a perfect starting point for constructing a virtual skeleton that can be the basis for animations, functional analyses, and a great variety of products for museum outreach and marketing. The second phase was to scan in each of the individual elements at high resolution to provide maximum flexibility downstream during the project. This was done using three different scanners: a high-grade, medical CT scanner for those skeletal elements capable of fitting in the aperture of a standard system; a white-light surface scanner for the sacrum and pubes; and a large industrial CT scanner for other large bones, including the massive skull. In all cases, bones from a research-grade cast were used to avoid not only stressing the actual fossils, but also taking them off exhibit. The CT results were converted to surface files. The final phase was to take these individual models and place them over their corresponding element in the area scan from Phase 1. Once in place, the area scan itself was removed and a final product produced of a whole skeleton made up of independent elements that can now be used for detailed functional work, animation, and those other products. This virtual skeleton is made up of models that are greatly reduced in resolution from the scanned models to facilitate the composite work. However, the high-resolution models are more useful for more detailed scientific study and reproduction using prototyping.

Poster Session III (Friday, November 4)

THE SKULL OF THE SOLEMYDID TURTLE *HELOCHELYDRA NOPCSAI* FROM THE EARLY CRETACEOUS OF THE ISLE OF WIGHT, UNITED KINGDOM, AND THE GLOBAL BIOGEOGRAPHY OF SOLEMYDID TURTLES

CHAPMAN, Sandra, The Natural History Museum, London, United Kingdom; JOYCE, Walter, University of Tubingen, Tubingen, Germany; MOODY, Richard, Kingston University, Kingston-upon-Thames, United Kingdom; WALKER, Cyril, The Natural History Museum, London, United Kingdom

Solemydidae is a poorly understood clade of fossil turtles known from the Late Jurassic to Late Cretaceous of North America and Europe. Remains of these turtles have traditionally been so fragmentary that the close relationship between European and North American forms was only recently recognized. A beautifully preserved skull referable to *Helochelydra nopcsai* from the Barremian Wessex Formation of the Isle of Wight, England, represents the first known skull of a European solemydid and provides first insights into the cranial anatomy of solemydid turtles. The cranium is characterized by a unique combination of traits,

including a greatly reduced dorsal exposure of the prefrontals, pterygoids that ventrally cover the basisphenoid, and fully confluent inner and middle ear cavities. A phylogenetic analysis places *Helochelydra nopcsai* close to *Mongolochelys efremovi*, *Meiolania platyceps* and *Kallokibotion bajazidi* just outside crown Testudines, but the interrelationships of these four taxa cannot be resolved with confidence. A review of the literature and of fossil material housed in public collections indicates that solemydids are known from the Late Jurassic (Tithonian) to Late Cretaceous (Maastrichtian) of Europe. The holotype of the North American taxon *Naomichelys speciosa* was erroneously reported from the Late Jurassic (Tithonian) Morrison Formation of Montana, but actually originates from the Lower Cretaceous (Aptian) Kootenai Formation. The known record of North American solemydids is therefore restricted to the Aptian to Campanian.

Poster Session II (Thursday, November 3)

THREE-DIMENSIONAL HISTOLOGY OF TOOTH CUSHIONS OF *LOPHOSTEUS* FROM THE LATE SILURIAN OF ESTONIA

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Lophosteus superbus from the Late Silurian of Estonia is one of the oldest and most basal osteichthyans known so far. Unfortunately, it has exclusively been documented by detached and fragmented dermal microremains, and the affinity of *Lophosteus* has been controversial. It has been placed basal to both actinopterygians and sarcopterygians, as well as ambiguously linked to either placoderms or acanthodians. Recently, however, the diagnostic characters of actinopterygians and sarcopterygians have been questioned, and even the monophyly of placoderms and acanthodians have been challanged. As a possible stem osteichthyan, *Lophosteus* is in a central position to increase our understanding of early gnathostome evolution and the origin of the osteichthyan body plan. Tooth cushions are among the best-preserved elements of *Lophosteus*, even though they have not been described properly. These tooth-bearing arched ossicles could arguably be homologous with the parasymphysial tooth whorls in chondrichthyans, acanthodians, sarcopterygians and even the parasymphysial tooth plates in tetrapodomorphs. With high-resolution synchrotron data, the three-dimensional architecture of *Lophosteus* tooth cushions can be reconstructed. The absence of the enamel layer and the large hollow spaces (bigger than normal osteocytes) in the deepest lamellar layer, confirms the assignment of the scanned specimen to *Lophosteus* The denticles look more or less irregularly distributed in external view, but internally there are large parallel vessels running along rows of denticles, which can be used to trace their mode of growth. The histological reconstruction of vascularization presented here, therefore, provides insight into early gnathostomes tooth patterning and can be further incorporated into a more comprehensive analysis of early gnathostomes phylogeny.

Technical Session VIII (Thursday, November 3, 2:30 pm)

A PHYLOGENETIC EVALUATION OF SEQUENCE HETEROCHRONY IN AMPHIBIAN SKULL DEVELOPMENT

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The lissamphibian skull is highly simplified compared with their Paleozoic relatives, lacking many bones in the circumorbital regions (e.g., jugal, postfrontal). These bones ossify late in the temnospondyl *Apateon*, and a paedomorphosis hypothesis (descendents retaining a larval morphology of their ancestors) of circumorbital bone loss in lissamphibians was proposed. Furthermore, salamanders and *Apateon* both show an early formation of tooth-bearing bones compared to the other skull elements. It was also proposed that the early ossification of tooth-bearing bones is a plesiomorphic condition in vertebrates, reflecting a functional constraint for early larva feeding. The two hypotheses above have great implications for lissamphibian origin, and here I offer the first rigorous test of them by incorporating phylogenetic information. Sixteen ossification events are compiled from the literature and coded for three outgroups and 13 amphibian taxa, representing temnospondyls, lepospondyls, and the three extant orders. Four fossil species are included. Although the lissamphibian origin is still debatable, I adopt the topology of a monophyletic origin of lissamphibians within temnospondyls as my framework for the heterochrony analysis. Under this hypothesis, the branch leading to lissamphibians and *Apateon* is characterized with a delayed ossification of the jugal, and an accelerated ossification of the tooth-bearing premaxilla, maxilla and dentary. In the succeeding branch leading to lissamphibians, the maxilla is delayed but the vomer is accelerated. This reconstruction rejects the early formation of tooth-bearing bones as a plesiomorphic condition but shows instead that it is a derived condition of *Apateon* and lissamphibians. The delay of the jugal in *Apateon* and lissamphibians is in direct contrast with an acceleration of the bone along the branch leading to lepospondyls and amniotes. This, combined with a consistent late ossification of the prefrontal and postfrontal at the basal node of *Apateon* and lissamphibians, indicates paedomorphosis as a likely mechanism of the circumorbital bone loss.

Poster Session III (Friday, November 4)

NEW SPECIMENS OF *CORDICHELYS* (PLEURODIRA, PODOCNEMIDIDAE) FROM LATE EOCENE MARINE STRATA OF FAYUM, EGYPT, AND A REEVALUATION OF *CORDICHELYS ANTIQUA*

CHERNEY, Michael, University of Michigan, Ann Arbor, MI, USA; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA; WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA; ZALMOUT, Iyad, University of Michigan, Ann Arbor, MI, USA; ANTAR, Mohammed, Egyptian Environmental Affairs Agency, Cairo, Egypt

Podocnemidid side-necked turtles are represented by only three living genera, *Podocnemis* and *Peltocephalus* from South America, and *Erymnochelys* from Madagascar. Fossil members of the group are significantly more diverse and widespread and include the *Shweboemys*-group taxa, which are known from the Tertiary of northern Africa, southern Asia, northern South America, southeastern North America, and the Caribbean. *Shweboemys*-group podocnemidids possess a secondary palate structure that is unique among turtles. It consists of palatal flanges, each formed by the maxilla and palatine, that are separated by a midline cleft. Currently recognized *Shweboemys*-group genera include *Stereogenys*, *Shweboemys*, *Bairdemys*, *Lemurchelys*, *Brontochelys*, *Latentemys*, and *Cordichelys*. The upper Eocene near-shore marine Qasr el-Sagha deposits of the Fayum Depression in Egypt have produced both *Stereogenys* and *Cordichelys* remains. A new specimen of *Cordichelys antiqua* from the earlier, off-shore marine Birket Qarun Formation of Wadi Al-Hitan, Egypt, expands the range of *Cordichelys*, supports a marine habitat for the species, and shows that material previously assigned to the taxon represents at least two distinct species. The reconstructed shell of the new specimen exhibits moderate doming, in contrast to previous descriptions of a flat shell for *C. antiqua*. Reanalyses of previously described *Cordichelys* shells from Egypt support this interpretation. A second skull-only specimen from the Qasr el-Sagha beds of the Fayum adds to the diversity of Egyptian *Shweboemys*-group turtles, representing a new species of *Cordichelys* that shares some traits with *Stereogenys*. These new specimens improve our understanding of the previously monotypic genus *Cordichelys*, increase the diversity of *Shweboemys*-group turtles from the late Eocene of Egypt, and provide insight into the relationships between *Cordichelys* and other *Shweboemys*-group taxa.

Technical Session X (Friday, November 4, 9:00 am)

ARBOREALITY IN PALAECHTHONID PLESIADAPIFORMS (MAMMALIA, PRIMATES): NEW EVIDENCE FROM A PARTIAL SKELETON OF EARLY PALEOCENE *TORREJONIA WILSONI*

CHESTER, Stephen, Yale University, New Haven, CT, USA; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; SARGIS, Eric, Yale University, New Haven, CT, USA; SILCOX, Mary, University of Toronto at Scarborough, Toronto, ON, Canada; WILLIAMSON, Thomas, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

Plesiadapiform skeletons representing four Paleocene-Eocene families suggest that they were all generally arboreal, although differences in postcranial morphology among these taxa indicate a diversity of positional behaviors. A dentally associated partial skeleton of *Torrejonia wilsoni* (NMMNH P-54500) from the late Torrejonian (To3), *Mixodectes pungens* Zone of the Nacimiento Formation, San Juan Basin, New Mexico, is the oldest known skeleton of a plesiadapiform and reveals the postcranial morphology of a "palaechthonid" for the first time. The new skeleton includes craniodental fragments, with all teeth erupted, parts of the axial skeleton, and partial fore- and hind limbs with some epiphyses unfused, indicating that it was a subadult. It has been proposed, based on craniodental evidence, that the "palaechthonid" *Palaechthon nacimienti* was terrestrial with limited ability to climb trees. We find that *T. wilsoni* is similar to all other known plesiadapiforms in having many postcranial features indicative of arboreality. The humerus has a fairly spherical head that extends superior to the tuberosities, a large medial epicondyle (similar to that of *Carpolestes* and *Phenacolemur*), and a spherical capitulum and trochlea separated by a groove, indicating a mobile shoulder and elbow. The innominate has an elliptical acetabulum and an articular surface that is expanded cranially (as in the arboreal treeshrew *Ptilocercus*). The femur has a large lesser trochanter oriented posteromedially, a demarcated, yet shallow, patellar groove, and fairly shallow femoral condyles with a slightly wider lateral condyle. The calcaneum has a large peroneal tuberosity, and a helical ectal facet, which is related to pedal inversion. Relationships of the dentally primitive and probably paraphyletic "Palaechthonidae" are complex, and previous dental analyses have suggested that *P. nacimienti* and *T. wilsoni* are part of a clade with the arboreal Paromomyidae. Though it is possible that some variability exists in the group, this new specimen supports the inference that "palaechthonids" were arboreal like all other plesiadapiforms for which postcrania are known.

Symposium 4 (Friday, November 4, 11:15 am)

SPATIALLY CONSTRAINED RAREFACTION AND GEOGRAPHIC INFORMATION SYSTEMS: MITIGATING THE EFFECTS OF THE SPECIES-AREA RELATIONSHIP IN DIVERSITY ANALYSIS

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Richness is an important ecological concept that is usually estimated from samples by individual-based (traditional) or sample-based (repeated sampling) rarefaction. Comparison of the two types of richness curves conveys information about diversity. Rarefaction can be

biased by variation in (1) the total spatial extent of samples, (2) the size of sampling units (in the case of sample-based rarefaction) and (3) time-averaging. Spatially constrained rarefaction (SCR) was recently proposed to mitigate the effects of spatial variation on sample-based rarefaction. In this method, adjacent sampling units are combined within standardized areas. We adapt this method for fossil samples using Geographic Information Systems (GIS) and apply it to both types of rarefaction analysis. We used GIS to arrange 439 digitized fossil mammal localities (>33000 specimens, 142 species) from the Willwood FM of the central Bighorn Basin in Wyoming. The localities were grouped into 17 100Kyr intervals, six of which fell within a cool period, followed by 11 intervals from an immediately subsequent warm period (5-8°C warmer MAT) divided into early (6) and late (5) warm intervals. Clusters of localities within a 5km2 area in each interval were identified as subsamples for rarefaction. Previous analysis of all data had identified an increase in richness from the cool period to the warm period and a subsequent decline related to increasing dominance of the fauna by a few taxa. The individual-based SCR analysis found little change in richness from the cool to the warm period, although the subsequent decline is still present. We interpret the previous (all-data) pattern as an artifact of the species-area relationship (richness estimate-interval area correlation coefficient=0.58, p=0.016). Although there is no consistent shift in locality area, the sample-based SCR analysis may yet be influenced by random variation in sampling unit size. Large-scale differences between sample-based and individual-based rarefaction estimates show that beta diversity (species distribution heterogeneity) increased during the early part of the warm period, whereas overall richness did not.

Poster Session IV (Saturday, November 5)

TAPHONOMY OF A NEW *CENTROSAURUS* BONEBED FROM THE OLDMAN FORMATION (CAMPANIAN) OF SOUTHERN ALBERTA, A COMPARISON ACROSS FORMATIONS AND TIME

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High-density monodominant bonebeds of *Centrosaurus apertus* are common in the Dinosaur Park Formation (DPF) of Alberta, occurring in nearshore, low coastal plain environments, but are extremely rare in the underlying, relatively drier, Oldman Formation (OF) from which only two bonebeds of *Centrosaurus brinkmani* have been documented in older strata. We report the first monodominant *Centrosaurus* bonebed from a section of the OF in southeastern Alberta that is time-equivalent to the lower DPF allowing for the opportunity to compare ceratopsid bonebed taphonomy between these two paleoenvironmentally different formations.

The OF bonebed lithosome is interpreted as a poorly-drained floodplain deposit. Approximately 90% of the specimens (n=511) are ceratopsid and referred to *Centrosaurus,* with multiple ontogenetic stages represented (approximately 50% shows juvenile and subadult stage). The remaining 10% include theropod teeth (mostly tyrannosaurid), freshwater vertebrates, and hadrosaurid bones, in descending order of abundances. All ceratopsid specimens are completely disarticulated; tooth-marks and the presence of shed theropod teeth suggest that the carcasses were scavenged. Dominance of slightly abraded specimens (stage 1 ~ 60%) and poorly-aligned orientations of long bones, indicate that these elements were transported and deposited by a low velocity current. Ubiquitous wet rot features, with a lack of subaerial weathering (99% specimens exhibit stage 0), indicates that the bones existed in humid or subaqueous conditions before and/or after the final burial event.

Regardless of the different depositional environments of the OF and DPF under which they were formed, the sedimentological and taphonomical features (e.g., age classes and abrasion) of the *Centrosaurus* bonebeds from both formations are very similar suggesting that similar taphonomic processes occurred within a tightly constrained time interval over a regional scale, independent of formation. Although the bonebeds were probably derived from the local flooding events, *Centrosaurus* can be inferred to have to have moved in large herd-like groups across a regional scale.

Poster Session III (Friday, November 4)

LIFE HISTORY OF THE EARLY CRETACEOUS BIRD *CONFUCIUSORNIS*: A HISTOLOGICAL PERSPECTIVE

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Over the past decade hundreds of the basal pygostylian bird *Confuciusornis sanctus* have been recovered from the Early Cretaceous of Northeastern China. The specimens exhibit remarkable variation in size and plumage. Traditionally specimens with long, ornamental rectrices were interpreted as males and those without them as females. Morphometric data has suggested a lack of correlation between the presence/absence of these feathers and size—they occur in specimens belonging to the two size clusters demarcated by morphometric data. While such distribution did not exclude the possibility of these feathers being a sexual trait, such variation suggests a more complex phenomenon. Here we investigate the microstructure of long bones (e.g., femora, tibiae, humeri and ulnae) of ten different sized individuals of *Confuciusornis* to assess life history patterns. In addition we examine multiple bones from single skeletons of *C. sanctus* to assess skeletal variation, as well as multiple bones from individuals which show obvious differences in plumage. Our results demonstrate variations in terms of histological characteristics such as bone texture, extent of vascularization, presence of growth marks, and endosteal resorption and bone deposition. We document these histological features across the different age-classes to assess how they relate to ontogeny, as well as variation within the skeleton of *C. sanctus*. On the basis of the histological data derived from this study of multiple individuals of different sizes we deduce a growth trajectory for *Confuciusornis*. Our results also address the question of whether the presence/absence of rectrices underscores sexual dimorphism or different (cryptic) species.

Technical Session XIV (Saturday, November 5, 11:15 am)

THE ANATOMY OF THE PARVICURSORINE BRAINCASE AND ITS IMPLICATIONS FOR ALVAREZSAUROID SYSTEMATICS AND EVOLUTION

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The relationships of the theropod clade Alvarezsauroidea have been contentious, with early research suggesting a derived position for the group within Avialae and more recent research suggesting a position for alvarezsauroids outside of Avialae as the basalmost taxon in Maniraptora. Members of the Parvicursorinae, a derived group of alvarezsauroids, are becoming increasingly well-known from Late Cretaceous deposits of North America and Asia. Parvicursorines are remarkable in sharing many features of the skull and postcranial skeleton with avialans. These features are explained as homoplasy in hypotheses that posit a basal position for alvarezsauroids within Maniraptora. Relatively little is known about the comparative anatomy of the parvicursorine braincase, even though this is a rich area for phylogenetic data. We examined the anatomy of the parvicursorine braincase by taking high-resolution CT scans of three of the five known skulls for the group. Digital reconstructions of endocasts and the braincase bones from these scans, coupled with information from a partial skull that preserves the braincase floor, reveal many features that are potentially homologous with those of more derived maniraptorans, especially birds and troodontids. These features include an enlarged floccular recess, medial expansion of the vertical semicircular canal, inflation of the ventral surface of the basioccipital, and position of the vestibulocochlear nerve openings within a bowl-shaped recess that is located proximal to the floccular recess. These data suggest either a more derived position for parvicursorines within Maniraptora, such that Alvarezsauroidea is polyphyletic, or that the homoplastic features shared by parvicursorines and avialans extend to characteristics of the braincase, in addition to the dermal bones of the skull and the postcranial skeleton.

Technical Session XVI (Saturday, November 5, 9:45 am)

A TALE OF TWO *"MIMIA"*S. A NEW BASAL ACTINOPTERYGIAN FROM THE LATE DEVONIAN GOGO FORMATION, WESTERN AUSTRALIA

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The famous Gogo Formation of northwestern Western Australia provides a priceless window into Late Devonian vertebrate anatomy and diversity due to exquisite fossil preservation within calcareous nodules. *"Mimia" toombsi* (currently a preoccupied genus) from the Gogo Formation is the most completely known and thoroughly described Palaeozoic actinopterygian, with the anatomy of this taxon underpinning many recent analyses into the interrelationships of early osteichthyans.

During the 2005 Museum Victoria expedition to the Gogo Formation, the author discovered a nearly complete fossil fish at Bugle Gap (Mount Pierre Station) that closely resembled *"Mimia" toombsi*, but with clear differences in squamation and body shape. A subsequent examination of fossil actinopterygians within Australian and British collections produced additional examples of the new form. It has became apparent that material previously figured as *M. toombsi* incorporates two distinct species of basal actinopterygian, although similar enough to be considered congeneric.

The new species of *"Mimia"* is known from at least 13 prepared specimens. It differs from *M. toombsi* in details of the snout, skull roof, parasphenoid, squamation and body shape. However, the anatomy of the neurocranium, branchial chamber and lower jaw are indistinguishable between the two species. A phylogenetic analysis of early actinopterygians resolves *Gogosardina* as the sister taxon to the two *"Mimia"* species. The discovery of the second *"Mimia"* species, along with other forms, reveals a higher diversity of actinopterygians in the Gogo assemblage than in any other Devonian fauna and indicates that northwestern Australia was an early centre of diversification for the ray-finned fishes.

Poster Session III (Friday, November 4)

MAMMALIAN COMMUNITY CHANGE IN THE PALEOCENE OF NORTH AMERICA

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The extinction event at the K/T boundary was responsible for the demise of most terrestrial vertebrates larger than a kilogram. The subsequent radiation of mammals into herbivorous niches recently vacated by the dinosaurs is a well-known phenomenon, reflected in a general body size increase and the adaptation of dentitions to the shearing forces that the breakup

of tough plant matter requires. However, the timing and nature of this transition has not yet been evaluated: tooth morphology has been used to suggest fruit feeding, but that is at odds with the body sizes and would suggest ecosystems radically different from anything found today.

The implication of this hypothesis is that body sizes increased prior to the invasion of mammals into high-fiber dietary niches, resulting in communities that have no modern analogs before this transition occurred. The timing and nature of mammalian dietary evolution in the Paleocene was investigated using low-magnification microwear techniques, which allows for the evaluation of an animal's herbivorous guild (grazer, browser, hard-object feeder) more precisely than is usually possible by analyzing tooth shape alone. Although the Paleocene saw a huge radiation of mammalian diversity in terms of taxonomy, results show that this trend did not extend to their diets. There was an initial transition from predominantly insectivorous communities in the Cretaceous to hard-object-feeding dominance in the Puercan; communities remained hard-object dominant through the Paleocene, however, even as both taxonomic and size diversity increased. Evidence of prominent leaf-browsing does not appear until the Wasatchian, when a general drying trend in the Western interior triggered a change from closed-canopy Paleocene rainforests to more open vegetation. These results suggest that Paleocene mammalian communities were strongly influenced by their environment, not resorting to browse consumption until the Paleocene rainforest fruit-fall became unavailable.

Poster Session II (Thursday, November 3)

IDENTIFICATION OF FRAGMENTARY LATE PLEISTOCENE MUSTELOIDS THROUGH MORPHOMETRIC ANALYSES

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Previous studies of Guy Wilson Cave (GWC) in Sullivan County, Tennessee revealed an abundance of late Pleistocene large mammal fossils, mostly herbivores such as deer (*Odocoileus* sp.) and flat-headed peccary (*Platygonus compressus*). Along with the herbivore remains were some bones of dire wolf (*Canus dirus*) and bear (*Ursus* sp.). Based on analysis of wear patterns on peccary long bones, previous research has suggested that GWC was a dire wolf den. Still other fossils from GWC were mostly fragmentary remains of small carnivorans. In particular, several partial mandibles with carnassials were recovered that appeared to be from musteloids. Geometric morphometrics has been successfully used to identify fragmentary specimens of other fossil taxa, therefore a pilot project was initiated to look at two closely related taxa (that appeared to be present in the sample). Specifically, we sought to develop a landmark-based, 2-dimensional approach for identifying musteloids that would focus on the lower first molar. Digital images of the lower carnassials of several GWC fossils and of extant reference musteloids were combined using the morphometrics programs tpsDIG1, tpsUtil and tpsSuper. The statistical analysis of the landmark data was performed in the program PASW Statistics (formerly known as SPSS). The result has been successful, even in separating 'sister' taxa such as martens (*Martes americana*) and fishers (*M. pennanti*).

Technical Session III (Wednesday, November 2, 3:45 pm)

BIOGEOGRAPHIC IMPLICATIONS OF OTARIIDAE (MAMMALIA: CARNIVORA) SYSTEMATICS

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The Otariidae (fur seals and sea lions) are represented by 14 species found in the North Pacific and throughout the Southern Hemisphere. Their current distribution is closely associated with regions of upwelling, and the biogeographic history of this clade may be tied to changes in the distribution and prevalence of these zones of high productivity. Conflict between molecules and morphology however has caused disagreement in the interpretation of ancestral biogeography for many of the otariid clades, and reassessment of the phylogeny of the group is needed.

A data set of 134 characters for 17 species of otariid and three outgroup taxa was assembled. Characters were coded using narrow allometric and scaled character coding methods to account for the influence of allometry and variation within the character set. Failure to account for allometry and polymorphism within morphological datasets has been cited as a major source of incongruence between molecular and morphology-based phylogenies. Phylogenetic analyses were performed in the Program TnT using parsimony and a search utilizing 10,000 random addition sequences. Support values were calculated using symmetric resampling and 10,000 replications.

The recovered phylogeny supports paraphyly of southern fur seals (*Arctocephalus*) and sea lions (Otariinae), a result shared with previous molecular analyses. Analysis of biogeography supports a northern origin for Otariidae, with two major invasions of the southern hemisphere, one invasion giving rise to an *Arctophoca* clade in South America, and another invasion giving rise to a clade containing southern sea lions. A lineage of southern sea lions then re-invaded the Northern Hemisphere, giving rise to the genus *Eumetopias*. The results of this study support a much higher rate of faunal interchange between hemispheres in marine mammal communities than suggested in previous studies, and increased low latitude upwelling at multiple intervals during the Pliocene and Pleistocene. Future research will focus on examining the biogeographic patterns in other pinniped groups (Phocidae, Odobenidae) and comparing them to the patterns present in other marine mammal clades.

Poster Session I (Wednesday, November 2)

NEW INFORMATION ON TRIBOSPHENIC MAMMALS FROM THE CLOVERLY FORMATION, MONTANA AND WYOMING

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In North America, the best-represented Aptian-Albian (Early Cretaceous) mammalian fauna is that of the Trinity Group, Texas and Oklahoma. Occurrences have been reported from other units, most notably the Cloverly Formation, Wyoming and Montana, which has previously yielded remains of *Gobiconodon*, an undescribed large mammal, two triconodontids, a spalacotheriid symmetrodont, and the tribosphenidan *Montanalestes*. Herein we report additional tribosphenic mammals from the Cloverly Formation, known by a mixture of fragmentary and relatively well preserved specimens obtained through surface prospecting, quarrying, and underwater screen-washing. At least four taxa of stem tribosphenidans are represented by fragmentary teeth that add to known diversity but are not otherwise informative. We provide additional details on *Montanalestes*, which we regard as a stem tribosphenidan, including contralateral variation in molarization of premolars, presence of a large labial mandibular foramen, and unusual development of the angular process. Two metatherians are represented by partial dentaries. One, almost edentulous, provides earliest documentation of the full metatherian dental formula (i4, c, p3, m4); the other, known by p2-m3, has rather advanced molar morphology, including reduced height differential between trigonid/ talonid and full twinning of hypoconulid-entoconid. Eutherians may have been present in the Early Cretaceous of North America but are not readily identified as such; by contrast, metatherians appear to have been well established on the continent by the Aptian-Albian.

Technical Session II (Wednesday, November 2, 2:00 pm)

A PROCOLOPHONID PARAREPTILE FROM THE TRIASSIC OF AUSTRALIA

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Parareptiles are one of the most diverse groups of terrestrial amniotes that lived during the Permian and the Triassic periods. The Procolophonidae is the most speciose clade within the Parareptilia, and their members are known from all continents. Despite being reported in Australia in the 1970s, the remains of procolophonids from this continent have not been described yet. The specimens under consideration were collected from two localities, namely Duckworth Creek and 'The Crater', both in the state of Queensland, in rocks of the Arcadia Formation, a geological unit that produces a *Lystrosaurus* age fauna (Lower Triassic). The Australian taxon is known from some 40 individuals comprising both cranial and postcranial material, and even a few articulated skeletons. All of the remains can be ascribed to a single, new species. The new taxon is rather small (skull length < 35 mm) and relatively gracile in comparison with well known forms like *Procolophon trigoniceps* or *Hypsognathus fenneri*. It also lacks the quadratojugal spines that are characteristic of these species. The new procolophonid features six to seven upper blunted monocuspid teeth that are circular in basal cross-section; a very low number in comparison with other procolophonids and owenettids that possess monocuspid teeth. A phylogenetic analysis places the Australian taxon within the recently recognized clade Theledectinae, composed by *Theledectes perforatus* from South Africa and *Eumetabolodon dongshengensis* from north China. The new taxon is the only tetrapod shared between Duckworth Creek and 'The Crater' sites in Australia, thus, providing evidence for a direct correlation between these localities. The relationships of the Australian procolophonid suggest that procolophonid dispersal took place between South Africa and China through Australia during the Triassic.

Poster Session I (Wednesday, November 2)

WHAT THE HAKE? NEW SPECIMEN OF AN EXTINCT GADIFORM FROM THE EOCENE OF SEYMOUR ISLAND, ANTARCTICA

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An isolated partial left dentary (BAS D515.2) collected by the British Antarctic Survey prompted a reevaluation of gadiform remains from the La Meseta Formation (conventionally Middle Eocene) of Seymour Island (Antarctic Peninsula). Modern gadiforms range from the Arctic to Antarctic, inhabiting deep-sea benthic, shore, estuarine, and fresh waters. Included among these fishes are the hakes (e.g., *Merluccius*) and cods (e.g., *Gadus*). Based on a fossil record primarily composed of otoliths, they are known to extend back to the Eocene (hakes) and Oligocene (cods). The new specimen was recovered on the eastern side of the island, thus in the uppermost part of the La Meseta. It is characterized by a single row of sharp, ankylosed teeth set upon robust bony pedestals, consistent with the type-1 tooth replacement found in *Merluccius*. Between each tooth is a deep cavity that is marked by several small pores. The symphyseal process is smooth on the articular surface and it is irregular lingual to the articular facet. There is minimal sculpturing on the lateral surface of the dentary; however, the surface anterior to the mental foramen exhibits ascending and descending ridges with slightly rugose texture. The ascending ridge is fractured, but partially covers the lateral

aspect of the tooth row. The rest of the lateral wall is convex and increases in dorsoventral extent from anterior to posterior. A smooth medial wall projects past the ventral margin of the lateral wall. A deep mandibular sensory canal is located between the walls on the ventral surface of the dentary. BAS D515.2 is unlike the dentary of macrourid gadiforms, a taxon recently recovered from the Eocene of Antarctica. BAS D515.2 does preserve several features similar to previously published accounts of the gadiform "†*Mesetaichthys"* from Seymour Island. These specimens are likely the same taxon and their combined character suite indicates it is a member of Merluccidae. Thus, these are the only non-otolithic skeletal specimens of an Eocene hake known outside of the London Clay taxon †*Rhinocephalus*.

Poster Session I (Wednesday, November 2)

A REEVALUATION OF THE GENUS *ORNITHOMIMUS* BASED ON NEW PREPARATION OF THE HOLOTYPE OF *O. VELOX* AND NEW FOSSIL DISCOVERIES

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The theropod genus and species *Ornithomimus velox* was erected in the late 19th century based on a distal tibia and partial pes (YPM 542) and a partial manus (YPM 548) from the Maastrichtian Denver Formation in Colorado. The family Ornithomimidae was erected at the same time, based on *O. velox* and two other extremely fragmentary specimens now considered a *nomen dubium* (*O. tenuis*) and a tyrannosaurid (*O. grandis*). Currently only one other valid species is recognized in the genus *Ornithomimus*: *O. edmontonicus*. The original description of *O. velox* differs from the preserved material, in which reconstructed metatarsals were figured, and manual phalanges were not described. Further preparation of the holotype, fully freeing pes and manus from the matrix for the first time in over a century, allowed the examination of bone surfaces that were previously obscured. Similar to *O. edmontonicus*, but different from other ornithomimid genera, metacarpal (MC) I of *O. velox* is slightly longer than MC II, which in turn probably was slightly longer than MC III, based on our reconstruction of the missing proximal end of MC III. Both the manus (YPM 548) and the pes (YPM 542) of *O. velox* are about two-thirds the length of the type specimen of *O. edmontonicus* NMC 8632. The pes of *O. velox* is relatively robust, however, a condition usually not observed in juvenile theropods, which tend to have a relatively thin and elongate metatarsus. In addition, metatarsal (MT) II is longer than MT IV, a condition that is not seen in any other ornithomimid specimens, except for a newly found unnamed specimen from the Campanian Kaiparowits Formation of Utah (UMNH VP 19467.3). A specimen previously assigned to *O. velox* from the Kaiparowits Formation, MNA Pl. 1762A, has a shorter MT II than MT IV, different from YPM 542 and UMNH VP 19467.3. Based upon these differences and the approximately ten million year gap between the Denver and Kaiparowits Formation deposits, we posit that *O. velox* is a valid species, and that there are at least two different ornithomimid morphs in the Kaiparowits Formation, which are unlikely to represent *O. velox*.

Poster Session I (Wednesday, November 2)

THE RELATIONSHIP BETWEEN MANUAL PHALANGEAL CURVATURE AND LOCOMOTOR BEHAVIOR IN ANTHROPOID PRIMATES

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Humans are distinguished from our hominoid relatives by relatively short and straight phalanges. However, the relationships among phalangeal length, curvature and positional behavior repertoire is poorly understood. A better understanding of these relationships can help us to reconstruct the positional behavior of extinct relatives and, ultimately, to understand the evolution of our unique bipedality. Phalangeal measurements and body mass estimations were collected from a broad sample of living anthropoid species. As one would expect, phalangeal length is tightly correlated with body mass. Phalangeal curvature (degrees of arc) is strongly correlated with length across the entire sample, but more weakly within a given taxon. Curvature is weakly correlated to body mass across the entire sample, and individuals are tightly clustered based on positional behavior. Phalangeal curvature and body mass together are able to predict the degree of suspensory behavior. Intra-group variation in curvature is still unexplained, but some have postulated that there is an ontogenetic remodeling component to this trait that may reflect individual variations in behavior. The hand of the recently described *Ardipithecus ramidus*, interpreted as an above-branch walker, clusters with animals with a more significant degree of suspension.

Poster Session IV (Saturday, November 5)

AN EXCEPTIONALLY PRESERVED HADROSAURID DINOSAUR SKELETON WITH INTEGUMENT IMPRESSIONS FROM THE UPPER CRETACEOUS KAIPAROWITS FORMATION OF UTAH

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Dinosaur skin impressions are typically rare in the fossil record, but have been described for a number of hadrosaurid ornithischians from the Late Cretaceous of western North America. We report a partial hadrosaurine hadrosaurid skeleton (probably *Gryposaurus*), UMNH VP 12656, with exquisitely preserved integument impressions that are closely associated with portions of the pelvis and tail, from the Upper Cretaceous (late Campanian) Kaiparowits Formation of southern Utah. The specimen is preserved in a medium-grained, upwards fining sandstone, with mudstone rip-up clasts at its base, indicating rapid burial in a high energy environment. The sacrum and tail are articulated and preserve large sections of skin impressions, but the more anterior skeleton is largely disarticulated and has few skin impressions. The close association of such large areas of skin preservation and lack of folds or breaks in the skin indicates minimal disturbance to the posterior portion of the body prior to burial.

There are two major morphologies of impressions. Along the dorsal ridge of the tail there is a single row of large, raised, non-osseous dermal scutes which range in length from 7-11 cm; these are heart-shaped with radiating grooves. Though the scutes do not correspond with each vertebral neural spine, they are directly associated with the spines' dorsal surfaces. These scutes contrast greatly with the continuous or segmented epidermal frills along the dorsal ridge of the tail described for *Edmontosaurus*. The rest of the skin is dominated by polygonal tubercles ranging in diameter from 5-12 mm. Occasional oversize tubercles 12-15 mm in diameter are present among numerous smaller tubercles. Each tubercle contains 9 to 15 radiating grooves and irregularly scalloped edges. There is a definite trend in tubercle size; the average diameter increases distally along the tail. On the proximal tail, the largest tubercles are dorsal, whereas they are ventral on the distal tail. These tubercles are nearly identical to other hadrosaurid skin impressions from the Neslen and Kaiparowits formations of Utah, but scalloped tubercle edges are absent in *Edmontosaurus* from Montana and Wyoming.

Poster Session I (Wednesday, November 2)

CHEMICAL AND MORPHOLOGICAL REINVESTIGATION OF THE DINOSAUR HEART

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In 2000, computed tomographic (CT) data were used to suggest the preservation of a four chambered heart in the thoracic cavity of a well preserved specimen of *Thescelosaurus neglectus* (NCSM 15728). This diagnosis was challenged by others without direct access to the specimen; but it was clear this claim needed further investigation. The specimen was re-investigated to test competing hypotheses of a biological (e.g. heart) or geological (e.g. concretion) origin to this structure. I coupled a full body and 'heart' specific morphological examination, using a 5x greater resolution CT, with additional techniques including histology and elemental analyses. These new data reveal structural features of the thoracic structure that do not support the original identification of a cardiac origin, and x-ray diffraction (XRD) analysis on a small block of the 'heart' showed that the composition of the structure was typical of a goethite-cemented immature sandstone. X-ray photoelectron spectroscopy (XPS) analyses on a powdered sample taken from the 'heart' wall showed no nitrogen or carbon associated with this sample, ruling out the presence of any original organic material. Light microscopy and scanning electron microscopy (SEM) were congruent with the XRD and XPS data, and favored the diagnosis of an iron-cemented sandstone of geologic origin. However, intriguingly, several small, non-geologically derived polygonal structures, that resemble either plant cuticle or vertebrate endothelial cells, were identified between sand grains. These patterns are not consistent with a strictly geological origin, but require further investigation to determine their origin. These polygonal microstructures also show microscale chemical differentiation, determined using energy dispersive x-ray spectroscopy under SEM, from the 'membrane' to the 'nucleus' that suggest chemical sequestration and microchemical differences that support a biological origin for these structures. Overall, the data support a geological origin for the thoracic structure.

Technical Session XIX (Saturday, November 5, 3:45 pm)

REDUCED MERIDIONAL GRADIENT IN EOCENE SEAWATER TEMPERATURES INFERRED FROM THE STABLE ISOTOPE COMPOSITION OF FOSSIL SIRENIAN TOOTH ENAMEL

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The Early to Middle Eocene was an interval of extreme climatic warmth. Though mean sea surface temperatures (SST) were elevated globally at this time, temperature proxies suggest that high latitudes warmed more than the tropics, producing a reduced meridional SST gradient . However, due to variation in tropical temperature proxies and numerical simulation results, debate regarding this interpretation persists. Stable isotope analysis of sirenian fossils can be used to reconstruct latitudinal temperature gradients as enamel δ13C values for sirenians reflect the carbon isotope composition of their diet, which, for individuals favoring marine habitats, consists largely of seagrasses. Due to the increased solubility of CO2 at lower temperatures, modern seagrass δ13C values are negatively correlated with latitude; given this relationship, sirenian enamel δ13C values should decline more rapidly with latitude during times with a large meridional SST gradient and less rapidly with a reduced gradient. Here we test this hypothesis by comparing enamel δ13C values for Paleogene and Neogene fossil sirenians (manatees, dugongs) recovered from part of the Atlantic Ocean and former Tethys Sea (paleolatitudes from 10 to 55°N).

Enamel δ13C values for 148 fossil and modern sirenian specimens were compiled from published and newly analyzed data. Eocene-aged specimens (n = 28) were sampled over paleolatitudes from 10.6 to 42.5°N, but showed no significant difference in enamel δ13C values for specimens sampled from low (≤ 30°N) or higher (> 30°N) latitudes (Student t

test, t = 0.408, p = 0.686). In contrast, post-Eocene-aged specimens (n = 120), which were sampled over a similar range of paleolatitudes (15.6 -51.2°N), showed a significant difference in mean enamel δ13C values for specimens from low and higher latitudes (Student t test, t = 5.206, p < 0.001). These results are consistent with interpretations that meridional SST gradients were reduced during the Eocene and did not approach present conditions until at least the Oligocene.

Poster Session I (Wednesday, November 2)

DEVELOPMENTAL CONSERVATISM IN THE DENTAL SYSTEM OF THE LATE DEVONIAN DIPNOAN, *SCAUMENACIA CURTA* (SARCOPTERYGII)

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Dipnoan dentition is characteristic among gnathostomes and corresponds to a unique combination of odontogenic and odontoclastic developmental processes. Developmental sequences of patterning events for the dental system of dipnoans has been partly described for living dipnoans (*Neoceratodus* and *Protopterus*) and some rare Paleozoic taxa. Among these fossil taxa, disarticulated dental material (rostral, vomerian, entopterygoid, prearticular and dentary tooth plates) of the Late Devonian *Andreyevichthys* has been used to reconstruct a partial developmental sequence composed of "hatchlings" and adults; however, only the size criteria of the dental elements has been used to hypothesize developmental stages. Although dental patterning was compared between small-sized *Andreyevichthys* and larval *Neoceratodus*, little is known on the early and transitional ontogenetic stages and the precise identification of respective life cycle stages [i.e., embryonic, larval (hatchling), juvenile, adult and senescent]. A relatively complete fossilized ontogeny (including larval, juvenile, adult and senescent stages) based on complete specimens of the Late Devonian *Scaumenacia curta* allowed us to reconstruct a developmental sequence of dental events as well as to calibrate this sequence with the development of the remaining anatomy of the fish. Larval *Scaumenacia* bear entopterygoid and prearticular tooth plates. Teeth associated to the premaxillae, vomers and dermopalatines are added at the juvenile stage. As expected odontogenic patterning proceeds by tooth and row addition without resorption from larval to senescent stages. Relative simultaneity of tooth addition in the rows of the tooth plates is documented allowing the identification of growth profiles. In contrast to *Andreyevichthys*, peripheral bands of enamel are absent in all stages, but peripheral denticles of enamel are added in juvenile, adult and senescent specimens. Developmental events associated to the dental system of dipnoans are refined and developmental conservatism is pushed backward some 20 million years (from the Famennian to the Frasnian).

Technical Session IX (Friday, November 4, 9:15 am)

RE-EXAMINATION SHOWS THAT *SINEOAMPHISBAENA HEXATABULARIS* IS A MICRO-TEIID (GYMNOPHTHALMIDAE, SQUAMATA), NOT AN ABERRANT AMPHISBAENIAN OR MACRO-TEIID

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Sineoamphisbaena hexatabularis, a Late Cretaceous squamate from Inner Mongolia, was originally identified as the basal member of Amphisbaenia. Subsequent re-appraisal of *Sineoamphisbaena* revealed support for its inclusion in the teiioid clade Polyglyphanodontidae based, in part, on the perceived presence of a large postorbital extending posteriorly beyond the supratemporal fenestra, and a frontal with subequal anterior and posterior border widths. Importantly, all analyses of *Sineoamphisbaena* interrelationships have been based on the morphological interpretations put forth in the original description. Re-examination of the type specimen of *Sineoamphisbaena hexatabularis* revealed that many previously identified sutures are actually cracks; the actual cranial sutures are very subtle and the species is less aberrant than previously thought. The lacrimal is similar to that of most squamates, being relatively small and limited to the orbital margin rather than extending onto the dorsal skull roof. The maxilla possesses a dorsal snout exposure and underlies the jugal posteroventrally. The postorbital is absent, and the postfrontal is limited to the orbital margin, whereas the supratemporal is expanded and extends anteriorly with a broad jugal contact. Preliminary analysis of 258 lepidosauromorph taxa (along with nine outgroups) scored for 813 morphological characters indicates that *Sineoamphisbaena hexatabularis* is a member of Gymnophthalmidae (TNT analysis; New Technology Search of 50 replications recovered 4 most parsimonious trees) based on the shared presence of blunt, rounded snout, bipartite occipital condyles, and a posterolaterally expanded frontal. Gymnophthalmidae previously had no fossil record and the fossil record of Teiidae proper (exclusive of Polyglyphanodontidae) is very limited. *Sineoamphisbaena* demonstrates that gymnophthalmids had begun to diversify by the Late Cretaceous and were present in Laurasia.

Poster Session II (Thursday, November 3)

NEW DINOSAUR-DOMINATED TRACKSITES IN LATE JURASSIC AND EARLY CRETACEOUS OF SOUTHERN TUNISIA

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Three new dinosaur-dominated footprint assemblages are found in the Continental Intercalaire deposits of Southern Tunisia. All footprints occur in calcareous strata representing coastal environments where early dolomitization initiated preservation of the footprints. Late Jurassic (Oxfordian) strata exposed near the village of Ghomrassen preserve approximately 200 footprints, the oldest evidence of a dinosaur fauna in Tunisia. Footprints occur over an area of approximately 130 square meters. Although the majority of impressions are poorly preserved, most are tridactyl (average 28 cm long and 20 cm wide) and can be referred to theropods. The second locality, near the village of Chenini, is early Cenomanian; 21 manus (less than 20 cm long) and pes (less than 30 cm long) impressions attributable to mid-sized ornithischians are preserved on the surface of 5 isolated blocks. These footprints are nearly identical to those reported from coeval tracks from the Apulian Platform in southern Italy suggesting a possible connection of these landmasses during the early Cretaceous. A third and younger Cenomanian site located only a few km east of the Chenini locality, contains the most diverse and best-preserved footprints assemblage. The track-bearing surface records more than 90 footprints diagnostic to ichnogenus. The most abundant are mid-sized (less than 30 cm long) theropod footprints. In addition, the footprints of small crocodilians and unusually small (no more than 2 centimeters long) birds tracks have been observed. Such well-preserved tracks represent the first occurrence of birds in the Cretaceous fossil record of Tunisia. These new Tunisian footprint sites provide a unique and useful census of terrestrial associations along the southern margin of the peri-Mediterranean area during the late Jurassic and mid-Cretaceous time.

Technical Session X (Friday, November 4, 11:00 am)

A NEW THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC APPROACH FOR DIETARY RECONSTRUCTION IN EXTINCT PLATYRRHINE PRIMATES FROM PATAGONIA, COLOMBIA, AND THE CARIBBEAN

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Substantial samples of extinct platyrrhine primates are known from three major temporal and geographic regions: the Early Miocene sites of Patagonia, the Middle Miocene site, La Venta, in Colombia, and the Holocene sites in the Greater Antilles. This study explores the paleobiology of these primate communities through the analysis of functional dental morphology with an aim toward dietary reconstruction.

A new approach using three-dimensional geometric morphometrics is employed to explore the relationship between molar shape variation and diet in a sample of laser-scan generated models of lower second molars. Nine extant and sixteen extinct platyrrhine genera are examined. Principal component analysis of twenty-three *x, y, z* coordinate landmarks describing the occlusal table and tooth sidewalls showed that dental relief was the main contributing factor to variation along the first axis. Discriminant function analysis (DFA) of PC 1 scores and centroid size accurately classified extant platyrrhines according to dietary preference 87.4% of the time; however, without centroid size, the successful classification rate was somewhat lower.

Within this framework, most of the fossil platyrrhines were predicted to have had a predominantly frugivorous diet, but several taxa were classified as having a frugivorous/insectivorous diet including the Middle Miocene *Neosaimiri fieldsi*, *Patasola magdalenae*, and *Laventiana annectens*, all from La Venta. Alouattins, including the Laventan *Stirtonia tatcoensis* and the Cuban *Paralouatta varonai*, showed variable classification as either frugivores or folivore/frugivores. *Xenothrix mcgregori*, from Jamaica, was classified either as a frugivore or frugivore/omnivore. Dietary profiles across different extinct platyrrhine communities differed with the Patagonian and Caribbean forms showing less dental and dietary variation among taxa than the La Venta community showed. The Patagonian sites have been heavily sampled for more than one hundred years, so sampling is thought not to be a factor, but the Caribbean primates remain relatively little known, thus rendering firm conclusions about the nature of this faunal community difficult.

Poster Session II (Thursday, November 3)

A SKULL OF *MOROPUS* (PERISSODACTYLA, CHALICOTHERIIDAE, SCHIZOTHERIINAE) WITH AN ASSOCIATED PREMAXILLA FROM THE EARLY HEMINGFORDIAN OF NORTHWEST NEBRASKA, USA

COOMBS, Margery, University of Massachusetts, Amherst, MA, USA; ROUNDS, Carolyn, University of Massachusetts, Amherst, MA, USA

Complete skull remains of chalicotheres are relatively rare. In North America, *Moropus elatus* (late Arikareean) and *Tylocephalonyx skinneri* (late Hemingfordian) are known from good skull material, and *Moropus hollandi* (latest Arikareean) by a single skull. Generally speaking, early Hemingfordian chalicotheres have occurred as sporadic, fragmentary fossils that make it difficult to reconstruct whole animals or analyze relationships. More recently Bruce Bailey collected a large, unusually complete chalicothere skull, now in the collections of the University of Nebraska State Museum, from Runningwater deposits in Cherry County, northern Nebraska. Dental morphology and the absence of a skull dome preclude reference to *Tylocephalonyx*. The upper cheek teeth resemble those of *M. elatus* and *M. hollandi*, but differ in several ways. Upper molars, especially M2 and M3, are notably elongated, with an unusually long cingular ridge extending posteriorly from the lingual side of the protocone. The premolars (P2-P4) are very robust. A particularly important aspect of this skull is the preservation in place of the delicate right premaxilla. Only one other premaxilla of *Moropus* has ever been described, that specimen being an isolated, less complete premaxilla attributable to *M. elatus*. The premaxilla of the Runningwater skull resembles that of *M. elatus* in general shape and in lacking the upper incisors and canine. It differs in being much shorter in proportion to the size of the rest of the skull, suggesting that the anterior snout of this animal projected less than its counterpart in *M. elatus*. *M. elatus* has well developed lower incisors and lacks a canine; the anterior lower jaw of this animal remains unknown. This skull may

represent a new species and provides a useful base of comparison for other early Hemingfordian chalicothere craniodental materials from the North American Great Plains.

Symposium 1 (Wednesday, November 2, 11:30 am)

CELLULAR PATTERNS OF BAT (*CAROLLIA*) FORELIMB SKELETOGENESIS AND THEIR BIOMECHANICAL CONSEQUENCES

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Mammals evolved a stunning degree of phenotypic diversity in bone architecture in response to their occupation of extreme habitats (e.g., aquatic, aerial). To achieve powered flight, bats altered the architecture of their long bones by reducing mineral concentrations and altering cross-sectional geometries. Unfortunately, the bat transitional fossils that could illuminate how this important evolutionary transition occurred have not been found. To understand how this transition happened we need to look beyond the fossil record. This study aimed to quantify the differences in adult bone architecture of the short-tailed bat (*Carollia*) relative to terrestrial rodents *(Mus*, *Peromyscus*). By integrating microstructural analyses via nanoindentation tests with whole bone bending tests, as well as visualization of cross-sectional areas, this study offers the first thorough documentation of architectural differences in limb bones of aerial and terrestrial mammals. Nanoindentation tests revealed that the metacarpals of bats are 40% as stiff and 36% as hard as that of *Mus*. Whole bone bending tests revealed that the humerus of the bat and mouse are roughly equivalent in stiffness, however the bat radius was much more compliant, suggesting a decreased mineral content. Micro-CT scans showed that the humeral, femoral, and tibial cross-sectional geometries are equivalent in both *Carollia* and *Peromyscus*; however, distal bones of the bat displayed 8-40% larger medullary cavities compared rodents. To determine how endochondral ossification differs between *Carollia* and *Mus* diaphyseal dimensions were measured. Results indicate that *Carollia* delays appositional ossification relative to *Mus*, but begins diaphyseal longitudinal growth earlier. At late fetal stages, *Carollia* rapidly elongates the diaphysis, a finding consistent with reports that most endochondral ossification occurs postnatally in bat forelimb bones. These findings further our understanding of the microstructural properties of chiropteran bone biology, and support the assertion that during its evolutionary history *Carollia* has altered its bone development and adult architecture relative to rodents.

Technical Session XV (Saturday, November 5, 11:30 am)

THE DEVELOPMENTAL BASIS OF 200 MILLION YEAR OLD MAMMAL TEETH

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One of the principal challenges in applying insights from developmental genetics to extinct animals is the limited number of ontogenies preserved in the fossil record. Fossils do, however, provide information about variation, which can be examined from the viewpoint of developmental biology. To examine the developmental potential of teeth at the base of mammalian evolution, we analysed morphological variation in a large population of the early triconodont-like mammal *Morganucodon* from 200 Ma fissure deposits in Glamorgan, Wales. We compared the results with both a population of the dentally morphologically similar extant ringed seal (*Phoca hispida ladogensis*) and a virtual population of *Morganucodon* shaped teeth generated by a gene-network based computer model of tooth development.

Using geometric morphometric methods, the results show that the variation in *Phoca* and *Morganucodon* dentitions are generally quite similar. Furthermore, small changes in two of the tooth developmental model parameters are able to transform a seal tooth into a *Morganucodon* tooth. Comparison with variation generated by tinkering with parameters of the developmental model indicates that the same 'patterning kernel parameters' are able to explain much of the variation in seals and *Morganucodon*. Finally, *Morganucodon* teeth show incipient decoupling of the anterior and posterior variation, a prerequisite for the evolution of tribospheny, 34Ma before fully tribosphenic teeth first evolved. We infer that the same core genetic and developmental pathways present in living seal teeth were already established in the teeth of the earliest mammals, some 200 million years ago, and that the panoply of subsequent mammalian tooth diversity has required only minor changes of genetic architecture.

Poster Session III (Friday, November 4)

MAGNETIC POLARITY STRATIGRAPHY, BIOSTRATIGRAPHY AND AGE OF THE EARLY MIDDLE CONTINENTAL EOCENE DEPOSITS OF EL KOHOL AND GOUR LAZIB FORMATIONS (ALGERIA)

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Despite numerous discoveries that have considerably enriched the Afro-Arabian Tertiary fossil record over the last decades, our knowledge of the evolutionary history of many continental African vertebrate groups during the Paleogene period remains inadequate, particularly when it is compared with the fossil records of Europe or North America. The Eocene Epoch in Africa is especially poorly documented, being restricted to a few fossiliferous localities. Our understanding of the early Tertiary emergence, diversification and paleobiogeographical history of Afro-Arabian mammals has been further hindered by the lack of a precise temporal framework for these sites.

Magnetostratigraphic analyses, associated with biostratigraphic studies, have been undertaken throughout the Paleogene fossiliferous sequences exposed in the northwestern Hammadas of the Saharan Platform in the Glib Zegdou area and in the Saharan Atlas at the El Kohol locality in order to constrain the age of these Algerian Eocene continental deposits.

Based on biostratigraphic constraints, the 6 polarity zones recognized from the El Kohol section have been correlated with Chrons C24n to C22r, providing the first direct age estimates for the El Kohol fossiliferous strata between 52 and 51 Ma. Correlation to the GPTS, relying on previously published biostratigraphic data for the Glib Zegdou fauna, suggests an age ranging between 49 and 45Ma.

The present study provides a high resolution magnetostratigraphic reference for the poorly known continental Eocene Epoch of North Africa, thereby allowing more precise faunal comparisons and correlations with other sections that could lead to a better understanding of the early Tertiary evolutionary history of mammals in Africa.

Poster Session II (Thursday, November 3)

ANATOMY AND AFFINITIES OF LARGE ARCHOSAUROMORPHS FROM THE LOWER FREMOUW FORMATION (EARLY TRIASSIC) OF ANTARCTICA

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Early Triassic fossils discovered in Antarctica in the 1960-70s revealed a vertebrate assemblage similar to that of South Africa, and added critical support to the nascent theory of plate tectonics. However, despite nearly 50 years of study, many aspects of the vertebrate assemblage of the Early Triassic lower Fremouw remain poorly known, particularly the reptile component. We describe a partial presacral vertebra and the distal end of a left humerus collected just above the Permian–Triassic boundary from the Cumulus Hills in the Shackleton Glacier region of the central Transantarctic Mountains. Our identification of these specimens as archosauromorphs that represent at least one taxon of large-bodied archosauriform increases the known reptile diversity of the lower Fremouw Formation considerably, and provides the first definitive evidence for the presence of Archosauriformes in the Early Triassic of Antarctica. These records increase faunal similarities between the lower Fremouw Formation and other Early Triassic assemblages. Although the lower Fremouw assemblage is typically considered a subset of the coeval *Lystrosaurus* Assemblage Zone (LAZ) of South Africa, the discrepancy in inferred body size between the Antarctic specimens and *Proterosuchus fergusi*, coupled with the fact that the LAZ of the Karoo Basin has been sampled much more thoroughly, suggests a real disparity in the maximum body size of apex carnivores between the lower Fremouw assemblage and the LAZ. The lower Fremouw specimens also demonstrate that one or more lineages of archosauriform had attained the large body size characteristic of later members of the clade very soon after the end-Permian mass extinction. This offers a point of contrast with the global pattern of post-extinction terrestrial communities, which are typified by a marked reduction in body-size (the 'Lilliput effect'). Further collection and redescription of vertebrates from the central Transantarctic Mountains should clarify the taxonomy, diversity, biostratigraphy and biogeography of Fremouw Formation reptiles.

Technical Session XVI (Saturday, November 5, 11:45 am)

THE PHYLOGENETIC RELATIONSHIPS AND EVOLUTIONARY HISTORY OF LEPIDOSIRENID LUNGFISHES: A TOTAL-EVIDENCE APPROACH

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During the Early Cretaceous breakup of Gondwana, Lepidosirenidae diverged into two morphologically similar groups, the African *Protopterus* and the South American *Lepidosiren*. No morphologically based phylogenetic hypothesis of the interrelationships of this clade existed previously. I used High Resolution X-Ray Computed Tomography scans and disarticulated skeletal material to examine the skulls of one extinct and six extant species of lungfish and to derive characters for the first morphological phylogenetic analysis of lepidosirenids. I included the Triassic *Arganodus atlantis* and the extant *Neoceratodus forsteri* as outgroups. In addition to the morphological analysis, I integrated molecular rRNA sequences from extant specimens into a combined analysis. In the morphological phylogeny, *Lepidosiren paradoxa* is the sister taxon to all species of *Protopterus* and *P. dolloi* is the most basal species of *Protopterus. Protopterus annectens* and *P. aethiopicus* are sister taxa, with *P. amphibius* recovered as sister to that clade. Diagnostic characters for *Protopterus* species include the curvature and presence of a ridge on the suboperculum, the shape of the anterior end and pattern of ridges on the parasphenoid, the length of the anterior process of the frontoparietal, and rib number. When the morphological and molecular signals were compared, the monophyly of both Lepidosirenidae and *Protopterus* was supported robustly, as was the sister taxon relationship of *P. annectens* and *P. aethiopicus.* However, the positions of *P. dolloi* and *P. amphibius* were incongruent between analyses. While the molecular data resolve many of the relationships among extant taxa, the inclusion of morphological characters allows for a starting point for the placement of new fossil discoveries and existing

problematic fossils. Because Cenozoic lepidosirenid fossil material is known from only jaw and tooth plate elements, this study provides an expanded suite of morphological characters that allows for the apomorphic identification of both extant material and disarticulated fossil specimens in this morphologically complex group.

Poster Session III (Friday, November 4)

FINITE ELEMENT ANALYSIS OF CANONICAL DUROPHAGOUS TEETH

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Due to their highly mineralized nature, teeth are common in the fossil record, and the gross morphology of teeth is often used to infer the diet of organisms. Durophagous organisms have modified jaws and teeth that allow them to eat hard prey, and can be found in a number of lineages, both extinct and extant. One proposed explanation for the molariform tooth shapes associated with this lifestyle is that they are an adaptation that allows teeth to more effectively crush the hard shells of prey items. An alternative explanation for durophagous tooth morphology is that it allows for increased resistance to tooth breakage. In this study, we test the second of these hypotheses, and explore the effects of forces on teeth using finite element analysis (FEA). FEA is an engineering technique used to analyze the effects of forces on complex shapes. The program takes a complex shape subjected to a force, subdivides the shape into smaller simpler elements, and determines the effects of the force on the elements. Finally, the program re-integrates the elements, showing the effects of the force over the entire shape. We constructed three series of tooth models that graded from one morphological extreme to another. These morphologies varied the degree of convexity/concavity of the occlusal surface, as well as the radius and height of a centrally located conical stress concentrator. The tooth models were subjected to a variety of loading regimes, simulating different prey morphologies. We used maximum principal stress as an indicator of where on the tooth failure was most likely to occur, and which tooth forms are most likely to fail. We found that shallowly domed and cupped teeth are probably most effective at resisting breakage, and that there are functional limits to the shape of a central force concentrator. Our results demonstrated that effective tooth shape depends, in part, upon the size and shape of the prey item.

Poster Session III (Friday, November 4)

EGGSHELL THICKNESS VARIATION IN CHINESE EGGS

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Observation of approximately 200 dinosaur eggs from the Cretaceous Tiantai basin, Zhejiang Province, China, reveals substantial eggshell thickness variation within the presumed *Spheroolithus* sp. eggs. Examination and analysis of eggs in hand sample combined with radial thin sections of two eggshells with differing variation allowed investigation of two potential sources of variation in eggshell thickness across an egg: original egg morphology or postmortem taphonomic processes. Eggshell thickness changes laterally from 2.0 mm to 0.6 mm and back to 2.0 mm across one side of an egg, with upper and lower values of 2.6 mm and 0.3 mm, respectively, and a standard deviation of up to .51 mm in the data set; observation of thin sections indicate a likely .3 mm overestimate for thickness measurements taken in hand sample. The thinnest areas likely represent the top or bottom of the egg and result from local dissolution during early diagenesis, with some global dissolution taking place shortly thereafter. The consistency of this variation among different localities within the Tiantai basin remains unclear. Because eggshell thickness is commonly used to assign fossil eggs to an oospecies, distinguishing biologic from taphonomic attributes is important for assessing the diversity of ootaxa in the Tiantai basin. The recognition of eggshell thickness variation as the result of a taphonomic process provides a non-empirical reference for explanation of sources of variation in the fossil record of eggs.

Technical Session X (Friday, November 4, 11:30 am)

STABLE ISOTOPES EXPLAIN ANACHRONISTIC PLANT DEFENSES IN MADAGASCAR

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The southern quadrant of Madagascar is home to a unique and diverse floral community dominated by spiny endemic plants, including the Didiereoideae, an endemic subfamily of the family Didiereaceae. Spines are believed to have evolved in response to pressure from climbing herbivores, but very few vertebrate species consume these plants today. Thus, spines can be viewed as anachronistic. The vertebrate community of Madagascar experienced a dramatic decline over the past 2000 years. Pygmy hippopotamuses, elephant birds, giant tortoises, and at least 17 species of large-bodied lemurs all vanished. Because elephant birds, tortoises, and hippopotamuses would not have been able to climb, the spines on tall trees cannot be viewed as defenses against such animals. Large extinct lemurs, on the other hand, are excellent candidates. To probe this further, we analyzed stable carbon and nitrogen isotope values of leaves collected from a broad spectrum of plant species and bone collagen from eight extinct lemur species.

The Didiereoideae rely on Crassulacean Acid Metabolism (CAM) to fix carbon dioxide. As a result, they have distinctly elevated carbon isotope values and nitrogen isotope values. Our results suggest that *Hadropithecus stenognathus* is the only extinct lemur that exhibits carbon and nitrogen isotope values compatible with regular CAM consumption. *Hadropithecus'* tooth wear patterns as well as its dental, cranial and postcranial adaptations provide additional evidence that this extinct lemur may have consumed foliage from the Didiereoideae. Moreover, its geographic distribution matches that of the Didiereoideae in the south and west. Stable isotope analysis provides a mechanism for identifying past species interactions. Apparent evolutionary anachronisms can be explained when the ecological roles of extinct species are taken into account.

Poster Session I (Wednesday, November 2)

VALIDATION OF THE FINITE ELEMENT METHOD ON AN AVIAN SKULL AND IMPLICATIONS FOR DINOSAURIAN MODELING

CUFF, Andrew, University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom

Finite element analysis (FEA) can deduce stress and strain in biological structures during function. It provides an insight into the mechanical performance of the musculoskeletal system, and can be used to test the functional significance of morphological features. FEA has been used in paleontology for over 10 years, but questions remain about how well modeling results replicate reality. For fossil taxa we must rely on validation studies in closely related living taxa to inform on which parameters influence the results of our fossil FE-models. A recent study on the ostrich (*Struthio camelus*) mandible demonstrated congruence between experimental and computationally derived strain. Here we extend this work to determine the validity of FE-models of the ostrich cranium. Muscle loads were applied via an artificial tendon to the M. pseudotemporalis superficialis muscle site of a defleshed ostrich skull held in a custom built testing rig. Strains on the skull were recorded *ex vivo* using 13 rectangular rosette strain gauges. Computed tomography (CT) scans of the same specimen were segmented in Avizo 6.3 to separate cortical bone, cancellous bone, sutures and rhamphotheca. The surface generated was transferred into Hypermesh 10.0 to produce a series of models with increasingly fine mesh size for convergence testing. Using the appropriate sized mesh (where change between mesh size models is <5% strain), the model was loaded with the exact conditions as the *ex vivo* skull, and strains at equivalent sites compared. Results show that, whilst not perfect, the FE-method produce results similar to those recorded by *ex vivo* gauges, although the FE-model is consistently stiffer than the ex vivo skull. The rhamphotheca reduced overall strain, but as seen in prior studies, the sutures have very little effect. These results provided increased confidence in data obtained from future FE-studies of fossil avians, and derived non-avian maniraptorans with rhamphotheca and/or reduced teeth.

Poster Session II (Thursday, November 3)

PRELIMINARY DESCRIPTION OF A SMALL SKULL SPECIMEN OF *ENALIARCTOS* (CARNIVORA, PINNIPEDIMORPHA) FROM THE MIOCENE OF WESTERN OREGON

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Enaliarctos is a genus that includes at least five species of early pinniped relatives, known from the Oligocene and Miocene of the west coast of North America. This genus, considered to represent the early phases of marine evolution in pinnipedimorphs, is highly diverse, and may be a metataxon. In order to better understand the diversity and evolution of this group some specimens are being reexamined. This study reports on a skull specimen from the early to middle Miocene of western Oregon. This specimen was originally referred to *Enaliarctos emlongi,* based on similarities of the dentition and morphology of the zygoma. *Enaliarctos emlongi* is known from only three specimens: A large, well preserved holotype skull specimen, a partial skull and snout, and a smaller slightly crushed skull. This smaller skull is the subject of the current study and due to its small size was considered to be a juvenile. Although the skull is slightly crushed dorsoventrally, the palate, portions of the basicranium, and the rostrum are well preserved. Results of this study reveal that the specimen is most likely to be an adult. The interfrontal, maxilla, basisphenoid-presphenoid, and maxilla-premaxilla sutures are all fully closed. Previous research in modern otariids, as well as studies of other mammals, has shown that these are among the last cranial sutures to close in ontogeny. Ongoing work will determine whether this small adult specimen represents a species different from *E. emlongi*. Alternatively this may be a female *E. emlongi*, an interpretation consistent with the appearance of the relatively low sagittal crest, and the more mediolaterally compressed canines. If the specimen is female, it would suggest that *E. emlongi* may have been highly sexually dimorphic, implying that strong sexual dimorphism, seen in modern pinnipeds, particularly otariids (sea lions), may have arisen early in the evolution of pinnipedimorphs.

Poster Session IV (Saturday, November 5)

FLEXIBILITY ALONG THE VERTEBRAL COLUMN OF *LEPTOCERATOPS GRACILIS* AND ITS IMPLICATIONS FOR LOCOMOTION

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Leptoceratops gracilis is a small neoceratopsian dinosaur known from the late Maastrichtian of Alberta, Montana, and Wyoming. Although previous studies have interpreted *Leptoceratops* as quadrupedal, bipedal, or both, these were based primarily on limb proportions. Here, we examined the vertebral anatomy of *L. gracilis* for additional insight into its locomotion,

as well as to document general trends in the vertebral anatomy of ceratopsians. In particular, we focused on the anatomy of the zygapophyses, structures important for constraining vertebral movement. Measurements and photographs of a *Leptoceratops* vertebral column (CMN [Canadian Museum of Nature, Ottawa, Ontario] 8889) were taken, the angles between the left and right zygapophyses were measured in ImageJ, and the data were graphed to visualize trends. The angle between the zygapophyses in the cranial dorsal vertebrae is around 90 degrees, but zygapophyseal angle increases caudally, measuring up to 130 degrees between the prezygapophyses in cranial view. The angle of the zygapophyses is also greater in the cranial cervical vertebrae, around 110 degrees between the prezygapophyses. Assuming that a greater angle allowed greater transverse movement, the results show that *L. gracilis* displayed a high amount of horizontal movement at both the front end of the neck and the caudal region of its trunk. This may suggest lateral undulation in the posterior part of the body during locomotion. More restricted horizontal movement in the cranial dorsal vertebrae could be related to the attachment of the scapula in this region. Similar patterns are seen in large, definitively quadrupedal ceratopsids such as *Triceratops*. This suggests that *Triceratops* and *Leptoceratops* had similar spinal flexibility and mobility, possibly consistent with predominantly quadrupedal rather than bipedal locomotion in *Leptoceratops gracilis*.

Poster Session III (Friday, November 4)

CAPACITY OF THE PTEROSAUR, *ANHANGUERA SANTANAE*, TO LAUNCH FROM WATER

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Here we present the results of a quantitative and comparative morphological analysis of the large pterosaur, *Anhanguera santanae*, regarding the capacity for water launch. Many of the large pterodactyloid pterosaurs come from marine sediments or inland freshwater deposits. It is likely that some species took food from the water, and as a result, it is plausible that some large pterosaurs were forced into the water through feeding behaviors or stochastic events. Unless a water launch was possible for large pterosaurs, such events would be lethal, unless a shoreline was immediately available.

We estimated the capacity for water launch by applying variable soft tissue reconstructions and then iteratively solving quasi-steady fluid equations for the maximum potential drag output against the water during limb extension with a slightly-opened wing. Our results indicate that *Anhanguera* could launch from calm water, without the assistance of wind or waves, using a form of quadrupedal takeoff. The initial escape phase from surface suction could be accomplished with a net remaining acceleration of approximately 15-20 m/s2, and an acceleration of up to 40 m/s2 on the subsequent propulsive bounds. These very brief, but large, accelerations would have the side effect of promoting rapid circulation generation on the wing at the end of the launch cycle. *Anhanguera* seems to have been adapted for a water launch using a series of repeated propulsions, which would have occurred as a series of "hops" across the water surface.

We cannot confirm that *Anhanguera* actually utilized a water launch in life. However, our model produces testable hypotheses of expected morphological patterns in marine versus terrestrial pterosaurs. *Anhanguera*, along with many other marine pterosaurs, present a suite of characteristics that would be expected in water-launching pterosaurs. Quadrupedal water launch behavior would help to explain features such as: the expanded scapula, reinforced scapular-notarial joint, warped deltopectoral crest, exceptionally broad MCIV-PHIV wing finger joint, limb length disparity, and expanded space for posterior brachial musculature observed in *Anhanguera*.

Poster Session III (Friday, November 4)

A VERY COMPLETE *DORCATHERIUM PIGOTTI* (TRAGULIDAE, MAMMALIA) SKELETON FROM RUSINGA ISLAND, KENYA: IMPLICATIONS FOR FUNCTIONAL MORPHOLOGY

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Tragulidae is the most primitive taxon in the suborder Ruminantia. Though there are three extant genera comprising up to ten species and dozens of fossil taxa, they remain enigmatic in terms of their taxonomy, functional morphology, and behavior. All extant species occupy tropical forests, though they vary in their tolerances to seasonally dry conditions. *Hyemoschus aquaticus* (the only extant African taxon) is considered to be the most water-dependent, intolerant to seasonal variation, and the most primitive of the tragulids. This species is regularly used as a model for the fossil genus, *Dorcatherium*, an extinct group of tragulids known from the Early Miocene of Africa and Eurasia.

Recent excavations from Miocene deposits of Rusinga Island (Kenya), which is famous for the *Proconsul* specimens found there, have recovered an *in situ* and very complete post-cranial skeleton of *Dorcatherium pigotti*. Almost every element is present, with only the axial skeleton not being well represented. Remarkably, forty of the forty-eight phalanges were collected and these can be assigned to exact skeletal position. Though there is compaction of the long-bone shafts, the joint surfaces are intact and almost completely unaltered, allowing for reconstruction of the individual's functional morphology. Unlike *Hyemoschus aquaticus*, this specimen does not exhibit extreme angulation in its joint surfaces. While *Hyemoschus* holds its lower limbs close together, it has a very round body, and thus its legs do not lie in a parasagittal plane. Functionally, this requires joint surfaces to be angled, especially in the knees, elbows, hock, and wrist. The limbs of *Dorcatherium pigotti* are less angled, and more elongate and gracile than in *Hyemoschus*. *D. pigotti* appears to have been adapted to terrestrial locomotion in a closed habitat. *Hyemoschus* is highly adapted in its predator-avoidance behavior in that it flees to water, dives in, stays submerged, and actually walks along the floor of the body of water. Therefore, it is possible that the morphology of *Hyemoschus* is in fact not primitive, but rather more specialized than previously considered, and thus not the best model for early tragulids.

Technical Session IX (Friday, November 4, 10:30 am)

DYNAMIC ANALYSIS OF THE SPECIALISED JAW MOVEMENTS IN *SPHENODON* AND RELATED CHARACTER ACQUISITION IN FOSSIL RHYNCHOCEPHALIA (DIAPSIDA: LEPIDOSAURIA)

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Sphenodon, the New Zealand tuatara (Rhynchocephalia), has a specialized feeding system in which the lower jaw closes between two upper tooth rows before sliding forward to tear food apart like a steak-knife. This shearing action is unique amongst living amniotes but some related osteological characters are known in Mesozoic rhynchocephalians.

The details of this jaw movement were analysed using Multibody Dynamics Analysis, where a 3-Dimensional model of *Sphenodon* was constructed from Computed Tomography scans and used to simulate a typical feeding sequence. This model included accurate joint contact surfaces and a detailed representation of the jaw muscles. Results show that the shearing mechanism is more complex than previously appreciated. Anterior shearing of the lower jaws is accompanied by long axis rotation that alters how the lower and upper dentition interact. At first shearing occurs between the anterolabial flanges on the dentary teeth and posterolingual flanges of the maxillary teeth, but towards the end of the shearing phase it occurs between the anterolingual flanges of the dentary teeth and the posterolabial flanges of the palatine teeth. Hence, precise point loading occurs that cannot be appreciated by manipulation of dried skeletal specimens. The hinge-like symphysis is integral to this prooral feeding system permitting the long axis rotation and necessary changes of the intermandibular angle.

A survey of the fossil taxa shows that many of the anatomical features required for the *Sphenodon* mode of feeding, such as the elongate articular and hinge-like symphysis, were acquired early in rhynchocephalian evolution (e.g. the Early Jurassic *Cynosphenodon*). The Upper Jurassic-Late Cretaceous eilenodontines appear to have elaborated on the *Sphenodon*-type jaw movement by transversely expanding their dentary and palatine teeth and closing the suborbital fenestra to create a single upper occlusal surface. This contradicts previous suggestions that the specialized jaw arrangement found in *Sphenodon* restricted continuing evolutionary development.

Poster Session I (Wednesday, November 2)

RE-EXAMINATION OF THE CRANIAL MORPHOLOGY OF *UTATSUSAURUS HATAII* FROM THE OSAWA FORMATION (LOWER TRIASSIC) OF MIYAGI, JAPAN

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Limited and poorly preserved material of chronologically early members of Ichthyopterygia has hindered interpretation of the early evolutionary patterns of the group. Relative to other Early (E.) Triassic ichthyopterygians, *Utatsusaurus hataii* is well known, but details of its cranial morphology remain sparse, making comparison to other basal forms problematic. The specimen that best preserves the skull, UHR 30691, has been referred to *U. hataii* based on a similar geologic occurrence and the following shared features: subthecodont tooth implantation; distomesially compressed tooth crowns; humerus longer than wide and bearing equally sized ulnar and radial facets. We re-studied the skull of UHR 30691 to improve its comparative utility and confirmed the following notable points: premaxilla slender; external naris with its dorsal margin formed by the nasal; frontal, parietal, and postfrontal bearing the anterior terrace; all teeth with blunt-tipped crowns; presence of pterygoid teeth. We describe the mandible for the first time, revealing: dental groove restricted to the anterior portion of the dentary; jaw joint enclosed anteriorly by a medial process of the surangular; splint-like coronoid that does not contribute to the coronoid process. Because of damage done since the original description, UHR 30691 no longer preserves the left quadratojugal, squamosal, supratemporal, the posterior portion of the left postorbital and parietals, or the atlantal pleurocentrum. We conducted a phylogenetic analysis using these data and found 12 equally parsimonious trees, with the strict consensus supporting a monophyletic Ichthyopterygia with eight unambiguous characters. *Utatsusaurus* occupies a position outside of Eoichthyosauria; however, the interrelationships at the base of Ichthyopterygia remain unresolved as a trichotomy between *Utatsusaurus*, *Parvinatator*, and Eoichthyosauria. This uncertainty underlines the importance of targeting known E. Triassic ichthyopterygian-bearing sites to seek additional material that will contribute to a more thorough understanding of early taxa and provide data pertinent to clarifying the patterns of relationship at the base of the group.

Technical Session XIV (Saturday, November 5, 8:15 am)

THE OPISTHOTONIC DEATH POSE AS A FUNCTION OF MUSCLE TONE AND AQUEOUS IMMERSION

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In the classic death pose of theropod dinosaurs (avian and non-avian) and other animals the head and neck are hyper extended resulting in a strongly arched neck with the skull roof resting above the sacrum and the tail arching cranially over the head and neck. In less extreme cases the neck and tail range from vertical to the classic case just described A number of mechanisms have been proposed for this pose, including desiccation, asphyxiation, and poisoning. Most specimens preserved in this pose were deposited in aqueous (fluvial or lacustrine) environments. We hypothesized that the swelling of the more massive epaxial musculature of theropods by the intake of water during prolonged submersion would swell elongate muscle cells equatorially, shortening them along the long axis. Our tests of this model utilized complete, fresh or frozen, plucked chickens completely immersed in cool water (n=7) for periods up to a month. Within seconds of immersion the heads and necks were pulled back into a range of death poses, including the extreme case with the head directly above the pelvis or with the head floating lateral to the back or pelvis. Over time hyperextension increased only slightly but tending to pull the head and neck into the saggital plane. A control desiccation study was conducted by placing a fresh chicken on sand (n= 1) in a fume hood with the neck out-stretched parallel to the back. No movement occurred over a period of three months.

The surprisingly simple and totally unexpected result of these experiments indicates that once immersed, natural muscle tone of the epaxial muscles hyperextends the skull and neck resulting in the classic death pose almost instantly. This movement is facilitated by the nearly "weightless" neck and skull (perhaps a function, in part, of the pneumatic skull and neck). Over time, the hyperflexion increases slightly, possibly due to further shortening of epaxial muscles.

Our experiments suggest that although the roads to the opisthotonic death pose are many, immersion in water is the simplest explanation.

Poster Session IV (Saturday, November 5)

SYSTEMATIC RELATIONSHIPS OF MID MIOCENE SPECIES OF *MONOSAULAX* (RODENTIA: CASTORIDAE) FROM THE GREAT BASIN OF NORTH AMERICA

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The Mid Miocene Climatic Optimum (17-15 Ma) was a time of dramatic change in both global climate and species evolution. During this geologic time span, in the Great Basin of North America, several local faunas were preserved. Four of the local faunas (e.g., Barstow, l.f.; Massacre Lake l.f.; Stewart Valley l.f.; and Eastgate l.f.) revealed *Monosaulax* taxa of which three species (*M. pansus*, *M.curtus*, and *M. tedi*) are known. At Eastgate, an endemic species of *Monosaulax* is represented by a large sample (>45 specimens) of maxillae, mandibles, and upper and lower cheekteeth. These specimens represent a range of life stages from juvenile to adult, and are sufficient to confirm a new species of *Monosaulax*. Quantitative analyses of upper and lower cheekteeth of *Monosaulax* includes coefficient of variation, principal components analysis, correspondence analysis, and cluster analysis. These univariate and multivariate methods support the identification of a new species of *Monosaulax* from Eastgate. Numerous qualitative characters of the maxillae, mandibles, and upper and lower cheekteeth taken from the Eastgate specimens and the literature were evaluated as well. Species A from Eastgate most closely resembles *M. tedi* but differs from it in being smaller in size, lacking a sigmoid pattern on the occlusal surface formed by the mesofossettid in the absence of the parafossettid and metafossettid, and in having a long mesostriid spanning greater than 50% of the total crown height of the cheekteeth.

Technical Session XI (Friday, November 4, 3:30 pm)

EARLY EVOLUTION OF TITANOSAURIFORM SAUROPOD DINOSAURS: TAXONOMIC REVISION, PHYLOGENY, AND PALEOBIOGEOGRAPHY

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Titanosauriformes was a long-lived, diverse, and geographically widespread clade of megaherbivores that included both the largest and smallest sauropods. I present a taxonomic revision of all Early Cretaceous North American sauropods, which results in augmented hypodigms, synonymization or invalidation of some previously distinct genera, and recognition of a new genus and species. Based on these taxonomic revisions, first-hand observations of relevant taxa, and development of novel characters, I present a genus-level cladistic analysis focusing on basal titanosauriforms. Three main clades are recovered: Brachiosauridae, composed of Late Jurassic and Early Cretaceous mostly Laurasian taxa (e.g., *Brachiosaurus*, *Sonorasaurus*), a clade composed of several Early Cretaceous East Asian taxa (e.g., *Euhelopus*, *Phuwiangosaurus*, *Tangvayosaurus*), and a paraphyletic, globally distributed set of taxa leading to Titanosauria (e.g., *Ligabuesaurus*, *Tastavinsaurus*). Several putative brachiosaurids are recovered as non-neosauropods, members of the East Asian clade, or close relatives of Titanosauria. The Early Cretaceous of North America contained both brachiosaurids and more derived titanosauriforms, all of which disappeared before or at the time of the incursion of the Western Interior Seaway. The ca. 30 million-year-long Late Cretaceous 'sauropod hiatus' in North America was the result of extinction and reinvasion of sauropods from another landmass. East Asia appears to have hosted an endemic clade of sauropods during the Early Cretaceous, though the effects of missing data in fragmentary taxa decrease support for this hypothesis. This study yields novel hypotheses of relationship and character evolution that help to form the basis for future examination of the origins of Titanosauria.

Poster Session I (Wednesday, November 2)

THEROPOD MATERIAL FROM LAMETA, INDIA, IN THE COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY AND ITS BEARING ON THE DIAGNOSIS AND PHYLOGENETIC AND TAXONOMIC STATUS OF *INDOSUCHUS RAPTORIUS*

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In 1923 a partially preserved specimen of a theropod dinosaur was discovered in the Lameta Formation (Maastrichtian) of the Narmada Valley near the town of Jabalpur, India. This material lay largely unnoticed in the collection until 1978 when the specimen was referred to *Indosuchus raptorius* and designated as a lectotype. The fragmentary nature of the remains of the holotype of *I.raptorius* has led to doubts as its taxonomic validity. Further, the AMNH material shares no elements in common with the described holotype material, making the referral to *I.raptorius* questionable. In order to clarify whether the AMNH material should in fact be referred to *I.raptorius* and whether *Indosuchus* is a valid taxon, we conducted the first detailed description of all the elements of the AMNH *"Indosuchus"* material, including the addition of two previously unrecognized cranial elements, a partially preserved left frontal and part of the left dentary with well-preserved teeth. In recent studies *I.raptorius* and other Indian theropods have been placed in the Abelisauridae and the AMNH material exhibits some abelisaurid features, such as sculpted ridges along the alveolar margin of the dentary. Phylogenetic analyses were conducted using multiple published abelisaurid datasets in order to test whether the AMNH material should be referred to *I.raptorius* The AMNH material was coded separately from *I.raptorius,* which was coded based on the original description. The results for all of the analyses were similar. In no analysis did the AMNH material group with the holotype of *I.raptorius,* however, as the preserved material shares nearly no elements in common, it is not possible to rule out that these are the same taxon. *I.raptorius* groups with the Carnotaurinae, while the AMNH specimen is a basal abelisaurid largely due to the primitive features exhibited by the caudal vertebrae and facial elements, which are not preserved in the holotype. *I.raptorius* does not form a clade with *Indosaurus*, supporting their original description as separate taxa.

Poster Session III (Friday, November 4)

NOT ALL GHOST LINEAGES ARE REAL: MISPERCEPTIONS OF WHAT TAXA REPRESENT MAY CAUSE ILLUSIONS

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Species and clades are basic concepts in phylogenetics, yet are difficult to define in practice. This is acutely true with fossil species, which are considered cladistically as valid species, equal with respect to other species, even though they are fundamentally different. This becomes an issue when stratigraphic data is correlated with cladistic data. The last common ancestor (LCA) of any sister species must be older than the first accepted datum (FAD) of either species. When species have disparate fossil records, this can cause large ghost lineages in which species are only assumed to be present. Methods attempting to include such data into analysis have largely not been accepted due to difficulties in dealing with the uncertainties of the fossil record. Cladistics uses two opposed tenets. It usually assumes that LCAs are not present in the species under analysis, that all species are stem groups, for well established reasons. It also demands that monophyletic clades must be derived from within more inclusive clades, forming a hierarchy of nested clades, such as Aves within Theropoda within Dinosauria. The origin of each clade must be earlier than all clades it includes. Computational demands and incomplete data make it impossible to perfom cladistic analyses using all species of large clades. Species are thus selected as representatives of much smaller, less inclusive clades. This simplification has profound impacts. We no longer have equal species, but clades of uncertain hierarchical affinity. When intervening species are removed, species representing nested clades appear as sister taxa in cladistic analyses. The LCA then becomes wrongly assumed to be older than either species. Moreover, the very arguments that establish that LCAs can be assumed to not be in the dataset also demand that ALL fossil species should not be treated as individual species, but as representatives of clades with uncertain affinity. Therefore, when dealing with fossil taxa, the assumption that the LCA of sister species must be older than either species is invalid and many of the ghost lineages can be allowed to disappear, as ghosts are wont to do.

Technical Session IX (Friday, November 4, 11:45 am)

CRETACEOUS SOFT-SHELLED TURTLES (TRIONYCHIDAE) OF MONGOLIA: NEW DATA AND A REVISION

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In the Lower Cretaceous of Mongolia, only fragmentary remains of Trionychinae indet. are known (Dzun Shakhai). In the Cenomanian-Santonian (Bainshire Formation), trionychids are represented by "*Amyda*" *orlovi,* and probably by one more taxon (Trionychinae indet.). "*Amyda*" *orlovi* is known only by an incomplete carapace (holotype) and an attributed plastron fragment (both from Bain Shire). We assign to this species an almost complete skeleton and an additional carapace (both from Burkhant). In the Campanian-Maastrichtian (Barungoyot and Nemegt formations), a number of different forms of trionychids have been recognized. Study of new materials shows that most of these forms are attributable to "*Amyda*" *menneri*. However, at least one more trionychid (Trionychinae indet.) was present in the same interval. An almost complete carapace with a preneural from the unknown horizon of the Late Cretaceous of Shiluut Ula is referrable to the genus *Aspideretoides* (first record from Mongolia). Inclusion of "*Amyda*" *orlovi* and "*A.*" *menneri* in a cladistic analysis of extant trionychids results in their position within the Apalonina, in one clade sister to the living genus *Apalone*. The clade "*Amyda*" *orlovi* + "*A.*" *menneri* is supported by the following characters: width/length of nuchal bone greater than four; seven or eight neurals; and five plastral callosities. The presence of Apalonina, which is a rather advanced and well supported trionychid clade, in the Late Cretaceous of Asia suggests that most other clades of trionychids had been established there by that time.

Poster Session II (Thursday, November 3)

A NEW WAY TO ESTIMATE THE DIRECTIONAL SENSITIVITY OF THE SEMICIRCULAR CANALS SYSTEM

DAVID, Romain, MNHN/Collège de France, Paris, France; ALLAIN, Ronan, MNHN, Paris, France; BERTHOZ, Alain, Collège de France, Paris, France; JANVIER, Philippe, MNHN/CNRS, Paris, France

The vertebrate vestibular system is involved in balance, gaze control, movement coordination and navigation. The inner ear houses the peripheral receptors of this system, the semicircular ducts system and the otolithic endorgans. The six semicircular ducts detect head rotations. The functioning of each duct depends on its sensitivity and its maximal response plane. The detection of a head rotation in space thus depends on the structure of a particular octahedron, composed of six semicircular ducts vectors. We named this set of vectors the 'semicircular canals system functional structure'. The ducts are contained inside labyrinths, which can be retrieved in fossil specimens using microtomography technologies and 3D-reconstruction. We developed a new method that allows us to: (1) extract the semicircular canals system functional structure from the bony labyrinth; (2) determine the sensitivity of the system for pitch, roll and yaw rotations; and (3) estimate the error of these inferences from key morphological parameters. The power of this method was ensured from a data set composed of bony and membranous labyrinths from five phylogenetically distant, extant tetrapods. We applied this new methodology to a data set composed of forty archosaurian specimens. This data set contains nineteen extant species (birds and crocodiles), as well as twenty-one extinct species (phytosaurs, suchians and dinosaurs). The key steps of this method will be explained and its applicability among vertebrates' labyrinths will be discussed. The directional sensitivity and the estimated range of angular head velocity retrieved through this method will be presented for two fossil specimens, a crurotarsan and a dinosaur.

Preparators' Session (Thursday, November 3, 11:45 am)

VIRTUAL AND REAL: USING 3-D SCANNING, MODELING, AND PRINTING IN RECONSTRUCTING A JUVENILE *APATOSAURUS* SKELETON

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Using *Apatosaurus* bones from the Morrison Formation of the Oklahoma panhandle collected between 1933-1941, the Oklahoma Museum of Natural History determined to build a full skeletal mount of the smallest individual represented, an animal only around 84 centimeters (33 inches) high at the hip and 4 meters (13 feet) long. In the 1990s a 28 meter (92 feet) long display mount had been created from bones representing a huge adult individual from the same quarry. A minimum of four juveniles, shown by duplicate right tibiae all within 10% of each other in size, contributed to bones in the smallest size grouping. Early on 3-D imaging and printing was chosen to produce mirror images of selected bones and models versus hand sculpting. Use of 3-D computer modeling expanded to where nearly 57% of the bone reconstructions by count (skull and jaws counting as only three pieces) were generated on the computer. Besides mirror images, methods included shrinking scans of bones from larger individuals to fit, blending between models or real bones to fill gaps in a series, and using formulas to generate other series by distortion of models. Some crushing, distortion, and damage was removed or repaired on scans of real bones. All regularly reconstructed bones or sculpted clay models were also 3-D scanned and a virtual skeleton made. Care was taken to retain juvenile characters that could be identified in the real bones and add the best guesstimates for missing bones. The virtual skeleton allowed evaluation of reconstruction choices and correction of those choices, if needed, as work progressed. The virtual skeleton remains as a resource to evaluate possible changes to the reconstruction in the future.

Poster Session I (Wednesday, November 2)

MICRO-COMPUTED TOMOGRAPHY REVEALS A DIVERSITY OF PERAMURAN MAMMALS FROM THE PURBECK GROUP (BERRIASIAN) OF ENGLAND

DAVIS, Brian, University of Oklahoma, Norman, OK, USA

The known sample of the important pre-tribosphenic mammal *Peramus tenuirostris*, housed in the Natural History Museum (London, UK), was imaged using micro-computed tomography (CT). Substantial morphological diversity was discovered, prompting establishment (and resurrection) of additional taxa from within the original hypodigm of *Peramus tenuirostris*: *Peramus dubius* comb. nov., *Kouriogenys minor* gen. nov., and *Peramuroides tenuiscus* gen. et sp. nov. The Peramura are revised; this group is restricted to taxa with clear evidence of a fully-functional upper molar embrasure for the dominant lower molar talonid cusp (hypoconid), either through development of wear facet 4 or differentiation of a distinct hypoconulid. The Peramura are the most likely sister-taxon to the Tribosphenida (including living marsupials and placentals) and represent a distinct molar morphotype, transitional between primitive lineages characterized by dominant orthal shear (e.g. dryolestoids) and those with modern, multi-functional tribospheny. A very large masseteric foramen is identified in peramurans, but this feature appears to be autapomorphic and of uncertain function.

Poster Session II (Thursday, November 3)

MULTIVARIATE DISCRIMINANT ANALYSIS OF PHALANGES OF SMALL *EQUUS* ALLOWS IDENTIFICATION OF PLEISTOCENE SPECIES AT PAISLEY CAVES, OREGON

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The late Pleistocene archaeological site at Paisley Caves, Oregon, is famous for its extraordinary preservation, including human DNA in coprolites. We present the first analysis of horse fossils from the site. Most of the equid specimens are phalanges, previously thought to be nondiagnostic to the species level. By constructing a discriminant function for late Pleistocene *Equus* from 268 known specimens of six species at other sites, we have been able to identify the small Paisley Cave horses as *Equus conversidens,* a small stout-legged species common to the American southwest. Specimens of *Equus* from the site have been dated to between 12,400 and 11,300 BP, coeval with the earliest evidence of humans at the site.

A critical question in research on late Pleistocene *Equus* in North America concerns disagreement between morphological and molecular evidence with respect to evolutionary distances among stout- and stilt-legged species. Previously, distinguishing between these forms employed complete metapodials. Our discriminant function is able to distinguish among species of *Equus* using only dimensions of the medial phalanx, with a success rate of 92.8%. Distinguishing between stilt-legged and stout-legged forms is possible with a success rate of 95.5%. With this new tool, it should be possible to dramatically increase the available sample pool for paleoecological and evolutionary studies, including ancient DNA analyses, allowing the construction of a more complete picture of North American late Pleistocene horse evolution.

Poster Session III (Friday, November 4)

COMPLETE CENSUS OF PUBLISHED FOSSIL DINOSAUR INTEGUMENT QUANTIFIES TAPHONOMIC BIAS TOWARDS PREVALENCE OF HADROSAURID SKIN

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Most examples of fossil dinosaur skin come from hadrosaurids but this taphonomic bias has never been quantitatively measured or fully explained. After a lengthy literature review of all published dinosaur skin and reanalysis of recent lithographic occurrence data, I can confirm quantitatively that hadrosaurid dinosaurs do fossilize skin at a much higher rate than any other clade of dinosaurs but this bias could be due to several factors. The amount of skin fossils found from all dinosaurs over time correlates extremely well with the number of named terrestrial formations per epoch, which we can use as a rough proxy of rock availability and worker effort. Besides living in the Cretaceous, a period heavily studied and possessing many named formations, hadrosaurids were also incredibly numerous and speciose. Neither of these seems to account for their elevated levels of skin preservation, though, as they still preserved more skin per body fossil found and per species than any other clade of dinosaurs. Hadrosaurids are also found predominately in sandstone, which is shown to preserve many more skin fossils than other common lithofacies. Within those specimens found only in sandstone, hadrosaurids still preserve more skin per species than other clades but in terms of skin preserved per body fossil, results are not statistically significant and we cannot rule out that we have yet to find many skin fossils from other common coeval dinosaurs like ceratopsians. There is also a large historical aspect to our notion of hadrosaurid preservational bias. North America's prolific paleontologists of the early 1900's produced numerous and spectacular examples of dinosaur skin from the Western Interior of the Cretaceous, an area heavily biased towards hadrosaurids. These specimens dominated the literature so completely that it was not until the mid-1990's that the total number of published non-hadrosaurid skin samples surpassed the number of published hadrosaurid skin samples. Despite these taphonomic biases, the amount and quality of hadrosaurid fossil skin begs us not to hastily rule out a true biological effect like specialized behavior or integument morphology.

Poster Session III (Friday, November 4)

PRESENCE OF PENTACODONTID MAMMALS IN THE EUROPEAN PALEOCENE

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A pentacodontid mammal is described from the early Paleocene of Hainin, a Belgian locality that yielded the earliest Cenozoic mammal fauna of Europe (MP1-5 reference-level). This taxon, represented by a new genus and species is the oldest and smallest European member of the order Pantolesta. It is also the first pentacodontid of Europe, a group that was previously only known from Western North America. The very small new taxon compares relatively well to *Bisonalveus* from the North American Tiffanian and *Aphronorus* from the North American Torrejonian. Lower molars differ from *Bisonalveus* in their smaller size, the more developed precingulid on m1-3, the more lingual position on the hypoconulid on m3 and the shorter m3 talonid. The Belgian species shares with other pentacodontids a decreasing size of the molars from m1 to m3 and a relatively low molar crown with rounded outlines. Both characters differentiate the family from the closely related pantolestids whose molars are increasingly larger from m1 to m3 and have sharper crowns. Derived pentacodontids such as *Pentacodon* feature a great size difference between the first, second and third molars, whereas the more primitive *Bisonalveus* displays almost similarly sized molars. The new pentacodontid that we present here has similarly sized molars, but the m3 talonid is slightly shorter than in *Bisonalveus* though not as short as in *Pentacodon*. The presence of a pentacondontid in the European Paleocene offers improving evidence for a faunal interchange between Europe and North America before the Upper Paleocene.

Poster Session II (Thursday, November 3)

SIGNIFICANT NEW MESOZOIC LOCALITIES FOUND DURING A PALEONTOLOGICAL RESOURCE INVENTORY OF BLM WILDERNESS LANDS IN WASHINGTON COUNTY, UTAH

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In 2009, the Omnibus Public Lands Bill was signed into law. In addition to the Paleontological Resource Preservation Act, it included the Washington County Wilderness Bill which designated 129,300 acres of public land administered by the Bureau of Land Management (BLM) as wilderness. As part of the planning process, the BLM funded the Utah Geological Survey (UGS) to conduct a paleontological inventory of these wilderness areas. This provides us with an opportunity for input into critical land-use and management decisions and is the first time that paleontological resources have been included in an initial natural resource inventory for a new public wilderness area.

As a starting point, we created potential fossil yield classification (PFYC) maps for the wilderness areas using data from UGS 1:24,000 and 1:100,000-scale geological maps of the region. These maps were used to prioritize paleontological data collection in the field. Important fossil-bearing strata in these areas include the Chinle, Moenave, and Kayenta Formations and, to a lesser degree, the Navajo Sandstone and Carmel Formation. Based on these geologic units and their proximity to developed areas, the BLM selected the Cottonwood Canyon, Red Mountain, and Canaan Mountain Wilderness Areas for field inventory.

Fieldwork began in the fall of 2010 at Red Mountain and Cottonwood Canyon. Numerous tracksites with tracks attributed to *Grallator*, *Eubrontes*, and *Brasilichnium* were discovered in the Navajo Sandstone along with several tracksites in the Kayenta Formation. In the spring of 2011, we focused our work on Canaan Mountain and made numerous significant discoveries. A spectacular dinosaur tracksite was discovered in the Whitmore Point Member of the Moenave Formation. A number of vertebrate bone-bearing localities were found in the Petrified Forest Member of the Chinle Formation including a bonebed, a possible crocodylomorph skull, and a partial phytosaur skull.

Symposium 1 (Wednesday, November 2, 11:00 am)

THE ORIGIN OF WINGS

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The evolutionary transformation of arms into wings marks one of the most extreme modifications of the tetrapod limb. Flight, in both an aerial and aquatic context, has evolved multiple times within amniotes. Here we discuss necessary morphological adaptations to create a viable wing. The three known cases of aerial flight in vertebrates (birds, bats and pterosaurs) have marked convergences in morphology, physiology and genome size. However, the question arises as to which of these changes are necessary and sufficient for flight and which are later refinements. Although flight dynamics are not identical across the three groups, the physical constraints of flight are. Theropoda present the best transitional series of morphologies that encompass the entire transition to powered flight. We examined the qualitative and quantitative trends in morphology inferred necessary for flight throughout the non-avian to avian phylogenetic history. The early transition period to powered flight is presumed to have passed through a rapid transition between Simpsonian adaptive zones where dramatic morphological changes occurred. We identify phylogenetic zones where rapid rates of morphological change are coupled with the origin of distinct allometric relationships and, in turn, the evolution of a novel pattern of inter- and intra-limb length covariance. Aves has a significantly different allometric relationships than non-avian theropods, with longer forelimbs and shorter hindlimb lengths at a given body size. The relationship between forelimb and humeral length and mass in volant birds was derived from a large extant avian dataset (>640 specimens), to yield minimal wing skeleton length values to compare to non-avian theropods and basal birds. All basal birds, including *Archaeopteryx*, meet this minimal threshold, as do a few small bodied paravians. This integrated approach suggests flight was present minimally at the base of Aves, and possibly even Paraves. By associating these nodes to the origin of powered flight, despite debate on the ecological circumstances of its origin, we can begin to isolate the modifications that are necessary and sufficient to evolve an arm into a wing.

Poster Session II (Thursday, November 3)

CLAVICULAR RING: A NEW METHOD TO ARTICULATE THE PECTORAL GIRDLE IN STEM-SAUROPODOMORPHS

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The correct positioning of the pectoral girdle on the ribcage in dinosaurs is difficult to determine. A horizontal scapula is observed in derived taxa, like birds and higher maniraptorans. However, in others taxa the coracoids are ventrally positioned and the scapular blade is inclined steeper than 45º to the horizontal, as can be seen in sauropodomorphs and even in highly derived ornithischians. Furthermore, it is difficult to determine of the position the pectoral girdle relative to the anteroposterior axis. As was determined in the research project "Digital *Plateosaurus*" this taxon has the anterior edges of the coracoids located below the last two cervicals. Here we present a new method, the "Clavicular Ring", to articulate the pectoral girdle in stem Sauropodomorpha (e.g. *Saturnalia tupiniquim*) using 3D software for a more precise positioning. A 3D model of the pectoral girdle, forelimb, anterior vertebra and ribs of *Saturnalia* was used in this study. The ribs were articulated to the vertebrae according to "Digital *Plateosaurus*". A semicircle was drawn to represent the incompletely preserved border of the coracoid. Then the pectoral girdle was cloned and mirrored and the left and right counterparts were articulated to the ribcage. Based on complete articulated skeletons of other basal dinosaurs such as *Plateosaurus* and *Eoraptor* we could determine that the length of the articulation between the scapula and the coracoid could be used as the diameter of a circle (Clavicular Ring) that contacted, ventrally, the coracoids at the articulation for the clavicles and, dorsally, the ventral surface of the first dorsal vertebra centrum. In *Saturnalia*, after articulating the pectoral girdle using the Clavicular Ring (diameter of 20.36 mm), the main axis of the scapula formed an angle of 60.13 degrees to the horizontal, which corresponds to the inclination proposed for the scapular blade in Sauropodomorpha. Although this reconstruction indicates the Clavicular Ring is valid for *Saturnalia* it is necessary to test it in other taxa to prove this new methodology.

Poster Session IV (Saturday, November 5)

EUROPEAN MONITOR LIZARDS (ANGUIMORPHA, VARANIDAE, *VARANUS*): NEW MATERIALS AND NEW PERSPECTIVES

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Monitor lizards have a wide current distribution embracing Africa, Asia, and Australia, but the fossil record indicates that the genus *Varanus* inhabited Europe at least from the Early Miocene to the Pliocene. The European fossil record is limited to about 35 localities that have provided mostly isolated vertebrae. The following European species have been erected so far: *Varanus atticus* (Late Miocene; Greece); *Varanus deserticolus* (Miocene, Hungary); *Varanus hoffmanni* (Middle to Late Miocene; Austria, France, Germany, Hungary, Spain, Moldova); *Varanus lungui* (Middle Miocene, Moldava); *Varanus marathonensis* (Late Miocene to Pliocene; Greece, Hungary); *Varanus semjonovi* (Late Miocene, Ukraine), and *Varanus tyrasiensis* (Middle Miocene, Moldova). With the exception of *V. marathonensis*, all these species were erected on the basis of isolated vertebrae that do not provide diagnostic criteria—and must be therefore considered *nomina dubia*, potentially being synonyms of other species—, or not even based on *Varanus* remains at all. Conversely, *V. marathonensis* was described on the basis of cranial material whose description is detailed enough to permit the recognition of relevant morphological characters.

Here we report unpublished *Varanus* material recovered from several localities of the late Middle Miocene local stratigraphic series of Abocador de Can Mata (Vallès-Penedès Basin, Catalonia, Spain), that is referable to *V. marathonensis*. Among several fragmentary vertebrae, two maxillae (IPS50119, IPS50292) show a character which has not been detected in the 188 specimens of 35 extant *Varanus* species used for comparison, but which is congruent with the description of *V. marathonensis*: the anterodorsal sloping surface of the facial process is apically wide and concave because it develops a medially directed, broad and slightly concave lamina. This result opens new perspectives in the taxonomy, phylogeny and biogeography of the European monitor lizards: *V. marathonensis* is a valid, diagnosable species,

distributed both in western and eastern Europe; and the purported, still unnamed new species from the Late Miocene of Mytilini (Samos, Greece) should be compared with it.

Poster Session I (Wednesday, November 2)

NEW TAXONOMIC, PALEOBIOGEOGRAPHIC, AND BIOSTRATIGRAPHIC RECORDS OF FOSSIL SALAMANDERS (CAUDATA) FROM THE HELL CREEK AND TULLOCK FORMATIONS OF GARFIELD COUNTY, MONTANA

DEMAR, JR., David, University of Washington, Seattle, WA, USA

A recent investigation of the caudate (salamander) fossil assemblages of the latest Cretaceous and earliest Paleocene (Lancian and Puercan North American Land Mammal "Ages" [NALMA], respectively) of Garfield County, northeastern Montana, resulted in the discovery of new caudate species and paleobiogeographic and/or temporal range extensions of known salamander taxa. Identifications of new Lancian salamanders are based on isolated atlantes and trunk vertebrae from the lower two-thirds of the Hell Creek Formation. Of particular interest is the presence of a single trunk vertebra similar in form to the Late Paleocene (Tiffanian NALMA) *Necturus krausei* (Proteidae) of Saskatchewan, Canada. If the phylogenetic relationships are correct, this specimen would push the known fossil record of proteids back into the latest Cretaceous. In addition to the identifications of new salamander taxa are specimens previously undescribed from a known fossil sirenid, *Habrosaurus prodilatus*. The original description of *H. prodilatus* from the Campanian (Judithian NALMA) Dinosaur Park Formation of Alberta, Canada, was based on isolated premaxillae, dentaries, and an atlas centrum. Here I describe a partial right maxilla (UWBM 93403) and a near complete left vomer (UCMP 556520) of *H. prodilatus* from the Hell Creek Formation and compare it to those of its congener, *H. dilatus*. Furthermore, trunk vertebrae of the fossil amphiumid, *Proamphiuma cretacea*, were discovered from three localities of the Tullock Formation. These specimens represent the first evidence of unequivocal Paleocene-aged *P. cretacea* outside of the temporally-mixed (latest Cretaceous—earliest Paleocene) fossil assemblages of the Bug Creek Anthills of McCone County, Montana. As the fossil record of latest Cretaceous and Early Paleocene lissamphibians improves, a better understanding of their diversity and biostratigraphic ranges will ultimately aid in the interpretation of their evolution, extinction, and recovery, specifically during the Cretaceous-Paleogene mass extinction.

Poster Session I (Wednesday, November 2)

DIETARY RECONSTRUCTION OF MIOCENE APES (PRIMATES: HOMINIDAE) FROM CATALONIA (NE SPAIN) BASED ON DENTAL MICROWEAR

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Diet is one of the most important parameters for understanding primate evolution from an adaptive viewpoint, with significant implications for dental morphology. Together with gross wear, the latter can provide many insights into the diet of extinct organisms. Dental microwear analyses, however, have the potential to reveal more subtle differences in dietary regimes and feeding behaviors (including seasonal changes) among a great variety of fossil species. Here we report microscopic wear patterns for five Middle to Late Miocene hominoid taxa from Catalonia (NE Spain), and explore their significance from a paleodietary viewpoint. The studied remains were recovered from several sites of the Abocador de Can Mata series (ACM; MN7+8; Vallès-Penedès Basin), as well as from Teuleria del Firal (TF; MN9; Seu d`Urgell Basin): *Pierolapithecus catalaunicus*, *Anoiapithecus brevirostris*, *Dryopithecus fontani*, and Hominoidea indet. from ACM; and *Hispanopithecus crusafonti* from TF. Molar occlusal facets were inspected at high magnification using environmental SEM, and microwear scars were recorded and measured. The following four variables were computed: percentage of pits (features with a length/width ratio below 4:1), breadth of scratches (ratio equal to or above 4:1) and pits, and pit length. Our results indicate the consumption of a significant amount of hard items in all the studied taxa except in Hominoidea indet. However, within this general sclerocarpic behaviour, there are clear differences between the microwear patterns (particularly in *Pierolapithecus*, which shows the thickest-enameled condition). These differences suggest that the studied taxa differed to some extent in their food preferences, probably reflecting their adaptation to somewhat diverging dietary niches and/or different types of fallback foods. Hominoidea indet. from ACM differs from the other taxa by a much lower percentage of pits and smaller microwear features, suggesting a greater reliance on ripe fruits. Our results therefore provide new paleoecological insights into the Miocene hominoid radiation, during a key period for understanding the origins of the great ape and human clade.

Poster Session II (Thursday, November 3)

MAMMALIAN ZOOGEOGRAPHY OF THE *HIPPARION* FAUNA DURING THE LATE MIOCENE IN CHINA

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Late Miocene fossil localities containing *Hipparion* faunas are numerous in China, especially in the red clay deposits of northwestern China. In eastern China, they are comparatively infrequent and preserved in fluvial sandstones or lacustrine marlites. The distribution of Neogene mammals indicates that the faunas of eastern and western China were obviously differentiated during the early and middle Miocene, while evidence for this differentiation is scarce for the late Miocene. Differences between eastern and western China before the middle Miocene are easily recognized because they have extremely different ecosystems, i.e., dense forests and open grasslands, respectively. Since the late Miocene, on the other hand, the dense eastern forests have become sparse woodlands that have more similarities to the open grasslands in the west, and thus the two are not easily distinguished. However, the known faunal components and sedimentary features of the late Miocene indicate the exinstence of a boundary between the eastern and western regions of North China, and zoogeographical subregions can be recognized. The south sector of this boundary is situated between Xin'an and Xinxiang in Henan, the middle sector is between Baode and Yushe in Shanxi, and the north extension is determined to situate between Siziwang and Sonid in Inner Mongolia. During the late Miocene, the east region of this boundary was humid forest grassland, persisting since the early Miocene, while the west region was a dry open steppe that had changed dramatically since the middle Miocene, being strongly affected by the Tibetan Plateau uplift. This boundary shows that the present Chinese zoogeographical distribution had been established since the Miocene. Based on faunal components, *Chilotherium* flourished in the western ecosystem of this zoogeographical division during the late Miocene, and it became extremely dominant in the community. The second largest group was various grassland hyenas. They composed a particular endemic fauna in China. In the faunas to the east of this boundary, *Chilotherium* was very rare, while *Hipparion* was dominant.

Poster Session III (Friday, November 4)

MAMMALIAN NICHE CONSERVATION THROUGH DEEP TIME

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Climate change is currently altering the distribution of species, causing plants and animals to move north or to higher elevations with current warming trends. Bioclimatic models predict the distribution of species based on extant realized niches and often assume that ecological niches are maintained over long time scales. Recent work has demonstrated that niche conservatism operates above the species level during the Quaternary. Here, we build upon this work by evaluating if niches are conserved at the family level through deep time, from the Eocene to the Pleistocene. We analyzed the occurrence of all mammalian families (with >3 occurrences in the Paleobiology Database) in the continental USA, calculating range area, range area rank, and range polygon centroids during each respective epoch. Range areas generally increase from the Eocene to the Miocene, decrease from the Miocene to the Pliocene, and increase from the Pliocene to Pleistocene, while range area ranks are largely conserved. Furthermore, centroids demonstrate a southeastern shift from the Eocene through the Pleistocene. These changes may correspond to major environmental events and/or climate changes such as the Miocene grassland expansion and cooling since the mid-Miocene climatic optimum. High statistical concordance between rank orders across time demonstrates that niches are conserved at the family level and further supports the idea that niche conservation at higher taxonomic levels is controlled by life history traits. Furthermore, families containing megafauna and/or terminal Pleistocene extinction victims did not incur significantly greater declines in range area rank changes then families containing only smaller taxa and/or only survivors, from the Pliocene to Pleistocene. Similarly, the time depth of a family does not affect range area rank changes. These results demonstrate the resilience of families to climate and/or environmental change in deep time, the absence of terminal Pleistocene "extinction prone" families, and the subsequent importance of conserving biodiversity at higher taxonomic levels to allow for greater flexibility to maintain existing niches.

E&O Poster Session

VERTEBRATE PALEONTOLOGY AS THE CORNERSTONE OF A FIRST-YEAR COLLEGE SEMINAR

DEWAR, Eric, Suffolk University, Boston, MA, USA; MACELI, Ashley, Suffolk University, Boston, MA, USA; PIETRANTONIO, Heather, Suffolk University, Boston, MA, USA

Many colleges and universities require incoming students to complete a first-year seminar to introduce them to the rigors of college-level work. At Suffolk University, the seminars are reading- and writing-intensive courses centered around topics chosen by faculty. Last year a new freshman seminar entitled "Vertebrate Fossils and Evolution" was developed with vertebrate paleontology as its organizing theme. Of the 20 students who chose this seminar, only six were biology majors—the rest came from across the curriculum. Given a wide range of experience in science and little familiarity with the fossil record of vertebrates, the most important goal of the seminar was for the students to learn to construct knowledge and critique scientific arguments, in this case focused on the paleobiology and evolution of vertebrates.

We attempted to reach this goal with a mix of lectures, discussions, field trips, and small-group projects. To get started with a diverse group, we needed to show how the scientific process works as applied to fossils. Foundational lectures about paleontological methods, taphonomy, and the relationships of the major taxa early in the semester gave way to readings from the primary literature about terrestrialization, the biomechanics of locomotion, and the mammalian radiations, among other topics.

Students practiced the construction of knowledge and making scientific arguments by observing exhibits of vertebrate fossils at local museums. For example, they learned to find and score dozens of morphological characters, and then try to see if they could find effective synapomorphies themselves. Working with fossils themselves was much more effective than lectures for the students to learn both the taxa and the pitfalls of constructing their own

phylogenies. Letting them measure fossil trackways to reconstruct locomotion was better than reading about it. Getting off campus as a group helped to bond them to each other socially and as collaborators. Formal lab reports were less important than demonstrating clear thinking in writing. This problems-based approach was effective to model scientific thinking for non-scientists and entering science majors alike.

Technical Session XII (Friday, November 4, 1:45 pm)

FROM EXTANT TO EXTINCT: EMPIRICAL STUDIES OF TRANSITIONAL FORMS AND ALLOMETRIC CORRELATES DELIMIT BOUNDARIES OF FUNCTIONAL CAPACITY

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Applying scientific rigor to hypotheses that ascribe functional capacity to historical forms is perpetually challenging. Only straightforward empirical evaluations of extant form-function patterns can limit the imaginative speculation regarding the functional capacity of fossil forms. Comparative functional anatomy is experiencing a revolution due to emerging technologies (e.g., dynamic internal and external 3-D imaging, micro- and macro-biomechanical recording equipment, computer modeling based on experimentally-derived data). These techniques allow us to clarify extant form-function relationships relevant to historical forms. Our work on the ontogeny and allometric correlates of avian locomotor performance may thus elucidate aspects of historical functional capacity.

Living birds commonly engage forelimbs and hindlimbs simultaneously to negotiate terrestrial obstacles and vertical substrates, even if they posses only an incipient flight apparatus. Such wing assisted incline running (WAIR) and controlled flapping descent in pre-flight developing birds are observable examples of locomotor function with clear incremental adaptive stages based on juvenile forms. Here I present an expansive and comparative study to document the adaptive benefits of incipient aerodynamic structures, skeletons, muscles, and nervous systems. I review behavioral and experimental data to include: 1. ontogeny of maximum locomotor performance, 2. fluid visualization using particle image velocimetry, 3. propeller experiments on prepared wings to directly measure aerodynamic forces, 4. 3-D skeletal kinematics (XROMM), 5. neuromuscular control and power output of the primary flapping muscle (pectoralis), 6. ground reaction forces of hindlimbs during inclined flap-running, 7. the negative allometry of maximum performance in adult birds and developing brush turkeys, and 8. the phylogenetic ubiquity (and probable plesiomorphic status) of WAIR. Comparative phylogenetic and experimental studies of extant forms that integrate behavioral, ontogenetic, and allometric measures are likely to delimit functional boundaries incorporated in hypotheses addressing the evolution of historical forms.

Poster Session II (Thursday, November 3)

NEW DATA ON THE LATE CRETACEOUS CARDABIODONTID SHARK BASED ON AN ASSOCIATED SPECIMEN FROM KANSAS, USA

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Cardabiodontids are large extinct lamniform sharks that lived during the Late Cretaceous, but much of their biology remains poorly understood. Here, we describe a specimen *Cardabiodon* Siverson from Kansas, USA that represents the first associated cardabiodontid material from North America. The specimen, FHSM VP-425 housed in the Sternberg Museum of Natural History in Hays, Kansas, consists of a set of teeth, pieces of calcified cartilage, and placoid scales. The combination of direct observation and radiographic (computed tomography) examination reveals that the specimen contains at least 53 teeth, including functional and replacement teeth. The teeth vary in size and morphology, suggesting that the dentition of the shark showed heterodonty. The total number of represented tooth rows in FHSM VP-425 is small and thus accurate dental reconstruction is difficult. However, the tooth set includes relatively large teeth with a crown tip that is highly curved distally, likely representing the 'upper intermediate teeth' that concomitantly support the previously proposed contention that the shark had a lamnoid tooth pattern. The tallest teeth are represented by erect anterior teeth with 20 mm in crown height. If one compares this tallest crown height in this *Cardabiodon* specimen to that of another Cretaceous lamniform, *Cretoxyrhina mantelli* (Agassiz), this *Cardabiodon* individual is estimated to have measured about 2.5 m in total length. The fragments of preserved calcified cartilage are tabular and consist of fused calcified cartilage prisms, likely representing pieces of the lower jaws. The placoid scales range from 0.3 mm to 0.7 mm in maximum dimension where each of them consists of a teardrop-shaped enameloid crown and a laterally extended root generally with one nutritive foramen at its base. The external crown surface of each scale shows 6-8 parallel grooves with keels that are very similar to scales of *Cretoxyrhina mantelli*. The grooved scales indicate that, like *Cretoxyrhina mantelli*, *Cardabiodon* was capable of fast swimming that may indicate that the shark was able to actively pursue lively prey.

Poster Session II (Thursday, November 3)

VARIATION IN THE CAUDAL VERTEBRAE OF THE EUROPEAN TITANOSAUR (DINOSAURIA, SAUROPODA) *LIRAINOSAURUS ASTIBIAE*

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Titanosaurian caudal vertebrae have strongly procoelous centra, especially the anterior ones. In derived titanosaurs, such as lithostrotians, this procoely extends into the middle caudal region. Exceptions are *Opisthocoelicaudia skarzynskii*, in which the caudal vertebrae of the anterior half of the tail are opisthocoelous, and *Andesaurus delgadoi*, in which the caudal vertebrae are amphiplatyan (except the very anteriormost ones, which are very mildly procoelus). Variation in caudal centra morphology has been described for some derived titanosaurs of North America (*Alamosaurus sanjuanensis*) and South America (e.g., *Rinconsaurus caudamirus, Rocasaurus muniozi* and *Saltasaurus loricatus*). These taxa are characterized by a progressive dorsoventral compression of the caudal series, beginning with the middle caudal centra in some of the taxa, and with the posterior caudal vertebrae displaying the highest degree of dorsoventral compression. In Europe, *Lirainosaurus astibiae* from the Late Cretaceous (Campanian-Maastrichtian) of Spain, also shows variation in the structure of the caudal vertebrae. The material of *L. astibiae* recovered from the Laño locality consists of forty-two caudal vertebrae (including the holotype, seven paratypes and thirty-eight referred specimens) from several individuals; the vertebrae are disarticulated but some of them were found as associated elements. *L. astibiae* was originally diagnosed by several features of the caudal vertebrae. A recent study of the material shows that the anterior caudal vertebrae of *Lirainosaurus* are procoelous, with centra that are slightly longer than high or wide, and are slightly compressed laterally. The neural arches are located anteriorly and the neural spines are directed posterodorsally. The length of the middle and posterior caudal centra (which lack transverse processes) is twice the height and width, and the middle caudal vertebrae have highly dorsoventrally compressed centra, whereas the distal ones are spool-shaped. This is the first time that a morphological variation in a caudal series is noticed and described in detail for a known European titanosaur taxon.

Poster Session IV (Saturday, November 5)

EVALUATION OF PLIOCENE FOSSIL RABBIT PHYLOGENY (GENUS: *HYPOLAGUS*) USING EIGENSHAPE ANALYSIS

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Hypolagus is the most diverse and widespread of the fossil rabbit genera making up the subfamily Archaeolaginae (Leporidae, Lagomorpha), ranging from the Middle-Miocene to the Late-Pliocene. Traditionally, the taxonomy of *Hypolagus* has been based primarily on tooth size as well as qualitative characteristics such as linear and angular measurements of reentrants on the occlusal surface of the lower third premolar (p3). A challenge with using these features to identify new specimens is that morphological variation overlaps between species. Also, this approach ignores the overall shape of the tooth which may be phylogenetically significant. Here we use eigenshape analysis of the lower p3 to determine whether the shape of the occlusal surface agrees with the proposed pattern of phylogenetic intra-relationships for North American *Hypolagus*. A cluster analysis using Ward's method was performed on eigenvalues resulting from eigenshape analysis of the North American species. Preliminary results recovered two groups with *Pewelagus? mexicanus* as the outgroup. *Hypolagus regalis*, *H. arizonensis*, and *H. ringoldensis* form a group separate from a second group containing *H. vetus, H. furlongi, H. gidleyi, H. edensis, H. tedfordi, H. fontinalis, H. limnetus, H. oregonensis, H. parviplicatus*, and *H. voorhiesi*. The second group contains most of the species of the traditionally recognized "Vetus" group. This group was characterized by a triangular shaped lower p3 with a point on the posterior mesial portion of the tooth and a shallow, posteriorly deflected, posteroexternal reentrant. The "Regalis" and the "Oregonensis" groups, as defined in the literature, were not recovered. The results show that morphological variation in occlusal shape of the lower p3 extends beyond the reentrants present on its labial surface. In particular, the shape of the mesial surface varies from rounded to pointed, and may be a factor driving the observed clustering. Eigenshape analysis of the occlusal surface of the lower p3 may provide new insight for investigating the origin and evolution of dental characters in this group over time.

Poster Session III (Friday, November 4)

ENVIRONMENTAL RECORDS OF BED I, OLDUVAI, TANZANIA FROM STABLE ISOTOPES OF MAMMALIAN TOOTH ENAMEL

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Carbon and oxygen stable isotopic analyses of tooth enamel carbonate from a variety of mammal taxa including *Antidorcas recki*, *Kobus sigmoidalis, Kolpochoerus heseloni* and *Elephas recki* show changes in environments between various sites within Bed I Olduvai. The δ18O data show a general trend towards more positive values through time, which is interpreted as a progressive drying trend. The δ13C results for individual taxa also show a general trend towards less 13C-depleted values through time. This is particularly marked in

A. recki where this gradual increase in δ13C composition through time suggests an increase in the amount of dietary C4 grass verses C3 browse. This isotopic data set matches well with the floral record from Bed I and provides further evidence that hominins and other fauna at Olduvai were subject to fluctuating environmental conditions during the earliest Pleistocene.

Poster Session III (Friday, November 4)

THE ISOTOPIC ECOLOGY OF MIDDLE MIOCENE HERBIVORES FROM THE MADRID BASIN (SPAIN)

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The Middle Miocene was a period of profound worldwide paleoclimatic change. The Miocene Climatic Optimum (MCO; ~17 to 14 Ma), characterized by warm conditions, was followed by a sudden drop in temperatures and an increase in aridity. This Middle Miocene Cooling (MMC; 14-13.8 Ma) event was related to the reestablishment of the Eastern Antarctica ice cap. These global climate episodes have been mainly studied in the marine record, but terrestrial studies have proved to add valuable information. The Madrid Basin (Spain) has provided a sequence of mammalian fossil sites that spans the Middle Miocene. Analysis of the δ13C, δ18OCO3 and δ18OPO4 values of mammalian tooth enamel have been performed on different herbivore genera from 16 fossil sites ranking in age from ~15.9 Ma to ~13.2 Ma (Middle and Upper Aragonian, MN5 and MN6, local zones Db to G). The δ13C results show differences in the ecological niches occupied by the taxa with the equid *Anchitherium*, the rhino *Hispanotherium matritense* and the bovid *Tethytragus langai* inhabiting more open environments, whereas the rhinos *Alicornops simorrense* and *Hoploaceratherium tetradactylum*, the gomphothere *Gomphotherium angustidens*, the cervid *Heteroprox moralesi* and the paleomerycid *Triceromeryx pachecoi* were inhabiting slightly more closed habitats. A δ13C trend spanning the local zones suggests a slight increase in humidity in local zone Dd (~14.8-14.1 Ma). The most notable feature of the δ18OCO3 and δ18OPO4 results is a decrease in the local zone E (~14.1-13.7 Ma), which is linked to a drop in the δ18O value of local water (and possibly air temperature) coinciding with the timing of the MMC event. In spite of this paleoclimatic change, no turnover on mammalian faunal assemblage has been detected in local zone E. Thus, the MMC event has been recorded for the first time by using stable isotope analyses on mammal tooth enamel from a terrestrial sequence highlighting the importance of exploring terrestrial records to build a more complete global picture of past climatic events.

Poster Session II (Thursday, November 3)

DIET OF THREE MIOCENE HYPERCARNIVORES FROM THE MADRID BASIN (SPAIN) BASED ON CARBON-ISOTOPE COMPOSITION OF TOOTH ENAMEL

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Stable-isotope analyses are rarely performed on extinct carnivorans due to the scarcity of their remains in fossil sites and their high value in systematics studies. Thus, ancient predator-prey systems remain understudied at least from the perspective of isotope geochemistry and this fact is more evident the deeper we go in time. Abundant and diverse mammalian remains of Vallesian age (Late Miocene, ca 9 Ma) occur in the fossil sites of Cerro de los Batallones (Madrid Basin, Spain). We conducted C and O stable-isotope analyses in fossil enamel from mammalian herbivores (Rhinocerotidae, Equidae, Giraffidae, Gomphotheriidae, and Suidae) and also from three hypercarnivores: the saber-toothed cats *Promegantereon ogygia* and *Machairodus aphanistus* and the amphicyonid *Magericyon anceps*. Preliminary results of the δ13C values are presented here and potential predator-prey relationships are inferred. Herbivore tooth enamel displays δ13C values indicative of a diet based on C3 plants from open woodland; there are no statistically significant differences among the δ13C values of the herbivores. The two saber-toothed cats are indistinguishable in terms of their δ13C values whereas both show statistically significant differences from *Magericyon anceps*. δ13C values of the carnivore enamel were adjusted by +1.3‰ to account for trophic-level isotopic fractionation and compared to herbivore values. ANOVA of δ13C values shows no significant differences so the three carnivores could have potentially preyed or fed upon any of the herbivores sampled. This inference does not imply that all the herbivores were equally probable prey because size constraints must be taken into account. Differences in the δ13C values between the saber-toothed cats and the amphicyonid result from more positive values of *Magericyon anceps*, implying that *Magericyon* utilized some prey (probably not measured in this study) from more open habitat.

Poster Session I (Wednesday, November 2)

FOOD SELECTION IN JURASSIC SALAMANDERS FROM INNER MONGOLIA, CHINA

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Conchostracans and corixids have been reported as the food of extant salamanders, all of which constitute an ecologically important part of lacustrine environments. The stomach contents, conchostracans and corixids were found in the guts of *Jeholotriton paradoxus* and *Chunerpeton tianyiensis* discovered at the Jurassic Daohugou locality, Ningcheng County, Inner Mongolia, China. This discovery provides real evidence supporting hypotheses about the ecology of vertebrate and invertebrate assemblages dating back to the Jurassic. It also provides fossil evidence that these Jurassic salamanders exercised prey selection; *Jeholotriton* preying only on juveniles of the conchostracan *Euestheria luanpingensis*, and *Chunerpeton* only on the corixid *Yanliaocorixa chinensis*. This supports inferences about dietary differences and thus niche partitioning in Jurassic salamanders based on structural differences in the jaw and hyoid elements.

Poster Session III (Friday, November 4)

CHARACTERISTICS OF THE CARMEL CHURCH BONEBED, A MARINE VERTEBRATE DEPOSIT FROM THE MIOCENE OF VIRGINIA

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The Carmel Church Quarry, located near the western edge of the Atlantic Coastal Plain in Caroline County, Virginia, exposes several formations of Paleocene to Miocene sediments. One of these units is Bed 15 of the Calvert Formation, which is approximately 1 meter thick at the site and contains an extremely dense bonebed of Miocene vertebrates in a gravel-to-cobble conglomerate. While the bonebed contains some amount of reworked material, the bonebed differs in numerous respects from other marine bonebeds such as Sharktooth Hill. The unusual features at Carmel Church include: a high percentage of articulated or associated cetacean remains (over 20% of all cetacean vertebrae), an abundance of microfossils, abundant evidence of scavenging by sharks, intermixture of delicate vertebrate elements with large rounded cobbles, abundance of lignite, immature and lithically diverse sediment that includes both angular and rounded grains that are generally normally graded, and shark teeth and other elements not preferentially preserved in a hydrodynamically stable orientation. The variety of signals preserved at Carmel Church suggests two different preservational events superimposed in a single bed. Material that is clearly reworked, which makes up approximately 50% of the shark teeth and <10% of the bones, seems to represent a transgressive lag that includes Eocene, Oligocene, and early Miocene material. The remainder of the material, making up almost all of the bone and approximately half of the shark teeth, seems to represent an unusual, possibly rapid depositional event. Mild to moderate abrasion of many bones and the presence of fairly common terrestrial animals suggests that there is some amount of time averaging involved, but the abundance of associated remains (including among the terrestrial remains), the lack of a preferred orientation among the shark teeth, and the abundance of diatoms suggest that winnowing did not play a significant role in forming the bonebed. The conglomerate and the bonebed appear to have been deposited simultaneously and may represent a relatively short-duration event.

E&O Poster Session

A LIVING LABORATORY APPROACH TO TEACHING STUDENTS ABOUT THE SCIENTIFIC METHOD AND EVOLUTION: CRAFTING A CURRICULUM THAT ALLOWS STUDENTS TO GENERATE THEIR OWN EVIDENCE AND FORMULATE THEIR OWN CONCLUSIONS ABOUT EVOLUTIONARY PROCESSES

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A non-traditional approach to teaching students at the baccalaureate level about fundamental concepts that form the foundation of evolutionary biology was undertaken as part of an elective course that services both biology majors and non-science majors. This approach was conceived as part of an outreach program to middle school girls to teach evolution and the scientific method. The approach was so successful that it was incorporated into a college setting. The traditional teaching paradigm of using lectures and/or laboratory exercises was not employed but rather a discovery-based and team-taught approach where faculty served as facilitators and mentors in guiding students in the development, administration, and interpretation of a series of semester-long research projects designed by students in teams. Each project was intended to investigate topics inclusive of the course outline. Weekly sessions with faculty were used for discussion of assigned readings for the topic of the week and for designing an investigation for that topic that would then be carried on independently by students throughout the semester. Projects involved active laboratory investigations that were intended to generate raw data that then was analyzed and from which conclusions were drawn. Even non-science students were expected to subject their data to statistical hypothesis testing – including employing multivariate statistical techniques using statistical software. Students were required to produce and defend scientific posters and also mock scientific journal manuscripts on a project of their choice. This methodology for teaching students about evolution proved to be a very powerful tool for enabling students to see in real time processes such as mutagenesis and selection for certain traits and provided a living laboratory for actively exploring these concepts. Student responses were overwhelmingly positive

to this approach and show a true investment by these students in the power of the scientific method as a process for the systematic study of the natural world through observation and experimentation.

Poster Session III (Friday, November 4)

DIAGENETIC ALTERATION AND COLORATION BANDING IN SPHEROOLITHID EGGS FROM THE TIANTAI BASIN, CHINA

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The mid-Cretaceous rocks of the Tiantai Basin, Zhejiang Province, China yield abundant fossil egg material representing several ootaxa, including more than 100 specimens attributable to the oogenus *Spheroolithus.* These eggs are prolate spheroid in shape, demonstrate variable shell thickness, and are usually preserved vertically compressed. The eggshells exhibit three or more varying patterns of horizontal shell coloration banding when viewed in radial section. Using petrographic light microscopy, cathodoluminescence (CL) and scanning electron microscopy (SEM), two specimens were examined to determine the extent to which diagenetic alteration influences the range of shell coloration. These analyses reveal moderately well-preserved microstructures including shell units, radiating spherulites, accretion lines, and obliquely oriented pores in-filled with secondary calcite. Thin-sectioning and SEM images reveal evidence of significant microstructural alteration to the upper 1/3 of the eggshell, a region that fluoresces bright orange under CL, indicating the presence of manganese. Spherulitic structures are visible within the lower 2/3 of the eggshell, a region dampened under CL, and iron oxide staining is evident in the mammillary cones and the lowermost 1/3 of the eggshell. In spite of the visible differences, SEM spot analysis indicates little or no chemical variation within the coloration bands. Initial investigations suggests that this coloration banding is the result of alteration to the physical structure and chemical composition of the eggshell and may primarily be the result of variable concentrations of heavy metals on the scale of part per million. Understanding these characteristics will help distinguish biological and digenetic features within these and other fossil eggs and aid in determining the nature and timing behind the fossilization of eggs in the Tiantai Basin.

Technical Session IX (Friday, November 4, 8:00 am)

AN EXCEPTIONAL NEW ICHTHYOSAUR FROM THE UPPER JURASSIC AGARDHFJELLET FORMATION (VOLGIAN), SVALBARD, NORWAY

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Ophthalmosaurid ichthyosaurs (Ichthyosauria: Ophthalmosauridae) were one of the dominant clades of secondarily aquatic marine vertebrates during late Mesozoic. Although geologically long-lived (Middle Jurassic to early Late Cretaceous) and cosmopolitan in their distribution, the overall diversity and relationships of the clade remain very poorly understood. Fieldwork conducted between 2004 and 2010 in the arctic archipelago of Svalbard, Norway has resulted in the discovery of several new specimens of Late Jurassic ichthyosaurs. In 2009, an exceptionally complete and nearly articulated skeleton of an ophthalmosaurid ichthyosaur was recovered in the Sassenfjorden area, on the island of Spitsbergen. The specimen was recovered from the Slottsmøya Member of the Agardhfjellet Formation, a 75 meter-thick unit of dark grey to black silty mudstone deposited in low oxygen, shallow marine settings on the Barents shelf. Molluscan and foraminferal biostratigraphy indicates a Volgian age for the unit, close to the Jurassic-Cretaceous boundary.

The well preserved specimen measures 4.5 meters in length and includes the entire skull, much of the axial column, the pectoral and pelvic girdles and a well preserved fore- and hindlimb. The Svalbard specimen represents one of the most complete and articulated ophthalmosaurid skeletons discovered to date and is significant in several regards. First, a comparative analysis of the skull and forefin to other ophthalmosaurids indicates the specimen represents a new taxon that most closely resembles *Undorosaurus*, a poorly known Russian genus. Secondly, it provides important new anatomical data for ongoing studies of ophthalmosaurid phylogeny, which is poorly resolved. Additionally, the well articulated pelvic girdle and hindlimb provide unequivocal new data regarding the orientation of the ophthalmosaurid femur. Finally, the specimen represents an important new data point to our rapidly growing knowledge of ichthyosaurian diversity and evolution at high paleolatitudes preserved in the Slottsmøya Lagerstätte.

Symposium 3 (Thursday, November 3, 10:30 am)

DIRECT EVIDENCE OF CROCODYLIFORM PREDATION ON SMALL DINOSAURIANS FROM THE KAIPAROWITS FORMATION OF UTAH

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Crocodyliforms are important taphonomic agents, capable of both accumulating and modifying vertebrate remains. Previous discussions of Mesozoic crocodyliform predation in terrestrial and riverine ecosystems have often focused on the largest members of the clade, and especially on their interactions with equally large dinosaurian prey. However, recent evidence suggests that the impact of smaller crocodyliforms on their environments should not be discounted. Here we present direct evidence of predation by a small crocodyliform on juvenile specimens of a basal ornithopod dinosaur from the Upper Cretaceous (Campanian) Kaiparowits Formation of southern Utah. Bite marks were identified on a left scapula and a right femur referred to this taxon. Two pits are present on the proximal portion of the scapula, one of which displays a prominent bisection. The femur exhibits two pits and a puncture, with a partial tooth crown embedded in the latter. Computed tomography (CT) scans of the puncture reveal impact damage to the surrounding bone and that the distal tip of the tooth was missing prior to the biting event. Between the morphology of the embedded tooth (ovoid in cross-section) and the presence of the bisected pit (diagnostic of crocodyliforms) these bite marks are confidently identified as crocodyliform in origin. While crocodyliforms continuously shed teeth throughout their lives, often during the act of feeding, this is the first incidence of a tooth from a member of this clade being found embedded directly into prey bone. These bite marks provide insight into the trophic interactions of the ecosystem preserved in the Kaiparowits Formation. The high diversity of crocodyliforms within this formation would have led to accentuated niche partitioning and intense competition for resources. Additionally, the presence of abundant dinosaurian eggshell fragments from a variety of taxa indicates close proximity to a nesting ground that would have provided regular influxes of small prey items into the ecosystem. This dynamic provided the ideal condition for the deposition and preservation of evidence of crocodyliform predation on young dinosaurs.

Poster Session II (Thursday, November 3)

LANDSCAPE NEOTAPHONOMY AND EAST AFRICAN CARNIVORE GUILD STRUCTURE: MODELING HOMININ SCAVENGING OPPORTUNITIES

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Landscape-scale bone assemblage structure and the amount of carcass resources available for hominin consumption are determined in part by population densities of carnivores relative to those of their prey and by carnivore guild structure. Because of hyenid bone-cracking adaptations, their population density compared to that of other carnivores such as meat-slicing large felids has a significant impact on what animal resources remain on the landscape after the initial predation event. Based on observations in Serengeti National Park/Ngorongoro Conservation Area (Tanzania) ecosystem, it is argued that among different habitats, those with large numbers of hyenas, particularly spotted hyenas (*Crocuta crocuta*), will present fewer scavenging opportunities for hominins. Neotaphonomic surveys in Amboseli National Park (Kenya) ecosystem document the effects of changing spotted hyena densities over time on bone survival and carcass fragmentation. In this study, we compare data on carcass fragmentation and bone destruction from Serengeti/Ngorongoro study with long-term data from Amboseli and new data from Shompole Conservation Area in southern Kenya. We test the generality of the relationship between spotted hyena density and carcass fragmentation across different habitats and through time. In environments with the highest spotted hyena density, we find the lowest skeletal element evenness (an index of carcass completeness), depressed axial skeletal element frequencies, and increased deletion of long bone epiphyses. Based on our observations in modern ecosystems, it is clear that past hominin scavenging opportunities must be considered in the context of dynamic ecosystems in which the abundance of bone-cracking carnivores can change over time and across habitat boundaries. Past scavenging opportunities would be expected to increase in times and places where bone-cracking members of the carnivore guild were relatively rare, suggesting that the abundance and paleolandscape distribution patterns of associated stone artifacts and hominin-modified vertebrate remains could reflect varying Plio-Pleistocene carnivore guild structures.

Technical Session XIV (Saturday, November 5, 8:45 am)

THEROPODS IN MORPHOSPACE: A GEOMETRIC MORPHOMETRIC APPROACH TO VARIATION AND DIVERSITY IN THEROPOD CRANIOFACIAL MORPHOLOGY

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Theropods present an excellent opportunity to study morphological variation over long timescales. Originating as small, morphologically conservative forms in the Late Triassic, by the end of the Mesozoic, theropods had diversified into a wide range of sizes, shapes, and ecological niches. The extent and pattern of morphospace occupation provides insight into factors that contributed to different morphologies, as well as trends and timing of diversification events. We examine the tempo and mode of theropod cranial evolution using discrete and continuous data, comparing the evolutionary rates of discrete characters to those within geometric morphometric space. The discrete character data was compiled from recent phylogenetic analyses, and the continuous data was produced by a principle component analysis on 2D Procrustes shape variables collected from the skulls of over 60 non-avian and early Aves taxa. Changes in morphological diversity through time were evaluated using multiple measures of disparity and compared to simulated data using Brownian motion models in discrete, continuous, and Procrustes character spaces. Allometric scaling plays a limited role in explaining interspecies variation, while skull morphology is significantly related to both phylogeny and diet. The skull shapes of different taxonomic groups partition into functional niches corresponding to bite biomechanics. The simulated data provides a null hypothesis to test for changes in size, shape, and disparity of morphospace occupation. Real and simulated

data show similar patterns of occupation in the Triassic and Jurassic, but significantly different patterns in the Cretaceous. Real data occupies a region of morphospace outside of that predicted by Brownian motion, corresponding to skulls with antero-posteriorly compressed antorbital regions, such as those of oviraptorids. Contrastingly, simulated data predict the existence of skulls with extreme dorso-ventral compression and expansion of the antorbital region, a shape not observed in real skulls, including spinosaurids. We present a novel method to discuss evolutionary rates of shape change against a neutral model of evolution.

Technical Session XI (Friday, November 4, 2:15 pm)

CRYSTALLOGRAPHIC INVESTIGATIONS OF A GROWTH SERIES OF *APATOSAURUS* LONG BONES: IMPLICATIONS FOR BIOMECHANICS

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Extinct sauropods and mammals have fast bone growth as evidenced in both groups by fibrolamellar bone. This convergent trait is hypothesized to be related to the biomechanics of the bone. Because bone crystallography can provide insights into biomechanics, we examined principal crystallographic orientation and apatite crystal size in an ontogenetic series of long bone cortices of the sauropod *Apatosaurus sp.* These samples were compared with recent and subfossil mammal bones, with the use of X-Ray diffraction and transmission electron microscopy (TEM).

Crystallographic texture investigations describe the degree of preferential orientation of apatite crystals during different growth stages of the sauropod. Similar to recent animals, our TEM results for *Apatosaurus* revealed distinctly different crystallographic orientations between primary and secondary bone as well as intermediate structures in secondary osteonal bone. Our X-Ray diffraction results indicate that an initial 001 crystallographic fibre texture aligned to the direction of the bone axis is maintained during all stages of ontogeny, even with progressive bone remodeling. This type of texture seems to be the most efficient pattern for resisting high compressive loads. The texture index in *Apatosaurus* was higher than in recent animals with the exception of the elephant, which had an equivalent index. Our result suggests that texture strength correlates with the weight of the animal.

Crystal sizes were determined using both techniques as well. Apatite crystals in fossil bone are larger than in recent and subfossil mammal bone, which is usually interpreted as a diagenetic effect. Although crystal size does not necessarily increase through sauropod ontogeny, a young *Apatasaurus* sample has a much wider crystal size distribution compared to the femora of an adult individual from the same locality. This suggests a relationship between crystal size distribution and ontogenetic age rather than a diagenetic effect. Apatite crystals in woven primary bone are smaller and have a higher aspect ratio (ratio between longer and shorter crystal dimension) than crystals in mature lamellar bone.

Poster Session IV (Saturday, November 5)

FAIRMEAD LANDFILL, A DIVERSE MIDDLE IRVINGTONIAN BIOTA IN CALIFORNIA'S CENTRAL SAN JOAQUIN VALLEY

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While there are several dozen Irvingtonian localities in North America, few sites fall within the 0.78 Ma to 0.55 Ma range, the age of Fairmead Landfill. Located along State Route 99 ten miles north of Madera, California on the Chowchilla River alluvial fan, Fairmead Landfill has produced thousands of specimens since the discovery of fossils there in May 1993. The site preserves a middle Irvingtonian biota consisting of 57 taxa (27 mammals, 5 birds, 3 reptiles, 2 amphibians, 1 fish, 1 bivalve, 1 gastropod, 1 plant macrofossil, 16 diatoms). Fossils occur in sediments representing distal alluvial fan channel, distal fan overbank flood or sheetflood, and marsh/lacustrine deposits of the upper unit of the Turlock Lake Formation. Fossils have been collected from a geographic area of over 40 acres and stratigraphically from depths of 4 m to 20+ m below ground surface. The vertebrate fauna includes: *Archoplites interruptus*, Caudata, Anura, *Clemmys marmorata*, *Xerobates agassizi*, Colubridae, *Athene cunicularia*, *Branta canadensis*, *Tadorna tadorna*, cf. *Aythya* sp., *Zenaida macroura*, *Sorex* sp., *Paramylodon harlani*, *Nothrotheriops shastensis*, *Megalonyx wheatleyi*, *Canis latrans*, *Canis dirus*, *Vulpes velox*, *Homotherium* sp., *Smilodon* sp., *Miracinonyx* sp., *Taxidea taxus*, *Arctodus* sp., *Spermophilus* sp., *Neotoma* sp., *Peromyscus* sp., *Microtus* sp., *Thomomys* sp., cf. *Dipodomys* sp., *Lepus* sp., *Mammuthus columbi*, *Equus* sp., *Camelops* sp., *Hemiauchenia* sp., *Tetrameryx irvingtonensis*, *Capromeryx* sp., *Odocoileus* sp., and *Platygonus vetus*. The fauna is dominated by large herbivorous mammals, particularly open-country grazers and mixed feeders such as *Equus*, *Camelops*, *Mammuthus columbi* and *Paramylodon harlani*. Evolutionarily many Fairmead Landfill taxa exhibit morphological, size and proportional characters that suggest they represent transitional populations between older and younger members of their respective lineages. Overall, Fairmead Landfill represents an age not well documented in the terrestrial vertebrate record of North America and helps to fill the gap in knowledge about the middle Irvingtonian.

Poster Session I (Wednesday, November 2)

LIFE HISTORY JUST ISN'T HIP: HUMAN EVOLUTION WITHOUT AN 'OBSTETRIC DILEMMA'

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Since the 1950s, the obstetrical dilemma hypothesis (OD) has dominated evolutionary reconstructions of human reproductive biology, locomotion, life history, and sociality. The OD holds that antagonistic selection for a large neonatal brain and a narrow, bipedal-adapted birth canal poses a problem for childbirth; the hominin solution is to truncate gestation, resulting in the birth of an underdeveloped, relatively altricial neonate.

However, the OD does not stand up to testing with current data: (1) We found no support for the assumption that a wider human pelvis is detrimental to bipedalism. In human walkers and runners, effective mechanical advantage is not predicted by biacetabular breadth (n=15; tests included kinematics, kinetics and oxygen consumption during walking and running as well as lower body MRI to determine how pelvic anatomy influences locomotor biomechanics). (2) Human gestation is not truncated; it is longer than expected when controlling for maternal body mass (z-score=0.6 calculated from log/log trend line for 21 primate species, r2=0.56). (3) Pregnant humans invest more, not less than expected according to the OD (relative neonatal body mass: r2=0.84, z-score=1.29; relative neonatal brain mass: r2=0.87, z-score=1.01). Finally, according to our model of fetal, neonatal, and maternal energetics (built with published measures of energy expenditure) a longer human gestation is not feasible. Regression analysis across 15 mammalian orders suggests that similar metabolic constraints explain the timing of birth across all mammals—with or without the constraint of a bony birth canal.

In conclusion, although pelvic remodeling during hominin evolution may have contributed to the present parturitional difficulty, this has not altered the timing of birth and is not the cause of human altriciality. Human altriciality is better described as prolongation of fetal brain maturation and growth irrespective of parturition. These findings have important implications for interpreting locomotion, life history, and sociality from fossil pelves of *Ardipithecus*, *Australopithecus*, and *Homo,* rendering many past practices obsolete.

Romer Prize/Technical Session 5 (Thursday, November 3, 8:00 am)

MAMMALIAN FAUNAL CHANGE AT RAVEN RIDGE, NORTHEASTERN UINTA BASIN, COLORADO-UTAH, DURING THE EARLY EOCENE CLIMATIC OPTIMUM

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Raven Ridge, in the northeastern corner of the Uinta Basin, Colorado and Utah, preserves a mammalian faunal assemblage that spans approximately four million years of Early-Middle Eocene time (Wa3-5 through Br2; ~53.5-49 mya), and is an excellent venue for testing if and/or how climatic warmth during the Early Eocene Climatic Optimum (EECO) impacted the mammalian fauna. The ridge comprises over 900 meters of fluvial mudstones and channel sandstones of the Colton Formation overlain by lacustrian shales and siltstones of the Green River Formation, which thus far have produced almost 10,000 mammalian teeth collected by crews from the University of Colorado Museum of Natural History (UCM). The assemblage is comprised of specimens representing 62 genera from 34 families, and is dominated by the condylarth *Hyopsodus*, omomyid primates, and rodents. In contrast to studies in Wyoming that have found a positive correlation between the warmer EECO climate and mammalian generic diversity, the Raven Ridge fossil mammal assemblage shows no significant change in generic diversity during the EECO until a decline during the early Bridgerian (Br1b biochron). The discrepancy between Raven Ridge and the Wyoming faunas does not appear to be a sampling artifact, as rarefaction analyses suggest relatively complete sampling in all biostratigraphic zones. Whereas mammalian generic diversity at Raven Ridge is stable during Early-Middle Eocene time, increased relative abundances of taxa with inferred arboreal habits, such as omomyid primates, are consistent with an increase in arboreal habitat at Raven Ridge that mirrors warming global temperatures by peaking during the earliest Bridgerian (Br1a biochron). In addition to describing the most complete North American record of mammalian faunal change during the EECO, this study of the Raven Ridge fossil assemblage demonstrates that diversity metrics are not sufficient to capture complex biotic shifts during intervals of global climate change.

Technical Session XVI (Saturday, November 5, 11:00 am)

GIANT COELACANTH *MEGALOCOELACANTHUS DOBIEI* FROM THE UPPER CRETACEOUS OF NORTH AMERICA AND ITS BEARINGS ON THE PHYLOGENY OF MESOZOIC COELACANTHS

DUTEL, Hugo, Muséum national d'Histoire naturelle, Paris, France; MAISEY, John, American Museum of Natural History, New York, NY, USA; SCHWIMMER, David, Colombus State University, Colombus, GA, USA; JANVIER, Philippe, Muséum national d'Histoire naturelle, Paris, France; CLÉMENT, Gaël, Muséum national d'Histoire naturelle, Paris, France

Megalocoelacanthus dobiei, a giant fossil coelacanth from the Late Cretaceous strata of North America, is re-described based on new complete and outstandingly preserved material. *M. dobiei* has been previously described on the basis of composite material that consisted of isolated elements. Consequently, many aspects of its anatomy remained unknown. Previous studies have suggested that *M. dobiei* is closer to the extant *Latimeria* and *Macropoma* than to *Mawsonia*, both from the Cretaceous. However, this assumption was only based on the morphometric analysis of the overall similarity of few anatomical features, but not on a phylogenetic character analysis. The new material allows the detailed description of the skull of *M. dobiei* and a new phylogenetic analysis of Mesozoic coelacanths. Although strongly flattened, the skull and jaws are preserved in three dimensions and show many derived features that are shared with Latimeriidae such as *Latimeria*, *Macropoma* and the Jurassic genus *Libys*. Notably, the parietonasal shield is narrow and flanked by very large, continuous vacuities forming the supraorbital sensory line canal. Such an unusual morphology is also known in *Libys*. Other features of *M. dobiei* such as its large size and the absence of teeth are shared with *Mawsonia* and *Axelrodichthys*. Previous phylogenetic analysis supported a sister-group relationship between these two taxa within Mawsoniidae. This close affinity between toothless, meters-sized Mesozoic coelacanths raised the question whether these features could have evolved once, or independently in several lineages. Our cladistic analysis supports the sister-group relationship of *M. dobiei* and *Libys* within the Latimeriidae. This topology thus suggests that toothless, large-sized coelacanths evolved in both the Latimeriidae and Mawsoniidae during the Mesozoic.

Technical Session VI (Thursday, November 3, 2:45 pm)

A DROWNED MESOZOIC BIRD BREEDING COLONY

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Despite a rapidly improving fossil record, the reproductive biology of Mesozoic birds remains poorly known: only a handful of undisputed, isolated Cretaceous eggs (some containing embryonic remains) are known. We report fossil evidence for a breeding colony of Mesozoic birds, preserved at the Upper Cretaceous (Maastrichtian) Oarda de Jos (Od) site in the Sebes area of Transylvania, Romania. This assemblage, preserved as a single, massive, lens-like accumulation deposited by floodwater and collected from the basal fluvio-paludal portion of the Sebe? section, includes the bones of adult enantiornithine birds, neonate skeletal elements, near-complete eggs, and a huge accumulation of eggshell fragments. Other non-avialian fossils are absent.

The Od accumulation shows clear zonation of eggshell indicating primarily hydrodynamic deposition: the lower layers comprise densely packed fragments concave-side-up (45-50 percent of matrix) while the upper layers include near-complete eggs and a mélange of shell and identifiable bone fragments (preserving enantiornithine synapomorphies). This, alongside consistent orientation and high abundance of shell fragments (more than 46 eggs per 100 cm3 of sediment estimated in the lower layer), preservation of tiny bones and almost complete eggs in a high pH water-logged environment, suggests gradual settling after short transport. Our interpretation is a large enantiornithine breeding colony that was swamped by rising water, washed a short distance and deposited in a shallow, low-energy pond. The same fate often befalls modern bird colonies.

Such a large concentration of breeding birds must indicate aquatic feeding and implies both the ability to disperse on foraging expeditions and a seasonally abundant food resource. These new data augment our understanding of enantiornithine biology and show that colonial nesting and synchronous breeding were not unique to crown-birds (Neornithes). Synchronous breeding in large colonies is a widespread and successful strategy in modern birds, with the largest examples often found at secure sites like small offshore islands or sandbars surrounded by flowing water.

Poster Session III (Friday, November 4)

INFERENCES OF THE PALEOECOLOGY OF THE BASAL PLEURODIRE *NOTOEMYS ZAPATOCAENSIS* BASED ON COMPUTED TOMOGRAPHY IMAGERY

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In 2006, a new specimen of the primitive platychelyid pleurodire turtle *Notoemys zapatocaensis* was found in a limestone layer of the Rosablanca Formation of Colombia, which has been dated to the Late Valanginian (Early Cretaceous). This specimen is the first and only one of this species to preserve a fully articulated carapace and plastron. In order to examine the skeletal elements embedded in matrix infilling the shell, CT images were obtained. Scans reveal that much of the vertebral column, the pelvic girdle, and the axillary and inguinal buttresses are preserved in the shell. Details of these elements offer insight on this basal pleurodire turtle's likely paleoecology. The morphology and orientation of the pelvis indicate that *Notoemys zapatocaensis* inhabited an aquatic environment. However, the geologic context for all known specimens suggests the species inhabited near shore environments, in contrast to the freshwater habitats occupied by all extant pleurodires. The vertebrae and the attachment sites for the ribs can provide information on the shape of the costovertebral tunnel, formed by the ribs, carapace, and vertebrae, and how this has changed over time by comparing our specimen with the extant pleurodire *Chelus fimbriatus* (Matamata). The costovertebral tunnel is greatly enlarged as in *Chelus fimbriatus*, indicating a large longissimus dorsi muscle, which is involved in the quick striking feeding motion in prey capture in *Chelus fimbriatus*. Based on morphology and ecological context, we infer a similar ambush predator ecology for *Notoemys zapatocaensis*.

Poster Session III (Friday, November 4)

RESOURCE PARTITIONING IN LATE MIOCENE CENTRAL EUROPEAN MAMMALS: ISOTOPIC EVIDENCE FROM THE RUDABANYA FAUNA

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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 that were characteristic of the Middle Miocene. In western and central Europe this turnover event is associated with increasing seasonality, as well as a shift in vegetation from subtropical evergreen to deciduous forest. Examining how fauna coexist within these changing forest ecosystems is critical to understanding Late Miocene mammalian evolution and dispersal patterns. The rich Late Miocene hominoid locality of Rudabánya in north-central Hungary provides a unique opportunity to examine resource use and partitioning during this time in Europe. To evaluate resource use and partitioning among the Rudabánya fauna, we examine the stable carbon and oxygen isotope values in enamel from ten genera of medium to large-bodied herbivores. Sampled taxa include *Hippotherium intrans*, *Miotragocerus* sp., *Tetralophodon longirostris*, *Aceratherium incisivum*, *Chalicotherium* cf. *goldfussi*, *Dorcatherium naui*, *Lucentia* aff. *pierensis*, *Micromeryx flourensianus*, *Parachleuastochoerus kretzoii*, and *Propotamochoerus palaeochoerus*. Isotopic values of the sampled fauna (n=65) conform with foraging in a forest to woodland environment, with restricted areas of closed canopy. The range of carbon isotope values indicates a diet of predominantly, if not entirely, C3 resources. Significant differences in oxygen and carbon isotope values occur among taxa, indicating resource partitioning. For example, the tragulid *D. naui* shows the most negative carbon values, suggesting feeding in a closed canopy. In contrast, the suid *P. palaeochoerus* shows the least negative carbon values, suggesting a preference for more open settings, possibly forest clearings. The relatively more negative oxygen isotope values of *T. longirostris* and *A. incisivum* may indicate feeding on fruits. The carbon values of *A. incisivum,* suggest similar habitat preferences to extant browsing rhinoceroses. These results provide insight into the paleoecology of the Rudabánya fauna during a highly dynamic period in the evolution of terrestrial mammals in Europe.

Symposium 3 (Thursday, November 3, 9:15 am)

COMPARISON OF LATE SANTONIAN-CAMPANIAN LARAMIDA MAMMALIAN FAUNAS FROM ALBERTA, CANADA, AND UTAH, USA

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Although terrestrial Upper Cretaceous rocks from Alberta (AB) and Utah (UT) document a rich succession of fossil mammals of late Santonian-Campanian age in North America, a detailed comparative study of mammals from the two regions has yet to be undertaken. Using current radiometric estimates for chronostratigraphic control, we compared mammal faunas from the late Santonian John Henry Member of the Straight Cliffs Formation (JH, UT) and the Milk River Formation (MR, AB), the mid-Campanian Wahweap Formation (W, UT) and Milk River, Foremost (F), and Oldman (O) formations (AB), and the early late Campanian Kaiparowits Formation (K, UT) and the Oldman and Dinosaur Park (DP) formations (AB). Although our analysis recognizes varying sample sizes, uncertain taxonomy, and limited chronostratigraphic constraints as major factors influencing levels of similarity, several trends are nonetheless recognized. In general, similarity between UT and AB is higher at the genus, rather than species level. Faunas of the JH and MR, and K and DP, were consistently most similar, with Simpson coefficients (SC) of 69-80 at the genus and 29-54 at the species levels, depending on confidence of taxonomic identification. Similarity was lowest between the W and F, with SC of 33-38 at the genus and 0-27 at the species level. The remaining comparisons show intermediate levels of similarity, with SC of 53-73 at the genus and 0-35 at the species level. Further, our comparisons indicate that the AB faunas are more taxonomically diverse than those from UT, particularly cimolomyids, pediomyids, and stagodontids, and the W fauna contains more archaic taxa than the nearly coeval O fauna. Although there are distinct differences between the Late Cretaceous faunas of UT and AB, the two regions cannot unambiguously be considered parts of distinct zoological "provinces" on the basis of mammals alone. The presence or absence of taxa at any one locality may owe, at least in part, to local ecology, a confounding factor seen clearly by distinct differences in the co-occurrence of genera and species between localities of approximately the same age and latitude across adjacent plateaus in southern UT.

Technical Session VII (Thursday, November 3, 3:00 pm)

MAMMALIAN DIVERSITY IN THE EARLY EOCENE HIGH ARCTIC

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As a result of over three decades of paleontological fieldwork in Canada's High Arctic, at least 23 mammalian genera in some 17 families and 11 orders, ranging from plagiomenid primates to creodonts and carnivorans to tapiroid perissodactyls, are documented from early Eocene (late Wasatchian; ~52-53 Ma) fossil vertebrate assemblages in the Eureka Sound Group on Ellesmere Island, Nunavut. Eocene mammalian fossils are considerably less abundant in the Arctic than at North American mid-latitude localities; specifically, a total of approximately 200 mammalian specimens diagnosed to genus level are known from central Ellesmere Island, and approximately one-third of these specimens were recovered from a single locality – Locality 85 near Bay Fiord on central Ellesmere Island (~79?N. lat). However, rarefaction techniques can be used to compare diversity in samples of different size. We calculated rarefaction curves for Ellesmere Island Locality 85, as well as late Wasatchian (Lostcabinian) localities from Huerfano Park in Colorado and the Green River and Wind River basins in Wyoming. Our results indicate that mammalian generic richness in the Early Eocene Arctic Locality 85 is within the range of expected richness for comparably aged, mid-latitude North American localities. Specifically, Locality 85 appears more diverse than expected diversity in the Green River Basin, though less diverse than the Wind River Basin fauna (specifically from University of Colorado Museum Locality 80062, known for its productivity and unusually high species richness). While mammalian diversity seems numerically comparable at mid- and high-latitude localities, there are notable differences in faunal composition. At the Early Eocene mid-latitude localities, *Hyopsodus* is the most abundant taxon and artiodactyls occur in modest diversity, whereas neither taxon is known from Arctic Locality 85, where plagiomenid primates are the most abundant faunal element. An implication of our study is that a relatively flat latitudinal diversity gradient for North American mammals existed during the Early Eocene, which correlates with a reduced latitudinal temperature gradient for this time interval noted by prior paleoclimate studies. This is in stark contrast to today's steep latitudinal diversity gradient in North American mammals.

Technical Session IX (Friday, November 4, 11:00 am)

SYNCHROTRON RAPID SCANNING X-RAY FLUORESCENCE OF SOFT-TISSUE PRESERVED IN FOSSILS

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Geochemical and biological analytical techniques have been employed by others in the identification and quantification of soft-tissues from the fossil record. However, almost all of these techniques require destructive sampling and are unable to provide high resolution, large scale, spatially resolved chemical information from fossil material. Synchrotron rapid scanning x-ray fluorescence (SRS-XRF) developed at the Stanford Synchrotron Radiation Lightsource (SSRL, CA, USA), non-destructively provides highly sensitive, in-situ and large scale 2D elemental maps with rapid scanning times (~30 sec/cm²). SRS-XRF reveals the distribution of elements present in a sample at concentrations below the detection limits of many conventional geochemical techniques. Furthermore, we have uniquely combined x-ray absorption near edge spectroscopy (XANES) with SRS-XRF to produce maps showing the distribution of only organic sulfur species within fossil material. Our recent multi-technique study of fossilised reptile skin (Green River Formation, USA, ~50 Mya), employing SRS-XRF, Fourier Transform Infrared (FTIR) spectroscopy and Pyrolysis-Gas Chromatography/Mass Spectrometry, strongly suggests that remnants of the living organism's original chemistry (protein-derived compounds) are preserved. FTIR maps of the fossil skin reveal that amide functional groups are discretely correlated with preserved scales, and this pattern is directly comparable to that observed in extant reptile skin. Py-GC/MS demonstrates that the chemical inventory of the skin is markedly different from the surrounding matrix. Trace metal composition and distribution revealed by SRS-XRF within the fossil skin is also comparable to extant skin. These results are duplicated in another preserved reptile skin specimen from the Green River Formation. From these results, a new taphonomic model has been proposed to explain the survival of these compounds, involving ternary complexation between organic molecules, trace metals and silicate surfaces.

Technical Session IX (Friday, November 4, 12:00 pm)

GIANT BOX TURTLES (TESTUDINES: EMYDIDAE) OF THE *TERRAPENE PUTNAMI* COMPLEX FROM THE LATE BLANCAN (EARLY PLEISTOCENE) OF FLORIDA

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The giant box turtle, *Terrapene putnami*, is poorly defined despite its common occurrence in the fossil record of the southern USA. The original description of the species was based on a single hypoplastron from the Alafia River, Florida that was said to be either Pliocene or Pleistocene in age, and diagnosed morphologically in being larger and thicker than modern congeners. Subsequently, the taxonomic nomenclature of *T. putnami* has been questioned and revised numerous times, most recently with a molecular study of extant *Terrapene* proposing the species be considered a junior synonym of the extant Gulf Coast box turtle, *Terrapene carolina major*. Historically, most large *Terrapene* fossils from the Hemphillian through late Rancholabrean have been assigned to either *T. putnami* or *T. c. major* based solely on size. However, more refined morphological analyses are required to better distinguish these taxa and their interrelationships. New fossil giant box turtle skeletons from the late Blancan (early Pleistocene) Haile 7G site in Alachua County, Florida, complete with skulls and associated postcrania, allow us to better diagnose the *putnami* group from other *Terrapene* taxa. Apomorphies of the *putnami* group include: very narrow and antero-posteriorly elongate vertebral scutes with a highly laterally constricted Vertebral 1; a narrow nuchal with a strong medial keel; a tall highly vaulted carapace with the costals steeply sloped at the lateral vertebral sulci; flared posterior peripherals; and the presence of an axillary scute that bisects the fourth marginal scute. A smaller *Terrapene* species resembling the *T. carolina* group is also present at Haile 7G and provides evidence that these two forms co-existed. Haile 7G represents a sinkhole lake paleoenvironment in which the larger form was much more common and more wholly preserved than the smaller. This further suggests that *putnami* was either more semi-aquatic or more apt to frequent peripheral aquatic habitats. These new, exceptionally preserved fossils provide morphological evidence that *T. putnami*, while sister to *T. carolina*, represents a distinct lineage and is most appropriately classified at the species level.

Poster Session III (Friday, November 4)

THE MUSCULATURE OF THE TEMPOROMANDIBULAR REGION IN THE MIO-PLIOCENE BALEEN GENUS *HERPETOCETUS* AND ITS INFERRENCE FOR FEEDING STRATEGY

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Inferring fossil mysticete feeding strategies based on osteological features has proven to be a perplexing conundrum for paleontologists. Modern mysticete bulk feeding strategies can be condensed into three main methods: active lunge feeding, passive skim feeding, and suction feeding. In general, fossil mysticete feeding strategies have been assumed based on morphological similarities and phylogenetic relationships to modern mysticete groups. The extinct fossil baleen whale genus *Herpetocetus* introduces a unique cranio-mandibular morphology, which may represent a novel feeding strategy or a new approach to a known method of acquiring nourishment.

The angular process of the dentary in *Herpetocetus* is posteriorly elongate, which likely suggests an increased importance in the pterygoid, masseter, and temporalis muscles. Unlike in modern mysticetes, the angular process of *Herpetocetus* is dorsoventrally shortened, which would decrease the surface area for musculature attachment, but it has been suggested that posterior elongation of the angular process could compensate for this factor. Furthermore, the postglenoid process of the squamosal is anterolaterally torqued in *Herpetocetus,* which appears to partially impede abduction (delta rotation) of the dentary, and therefore prohibits members of *Herpetocetus* from enlarging their gape to the same degree as modern mysticetes. This fact is counter intuitive to the notion of bulk feeding, and suggests that these morphologies were positively selected for function. Further study of the temporomandibular region of several undescribed *Herpetocetus* specimens from San Diego and Santa Cruz, California, will provide clues to elucidate the feeding strategy of this bizarre mysticete genus.

E&O Poster Session

A PARADIGM SHIFT IN SCIENCE OUTREACH: NEW STUDENT-DEVELOPED PROGRAM FACILITATES AND REINFORCES ACTIVE LEARNING IN PALEONTOLOGY THROUGH PERSONALIZED MENTORING AND DEVELOPMENT OF LEARNING TOOLS

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In the United States, science education development is a priority of educators and policy makers due to poor performance of students in science literacy assessments. In addition to this focus on improving standards of science literacy, scientists and educators are concerned with the treatment and presentation of evolution in science curricula. Quality science educators are in short supply, especially educators that can effectively teach concepts in evolution. Many science outreach programs exist with a focus on natural sciences, but the impacts of these programs are often minimized by short duration and lack of concept reinforcement. Short duration also makes it difficult to evaluate long-term program impact.

A new model for science outreach incorporates prolonged and reinforced science learning experiences as well as tracking mechanisms for immediate and broad impact assessment. Paradigm Shift is a science outreach program developed by undergraduates with the goal of enhancing science outreach and the scope of its effect. The program connects middle school and undergraduate students in a ten-week afterschool program designed to facilitate personal and mutualistic mentoring relationships. Working in small teams, students investigate a particular scientific concept through interactive and multimedia activities and collaborate to develop original learning tools that illustrate their topics of investigation. Program effectiveness will be assessed through a longitudinal study of scholastic performance, science literacy, and education and career trajectories of former participants.

The Paradigm Shift model presents an innovative method for outreach initiatives in paleontology and other natural sciences in an afterschool setting. The program's emphasis on interactive learning activities are especially useful for communicating tactile methods of paleon-

tological research as well as theoretical methods used to analyze evolutionary processes in geologic time. Learning tools and activities developed through the Paradigm Shift program will also be made publicly available on an open-source web domain.

Poster Session I (Wednesday, November 2)

UP, DOWN, AND SIDEWAYS: ABUNDANT THERAPSID TRACKS ON A DUNE SLIPFACE IN THE NUGGET SANDSTONE (EARLY JURASSIC) FROM NEAR HEBER, UTAH

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A single slab of Nugget Sandstone on exhibit at the University of Utah preserves a remarkable record of therapsid tracks. The Early Jurassic Nugget Sandstone was deposited in a vast erg that covered much of the western US. Although therapsid tracks have been reported from other sites in deposits of this Early Jurassic erg in the western US, this slab is especially noteworthy in several ways.

Nearly 400 tracks are preserved on the 1.4m x 1.2m slab and the original, complete surface undoubtedly held many more. Most of the tracks are referable to therapsids and occur as both three and four toed impressions. Tracks with similar morphology in the Early Jurassic desert deposits of the western US have been referred to the genus *Brasilichnium*.

The orientation of the loose slab can be determined from wind ripples oriented parallel to dip across the lee surface. A number of trails can be identified. Most tracks are directed up slope, as evidenced by a crescentic push-up of sand at the back end of the impression. However, at least two trails are progressing downslope. These downslope trails show greater deformation of surrounding sediment than upslope tracks. Collapse features define the upslope side of the tracks. A flat-topped crescent occurs on the downslope side. Downslope impressions are deeper at the front end of the impressions, and a few downslope tracks show toe impressions. A few tracks traverse the slope as indicated by the orientation of toe impressions.

Track size ranges from a width of 32mm to 7mm. The latter among the smallest therapsid/mammaloid tracks reported from the Jurassic. Other therapsid track sites from Early Jurassic erg deposits consist of few trails and a limited number of tracks, most reports indicating tracks of similar size. It has been suggested that different size tracks represent different species or different body lengths. If true, then it would appear that the species were segregated and did not occupy the same locales. Track variation on the Utah University slab shows that either different therapsid species, or adults and juveniles of the same species occurred together, or both of these factors are true.

Technical Session VI (Thursday, November 3, 3:30 pm)

PHYLOGENETIC PATTERNS OF PTEROSAUR WING SKELETON ALLOMETRY

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Pterosaurs exhibit two major body plans, which have implications for the evolution and function of their wing skeletons. A paraphyletic group of basal pterosaurs, including the well-represented genus *Rhamphorhynchus*, have long tails and relatively small crania, whereas the monophyletic Pterodactyloidea have short tails and relatively large crania. Differences in relative lengths of skeletal elements have been shown to influence flight mechanics and aerodynamic performance in extant flying vertebrates, both between clades and ontogenetically within species. To explore the possibility of similar patterns in the Pterosauria, we examined allometric scaling of the lengths of the individual wing bones of pterosaurs across their entire phylogenetic range and through the ontogenetic growth in a single species. The comparative analysis employed a phylogenetically-informed generalized least squares regression to control for the shared evolutionary history of the twenty-five species included. We found that the humerus, radius, fourth metacarpal, and the third and fourth phalanges scaled isometrically relative to one another across Pterosauria. However, pterodactyloids had a significantly longer fourth metacarpal than more primitive pterosaurs, approximately three times longer for a given humerus length. The first and second wing phalanges scaled with slightly positive allometry relative to the humerus. The ontogenetic analysis of 48 specimens of *Rhamphorhynchus* revealed a significant shift in scaling between the younger and older groups, possibly indicating the crossing of a life-history milestone. The second, third, and fourth phalanges did not have a significant difference between age groups but exhibited positive allometry relative to the humerus. These results suggest large-scale patterns in relative growth of the pterosaur wing skeleton, not only between basal and derived taxa, but also within the ontogeny of a single taxon. These patterns will provide insights into the evolution and function of the pterosaur flight apparatus.

Poster Session IV (Saturday, November 5)

THE HISTOLOGY OF HADROSAURID DINOSAUR TEETH -- REPTILES THAT EXCEEDED MAMMALS IN DENTAL COMPLEXITY?

ERICKSON, Gregory, Florida State University, Tallahassee, FL, USA; NORELL, Mark, American Museum of Natural History, New York, NY, USA

Horses, bison, and elephants have grinding dentitions for finely titrating extremely tough and abrasive plants. Their teeth are among the most sophisticated ever to evolve, being composed of intricate multi-tissue complexes that self wear to create the coarse chewing surfaces. Reptile teeth are considerably more simplistic. Nevertheless, one group, the duck-billed dinosaurs (Hadrosauridae) evolved a similar dentition. This innovation allowed them to become the first animals to broadly exploit flowering plants and dominate Laurasian herbivorous niches for over 35 million years. Did these reptiles somehow evolve advanced mammal-like dental sophistication? We used modern histological techniques to reveal that hadrosaurid cheek teeth were much more complex that previously realized, and actually exceeded mammals in complexity. Six tissues were present on the occlusal surfaces of their dental batteries. These include coronal cementum, a tissue often cited as evidence for the advancement of mammalian dentitions beyond those of reptiles. Variance in the distributions of these tissues within teeth and between taxa allowed for changes in form and function relevant to feeding ecology.

Poster Session IV (Saturday, November 5)

THE SYSTEMATIC UTILITY OF THE ILIO-SACRAL BLOCKS OF THE EUROPEAN STEGOSAUR *DACENTRURUS ARMATUS*

ESCASO, Fernando, Uned, Madrid, Spain; ORTEGA, Francisco, Uned, Madrid, Spain; Sanz, José Uam, Madrid, Spain; MALAFAIA, Elisabete, Mnhn, Lisbon, Portugal

Dacentrurus armatus was the first stegosaur named, and until recently was considered one of the most widespread European dinosaurs. Currently, *Dacentrurus armatus* is restricted to the type material (BMNH 46013) from the Kimmeridgian of England, whereas the rest of the specimens described in France, Portugal and Spain (and previously ascribed to this species) are considered only at generic level. Unfortunately, the incompleteness of the numerous partial skeletons reported to date difficult to define a solid character combination to diagnose this taxon. One of the most common skeletal remains preserved for this stegosaur are the pelvic bones, highlighting ilio-sacral blocks. Here we discuss the taxonomic relevance of the ilio-sacral blocks of this dinosaur based on a reevaluation of Portuguese specimens. The study of this material indicates that the pelvic girdle of *Dacentrurus armatus* is unique among stegosaurs showing, at least, two exclusive autapomorphies on the ilio-sacral region. All the known ilio-sacral blocks exhibit a smooth curvature between the anterior margin of the sacral plate and the medial margin of the iliac anterior process and, when preserve, a cranially short and broad anterior process of the ilium. Thus, these two features and the transverse broadness of the supraacetabular region provide a butterfly-shape to the ilio-sacral block of *Dacentrurus*, are diagnostics for this taxon. Slight differences observed in the ilio-sacral blocks from the European *Dacentrurus* specimens are explained as the result of taphonomical distortion or individual variation, including sexual dimorphism.

Preparators' Session (Thursday, November 3, 8:00 am)

NEW APPLICATIONS FOR MEDIUM AND SMALL SCALE 3D PHOTOGRAMMETRY IN VERTEBRATE PALEONTOLOGY

ESKER, Donald, The Mammoth Site of Hot Springs, South Dakota, Hot Springs, SD, USA

Photogrammetry is the science of taking measurements from photographs. In the past this was done strictly on the largest scales for the purpose of producing topographic maps. The process required precisely calibrated equipment and took time-consuming, painstaking manual labor; thus photogrammetry on the scale of a single paleontological site was impractical. Fortunately, recent advances in computer processing power and new software has brought photogrammetry into the digital age and made it a practical tool for bonebed cartography. Simply by loading multiple images into the appropriate program, would-be photogrammetricians can produce a precise and accurate three dimensional representation of nearly any surface, at nearly any scale. The significance of these advances was not lost on paleontologists. Digital photogrammetry has been used for years to document and monitor large ichnosites with great success. The technology need not be limited to the study of trackways; with appropriate vantage points, entire paleontological sites can be mapped. On the other end of the scale, it is possible to combine macrophotography with photogrammetry to produce accurate three-dimensional computer models of even the tiniest specimens.

At The Mammoth Site of Hot Springs South Dakota, progress is being made on both fronts. Much of the western half of the sinkhole has been mapped with digital photogrammetry, with results that compare well to the site's state-of-the-art geographic information system map. Researchers who are unable to travel to South Dakota can now study the bonebed almost as if they were there in person. Macrophotogrammetry has proven invaluable for studying the microfaunal material from the site. Most of this material has consisted of invertebrate shells, scattered fish bones, and miniscule rodent teeth. By producing digital models of these specimens, it is possible to examine them closely without risk of damage. With the advent of rapid-prototyping, it is even possible to 'print out' a greatly enlarged copy of the specimen under consideration. Photogrammetry promises to revolutionize paleontological cartography at every scale.

Technical Session XV (Saturday, November 5, 11:45 am)

THE INHIBITORY CASCADE IN MARSUPIALS

EVANS, Alistair, Monash University, Melbourne, Australia; PROCTOR, Karlena, Monash University, Melbourne, Australia

The inhibitory cascade is a developmental and macroevolutionary model for the evolution of relative molar sizes in mammals. It predicts that the relative sizes of molars follow a simple formula, such that the middle molar in a series of three will always be 1/3 of the total row area. In a morphospace of relative tooth sizes, plotted as m2/m1 vs m3/m1, the centre of the

morphospace at (1,1) represents equal-sized teeth, and the inhibitory cascade is a diagonal line passing through the centre at y = 2x - 1. We present the first comprehensive test of the model in the second-largest radiation of extant mammals, the marsupials. Marsupials have four molars rather than the general maximum of three in eutherians, in which the model was developed. We investigated whether the presence of a fourth molar causes the molar proportions to substantially deviate from the pattern predicted by the inhibitory cascade in more than 50 modern and 10 fossil marsupial species. To do this we considered the molars 1-3 as the first series of three teeth and molars 2-4 as the second series.

We found more deviation from the predicted inhibitory cascade pattern in some species than found in most placentals. In a few species, such as the koala *Phascolarctos cinereus*, all four teeth are approximately the same size and so both series fall in the centre of the morphospace. In other species, such as the red kangaroo *Macropus rufus*, both series fell close to the inhibitory cascade line, but the first series was positioned further towards the top right-hand quadrant of the morphospace than the second series. Several species showed a pattern of the one series on the inhibitory cascade line and the other series below it (including the mountain pygmy possum *Burramys parvus*), and in others, both series sat an approximately equal distance below the line (such as *Antechinus*). The South American didelphids appeared more conservative in their deviation from the inhibitory cascade. Molar ratios for fossil species examined largely followed their closest extant relatives.

The inhibitory cascade line appears to form an upper bound in the morphospace in marsupials, but some deviation below the line for one or both series is common. We conclude that the inhibitory cascade is therefore a major controlling factor in tooth size patterning but not the only developmental factor.

Symposium 3 (Thursday, November 3, 11:30 am)

NEW PERSPECTIVES ON THE EVOLUTION AND HISTORICAL BIOGEOGRAPHY OF CAMPANIAN HADROSAURIDS (ORNITHISCHIA) OF LARAMIDIA

EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; GATES, Terry, Field Museum of Natural History, Chicago, IL, USA

Hadrosaurs were a widespread and diverse group of ornithischian dinosaurs in Late Cretaceous ecosystems of Asia and North America. By any taphomonic mode, hadrosaurs dominate Campanian dinosaur assemblages of western North America (Laramidia). Hadrosaurs therefore provide a taxonomically diverse, densely sampled dataset for evaluating hypotheses of dinosaur evolution and biogeography in the Cretaceous. Considerable new efforts to refine the biostratigraphic and geographic ranges of hadrosaurs in the Western Interior Basin (WIB) of North America have resulted in a high-resolution biostratigraphic framework that is summarized here. The biostratigraphic ranges of lambeosaurines are well documented in the northern WIB. New data on the biostratigraphy of hadrosaurines in the Campanian of Alberta reveals no overlap between *Prosaurolophus* and *Gryposaurus* within the Dinosaur Park Formation. Extensive overlap of *G. notabilis* and *G. incurvimanus* within a narrow stratigraphic range at the base of the Dinosaur Park Fm argues against their recognition as separate taxa. New high-resolution biostratigraphic data from the southern WIB reveals that with the possible exception of *Gryposaurus notabilis*, northern and southern regions of the WIB do not share any hadrosaurid species in common during the late Campanian, suggesting that dispersal between the two areas was limited during this time.

A new species-level phylogeny of hadrosaurine hadrosaurids provides a framework for assessing historical biogeography within this clade, as well as permits comparison and integration with similar data for Lambeosaurines. A cladistic historical biogeographic analysis (PACT) was performed on hadrosaurine and lambeosaurine clades, with Pachycephalosauridae used to resolve biogeographic ambiguities. The time-calibrated General Area Cladogram reveals at least one general dispersal event from North America to Asia in the late Campanian, possibly initiated by dropping sea-level at this time. The analysis also reveals interchange between northern and southern biotic provinces within the WIB occurred in the middle Campanian.

Technical Session IX (Friday, November 4, 10:45 am)

THE EARLY CRETACEOUS LIZARD *YABEINOSAURUS*: INSIGHTS FROM NEW SPECIMENS

EVANS, Susan, University College London, London, United Kingdom; WANG, Yuan, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

The lizard *Yabeinosaurus tenuis* was one of the first tetrapods to be described from the Early Cretaceous Jehol Biota of north-eastern China, but it was misinterpreted for decades because both the lost holotype and a subsequent neotype were poorly preserved juveniles. However, the recovery and identification of more mature specimens from the Yixian and overlying Jiufotang formations (125-120 million years ago) has now shown that the adult *Yabeinosaurus* was a large (~300 mm SVL) robust lizard that probably reached full size over several seasons. New skeletal data, including scattered osteoderms, has allowed more comprehensive phylogenetic analysis, placing *Yabeinosaurus* and its sister taxon, the roughly contemporaneous Japanese (Tetori Group) *Sakurasaurus*, on the scleroglossan stem. It has also provided a basis from which to review the type specimen of '*Yabeinosaurus' youngi*, revealing errors in the original interpretation and confirming its distinction from *Y. tenuis*. Perhaps more importantly, recently recovered specimens from a new locality in the Jiufotang Formation at Xiaotaizi, Jianchang County, Liaoning Province, have yielded information on the biology and lifestyle of *Yabeinosaurus*. One remarkable female specimen provides an insight into the reproductive strategy of the lizard, and two preserve gut contents. The latter show that adults predated small vertebrates, including fish. Fish eating is rare in living lizards, reportedly occurring only in the small clade encompassing *Shinisaurus*, *Lanthanotus* and *Varanus*. Like them, *Yabeinosaurus* presumably foraged in and around the water although it shows no obvious aquatic specialisations.

Poster Session III (Friday, November 4)

A TERRESTRIAL VERTEBRATE TAPHOFACIES MODEL OF A HIGH ENERGY LAKESHORE ENVIRONMENT

EVANS, Thomas, Montana State University, Bozeman, MT, USA

A taphofacies model was developed for a high energy gravel and cobble lakeshore environment through observations of terrestrial vertebrate remains (excluding fish) along the modern shoreline of Lake Iliamna, Alaska. The lake was visited in 2006, 2009, and 2010, and portions of the lakeshore walked (total ~130 miles) to collect skeletal material. In 2006 twelve samples were collected, in 2009 eighteen samples were observed (seventeen collected), while in 2010 two hundred twenty-two samples were observed and collected, totaling 252 samples. During collection most bones or articulated units were photographed, sample and shore orientations measured, burial, geomorphology, and bed descriptions were recorded. Each sample was identified to element and taxon and scored for abrasion, weathering, breakage, and articulation.

Twenty-five samples (~10%) were avian, while the remainder, 227 samples, were mammal (~90%) with the vast majority being caribou and moose (4 bones were from carnivores and 2 from rodents). Most bones were in weathering stage 0 (225 or ~92%) and the remaining were in weathering stage 1 (20 or ~8%). Similarly, most bones were heavily abraded (abrasion scale 3, 217 or ~87%) and few with light (abrasion scale 1, 14 or ~5%) or medium abrasion (abrasion scale 2, 19 or ~8%). Only 12 samples were articulated, 11 of which were avian. No association between the presence of bones and geomorphology or grain size (predominately gravel and cobbles) was noted. No correlation between the orientation of beach berms and sample orientation existed (N=178). Brown and black discoloration, tooth marks, acid etching, and invertebrate boring were also observed.

Fossil assemblages from high energy lakeshore environments may be recognized in the fossil record by a skeletal assemblage comprised primarily of large robust bones with few smaller bones. Weathering damage would be rare and light when present. Nearly all bones would show some form of abrasion and most bones would be heavily abraded. Bones would be disarticulated except from smaller animals which may be articulated often with little or no abrasion. Sedimentary context should also be used during interpretation.

Poster Session I (Wednesday, November 2)

A 3-D MORPHOMETRIC ANALYSIS OF THE LOCOMOTORY ECOLOGY OF *DECCANOLESTES*, A EUTHERIAN MAMMAL FROM THE LATE CRETACEOUS OF INDIA

FABRE, Anne-Claire, University College London, London, United Kingdom; CORNETTE, Raphaël, Muséum National d'Histoire Naturelle, Paris, France; PRASAD, Guntupalli, University of Delhi, Delhi, India; BOYER, Doug, Brooklyn College, City University of New York, Brooklyn, NY, USA; GOSWAMI, Anjali, University College London, London, United Kingdom

Known only from isolated dental, mandibular, and postcranial elements, the relationships and ecology of *Deccanolestes*, a eutherian mammal from the Late Cretaceous of India, have been a topic of considering interest and debate. A recent comprehensive study has placed it within Adapisoriculidae, but near the base of the eutherian tree. On the ecological side, it has been described as having an arboreal or scansorial lifestyle, based on similarities in ankle morphology with euarchontans. We present a 3-D geometric morphometric (GM) study of the astragalus to rigorously test hypotheses of *Deccanolestes*'s phenetic affinities. We focus on the astragalus because it bears several key characters that relate to foot mobility and is often used to characterize the locomotory ecology of extinct mammals. 26 landmarks that represent the complex shape of the astragalus morphology were derived from 3-D surface scans and microCT scans. Generalized Procrustes Analyses and Principal Components Analysis were performed on astragali of 16 extant species belonging to extant eutherians (Carnivora, Primates, Dermoptera and Scandentia) and metatherians (Didelphomorphia), which display a range of terrestrial to arboreal lifestyles. We further included relevant Paleocene and Eocene taxa, from extinct euarchontans, such as Plesiadapiformes (*Pronothodectes* and *Plesiadapis*) and Euprimates (adapiformes, omomyids, *Catopithecus*), to *Protungulatum*, an early condylarthran. In addition, we constructed a neighbor-joining tree based on Euclidean distance shape variables to identify similarities among taxa. Results show *Deccanolestes* to cluster most closely with plesiadapiforms, which, together with *Protungulatum*, form a separate cluster from all extant mammals and extinct Euprimates. The astragali represented by this cluster are more robust, with a relatively short neck. The astragalar morphology of *Deccanolestes* seems to have no analogue among living species, but this morphology appears prevalent among Paleocene eutherian mammals. Consistent with previous studies, the morphological proximity of *Deccanolestes* to plesiadapiforms supports its reconstruction as an arboreal mammal.

Poster Session III (Friday, November 4)

DIETARY ADAPTATIONS IN EOCENE ARCHAEOCETE WHALES REVEALED BY MICROWEAR AND MACROWEAR ANALYSIS AND STOMACH CONTENTS

FAHLKE, Julia, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; BASTL, Katharina, Institut für Paläontologie, Universität Wien, Vienna, Austria; SEMPREBON, Gina, Department of Biology, Bay Path College, Longmeadow, MA, USA

Eocene archaeocetes gave rise to all modern whales. The cetacean transition from life on land to life in water is well-documented in the fossil record. It has been hypothesized that an early shift to piscivory initially caused cetaceans to abandon land. To assess archaeocete diet and its evolution through time, we analyzed microwear of pakicetid, protocetid, and basilosaurid archaeocetes, representing the full terrestrial-to-marine transition throughout the Eocene. We quantified wear features on shearing facets of upper and lower cheek teeth using low-magnification stereoscopic microwear analysis. Our modern comparative sample included terrestrial canid, felid, and hyaenid carnivores, (semi-)aquatic mustelid, phocid, otariid, and odobenid carnivores, and marine delphinid and phocoenid odontocetes. Archaeocetes have more scratches and fewer pits than terrestrial and aquatic predators, but overlap with odontocetes and pinnipeds. Large pit numbers are higher than in the modern sample, suggesting the presence of more hard objects in the archaeocete diet. Archaeocete microwear most closely resembles that of delphinids and otariids. These results suggest that their diet consisted of fish and cephalopods, and likely included crustaceans. An exception is the earliest cetacean in this study, *Pakicetus inachus*, which has previously been assumed to have foraged in freshwater. Microwear of *P. inachus* resembles that of the modern walrus, which is a bottom feeder relying mostly on invertebrates. Stomach contents of *Dorudon atrox* consist of fish, but stomach contents of *Basilosaurus isis* include remains of juvenile *Dorudon* besides pycnodonts and sharks. Macroscopic tooth wear shows more evidence of crushing in *B. isis* than in any other archaeocete, and microwear shows heavy gouging, supporting the hypothesis that *B. isis* fed on organisms with a heavy skeleton or shell, like large mammals or sea turtles. We conclude that piscivory developed early in cetaceans, possibly via a stage of bottom-feeding in *Pakicetus*. Piscivory was maintained during whale evolution, occasionally supplemented with crustaceans. Some later forms included mammal meat in their diet (*Basilosaurus*, *Orca*).

Technical Session XI (Friday, November 4, 1:45 pm)

EVOLUTIONARY TRENDS IN SAUROPOD BODY PLAN EXPRESSED IN FOSSIL TRACKS AND TRACKWAYS

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Fossilised tracks are widely cited as providing evidence of behaviour, biomechanics and ecology of vertebrates, thus complementing and supplementing the osteological record. However, trackways are often overlooked in macroevolutionary studies. The loading of the foot is a direct result of the limb motion relative to the centre of mass of the animal, and variations in limb motion or centre of mass may be expressed in the 3D morphology of any resultant track. For example, variations in centre of mass of quadrupedal animals will result in differential loading between manus and pes, which when combined with the relative surface areas of fore- and hind-feet, may produce drastically different under-foot pressures. If a substrate exhibits an elastic-plastic behaviour, a specific load will be required to exceed the elastic response of the substrate and cause it to plastically deform and produce tracks. We show that predicted underfoot pressures of different sauropod dinosaurs preferentially produce either manus-dominated or pes-dominated trackways depending on whether the centre of mass is more anterior or posteriorly positioned. The temporal distribution of these taxa correlates with a significantly greater number of pes-dominated sauropod tracks from Jurassic age rocks, followed by a switch to manus-dominated trackways in the Cretaceous. We interpret this as being the result of sauropods evolving to be more 'front heavy' throughout the course of their evolution. Additionally, the substrate types in which manus- or pes-dominated tracks occurred were noted. There is no association between tracks and substrate in the Jurassic. However, in the Cretaceous, manus-dominated tracks are most commonly recorded in cohesive substrates (e.g. mudstones), whereas pes-dominated tracks tend to be restricted to non-cohesive substrates (e.g. sandstones). This may be the result of niche partitioning among sauropods, associated with the Cretaceous diversification of the anatomically and environmentally specialised titanosaurs.

Poster Session I (Wednesday, November 2)

NEW DATA ON TWO LARGE DINOSAUR TRACKSITES FROM THE MIDDLE JURASSIC OF EASTERN TURKMENISTAN, CENTRAL ASIA

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A collaboration between the University of Bologna, Italy, and the National Institute of Deserts, Flora and Fauna of the Ministry of Nature Protection of Turkmenistan allowed to visit one of the largest dinosaur tracksite ever reported in Central Asia. This unique site is located in the Koitendag National Park, Lebap Province, north-eastern Turkmenistan and has been assessed an Oxfordian-Kimmeridgian age. Known as the "Hodjapil-ata" tracksite, it has been the object of two preliminary studies by K. Amanariazov in the 80's and later by a team led by Martin Lockley in the 90's. Accurate GPS mapping as well as a comparison with previous studies provide the most detailed database available for this extraordinary site. The track-bearing surface, resulted from an ancient landslide, is exposed discontinuously over an area of 28.500 sq.m. Four continuous trackways exceed 95 meters in length, and two reach approximately 220 meters. We conclude that 22 trackways and a total of 796 footprints are preserved, and confirm the co-occurrence of the two ichnogenera *Megalosauripus* and *Therangospondylus*. To support these conclusions, several footprints and tracks have been measured and acquired by using high-resolution photogrammetry and secondarily examined with 3D software. In addition, a second and previously unreported site named "Ak gaya" (meaning "white stone") located a few km to the east has been studied. Overall the exposed sections of the track-bearing surface extend over 24.000 sq.m., and a total of 40 trackways and 730 footprints have been mapped and measured. Furthermore, isolated footprints have been observed in a second layer which is largely covered by slumped detrital and several outcrops were not examined due to weather conditions. Rock samples were taken from both sites in order to refer the track-bearing layers to a specific depositional facies. These sites represent the sole evidence of dinosaurs in Turkmenistan and they are among the richest in the world.

Symposium 3 (Thursday, November 3, 11:00 am)

THE RADIATION OF HORNED DINOSAURS ON LARAMIDIA

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Horned dinosaurs (Ceratopsidae) were a major component of Campanian-aged faunas of western North America (Laramidia), and a number of recent discoveries illuminate the origin and early evolution of this clade. *Zuniceratops* and *Turanoceratops*, sister taxa to Ceratopsidae, both date to approximately 90 Ma. *Diabloceratops*, the oldest unambiguous ceratopsid, dates to 80 Ma, and is from southern Laramidia; the earliest ceratopsid fossils from northern Laramidia are known from slightly younger sediments. The sparse record for ceratopsids prior to the mid-Campanian thus prohibits a more precise assessment of the location and timing of this clade's origin, as well as of the origins of Chasmosaurinae and Centrosaurinae. During the mid- to late Campanian, interchange of ceratopsid species between northern and southern Laramidia was apparently minimal. Although some Laramidian formations exhibit a stratigraphic succession of centrosaurines and/or chasmosaurines, it is not yet possible to assess the relative roles of anagenesis and cladogenesis. The co-existence of closely related but ontogenetically distinct species (e.g., *Utahceratops* and *Kosmoceratops*) clearly indicates several cladogenic events. In other instances (e.g., *Utahceratops* and *Pentaceratops*), anagenesis is possible, but small sample sizes and a discontinuous fossil record prohibit falsification of the hypothesis. A key issue in understanding ceratopsid morphological evolution concerns the origin of the disparate frill morphologies of centrosaurines and chasmosaurines, particularly the free "blade" of the squamosal. The non-ceratopsid *Protoceratops* and the early centrosaurine *Diabloceratops* show the plesiomorphic condition of a rectangular "blade" measuring approximately twice as long as wide. The medial margin is "stepped," a feature retained in other centrosaurines but lost in chasmosaurines. Later centrosaurines expanded the lateral margin of the squamosal, preserving the plesiomorphic shape of the parietal, whereas chasmosaurines elongated the entire squamosal, creating a unique parietal morphology.

Poster Session II (Thursday, November 3)

A FUNCTIONAL EXPLANATION FOR THE PROPUBIC AND OPISTHOPUBIC PELVIS IN EXTANT ARCHOSAURS AND DINOSAURS

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One of the major characteristics of the two major dinosaur clades is the architecture of their pelvis, which is propubic in (non-avian) saurischian dinosaurs and opisthopubic in ornithischian dinosaurs. Among extant archosaurs, crocodiles are characterized by a propubic pelvis and birds by a opisthopubic pelvis. Although soft-tissues attaching to the pelvis and their function are well known for extant archosaurs, no hypothesis was established that explains the retroversion of the pubis in birds and extinct dinosaur groups. Thus, we studied the mechanical loading of the pelvis of extant archosaurs in order to provide a functional explanation for the orientation of the pubis and ischium, basing on the assumption that the shape of a bone is a response to its mechanical loading. The myology attaching to the pubis and ischium of crocodiles and birds was dissected and measured. Finite element models were created based on CT scans of the pelvis of crocodiles and birds. External forces were applied and the statical balance of the muscles was adjusted. In extant crocodiles, Mm. obliquus externus, transversus abdominis and rectus abdominis pull the pubis craniodorsally, whereas M. ilioischiocaudalis pulls the ischium caudodorsally. Mm. ischiopubis, ischiotruncus and truncocaudalis counteract these loading by pulling pubis and ischium towards each other. In birds, Mm. obliquus externus abdominis, transversus abdominis and rectus abdominis pull the pubis craniodorsally, whereas Mm. pubocaudalis externus and internus pull the distal end of the pubis caudodorsally. The Membrana puboischiadica permits the uniform loading of the pubis. According to these findings, the arrangement of the abdominal muscles is responsible for the orientation of both pubis and ischium in crocodiles and birds. Applying these findings to dinosaurs demonstrates that also the architecture of their pelvis is strongly influenced by their respiratory musculature.

Poster Session II (Thursday, November 3)

CROCODYLIFORM AQUATIC LOCOMOTION AND AXIAL FLEXIBLITY: COMPARATIVE VERTEBRAL ANATOMY OF MESOEUCROCODYLIANS

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As semi-aquatic predators, modern crocodylians display a wide range of locomotor patterns, including semi-erect high walk, sprawling low walk, and undulatory swimming. Although the functional morphology of terrestrial locomotion in crocodylians is well documented, the current understanding of swimming locomotion is restricted to observations that thrust is accomplished by using vertebral column undulations. In other undulatory swimmers, locomotor behavior is constrained by axial flexibility, which is mediated by the skeletal, muscular, and integumentary systems. For instance, regional variation in vertebral anatomy of marine undulatory swimmers underlies their relative flexibility. In crocodylians, axial mobility is also constrained by skin elasticity and osteoderm configuration. The present study seeks to characterize axial skeletal morphology in representative extant and extinct crocodyliforms, including those occupying terrestrial, semi-aquatic, and fully marine habitats. We evaluate the hypothesis that, like other swimming tetrapods, crocodylians possess specialized axial skeletal morphology related to a semi-aquatic lifestyle. The tail of crocodylians is stiffest proximally, increasing in flexibility distally. The vertebral anatomy is predicted to reflect this trend and to correlate with locomotor style.

We quantified vertebral metrics (e.g., centrum length, centrum height, neural spine height) in seven extant species, including representatives of the major crocodylian clades (e.g., *Caiman crocodilius, Alligator mississippiensis, Gavialis gangeticus*), and several mesoeucrocodylians (e.g., *Pakasuchus*, *Simosuchus*). Methods for comparing serial structures were applied to analyze the vertebral metrics. Preliminary data show that semi-aquatic and terrestrial crocodyliforms differ in that terrestrial taxa have dorsal centra that are approximately as wide as they are tall, whereas semi-aquatic crocodyliforms have dorsal centra that are wider than they are tall. This supports the hypothesis that swimming crocodyliforms have different vertebral anatomy than their terrestrial relatives, providing new insight into the biomechanics and ecomorphology of Crocodylia.

Romer Prize/Technical Session 5 (Thursday, November 3, 11:45 am)

EVIDENCE FOR NICHE CONSERVATISM IN PLEISTOCENE MAMMALS FROM EUROPE

FERANEC, Robert, New York State Museum, Albany, NY, USA; GARCIA, Nuria, Universidad Complutense de Madrid, Madrid, Spain

Niche conservatism suggests that species maintain their ecological characteristics over time, which has implications for speciation and creation of biodiversity. While the concept of niche conservatism has, in general, been supported by data, many studies on the topic do not directly examine aspects of a niche over the time span that a particular species existed. Instead, these studies use proxy data to infer niche characteristics, such as a species' geographic range. The aim for this study was to investigate the concept of niche conservatism using data that directly examined aspects of niches over time. The study focused on identifying diet and habitat use in mammals, and specifically tested the hypothesis that species maintain their ecology and ecological relationships over spatial and temporal scales during the Pleistocene of Europe.

To determine the ecology of ancient species, stable carbon and oxygen isotope values from the tooth enamel of large mammals were examined. The analysis of δ13C and δ18O values obtained from the teeth of fossil mammals has proven extremely useful for ascertaining the paleoecology of ancient species. Numerous additional samples were obtained and compared to previously published data from sites in Central and Western Europe. Results show that C3 plants dominated the Pleistocene landscape of Europe as they do today. Horses (*Equus* sp.), red deer (*Cervus elaphus*), and bovids (i.e., *Bos primigenius* and *Bison* sp.) commonly displayed the most positive δ13C values and maintained a regular ecological relationship when present together at a locality. Consistently, the most negative δ13C values were displayed by individuals in the cave bear lineage (i.e., *Ursus spelaeus, Ursus deningeri*), and suggest herbivory. For oxygen, canids (*Canis* sp.) generally displayed the most positive δ18O values, which may relate to obtaining water from a different source than the other analyzed taxa. Overall, the data show limited isotopic differences over time and between localities implying that species maintained their ecology. These data support the tested hypothesis as well as the concept of niche conservatism in Pleistocene European mammals.

Poster Session II (Thursday, November 3)

PHYLOGENETIC DIVERSITY VERSUS SPECIES RICHNESS ACROSS THE MID-MIOCENE CLIMACTIC OPTIMUM: A CASE STUDY IN CANIDS

FERRER, Elizabeth, Museum of Paleontology, Berkeley, CA, USA; MATZKE, Nicholas, University of California, Berkeley, CA, USA

To explore patterns in diversity at macroevolutionary time scales, paleontologists have traditionally counted taxa to estimate paleobiodiversity. Although these methods may be employed in phylogenetic context, they rarely account for the relative amount of evolutionary *depth* lost for each taxon. Loss of the same number of species may differentially affect the higher-level diversity in a community, depending on the taxa involved and their phylogenetic isolation from other taxa. Other biological methods that account for evolutionary depth may have value in assessing shifts in diversity in the fossil record. We tested these methods for fossil taxa using a species-level phylogeny of borophagine and canine canids and compared shifts in taxonomic versus phylogenetic diversity across the Mid-Miocene Climactic Optimum (MMCO), using methods common in modern conservation biology research. Extant communities are synchronous, and phylogenetic diversity is normally compared among different locations. In our study, phylogenetic diversity (PD) was compared across bins that were defined as time intervals. We examined these trends in canid diversity at two scales: one broader (pre- and post-MMCO), and one finer (5My intervals across the MMCO). Both scales show species richness and PD increasing before the MMCO, but since 15Mya, species richness plateaus or continues to rise (with one fall around 4 mya), while PD has greatly decreased. This shift in diversity pattern correlates with the decline of Borophaginae around the time of the MMCO and the subsequent radiation of Caninae. Borophagines include many long-branched taxa, so their loss greatly affects the PD after the MMCO. For an alternate view of PD on the overall phylogeny, we develop a method called "chainsawing": for each 5My interval, the tips of the phylogenetic tree extending past that interval in time were cut and branch lengths (equivalent to time) were recalculated. PD was measured with groups identified as either "borophagine" or "canine". We found that closer to the recent, the borophagine diversity explains more of the PD in the tree. In the future, various ways of measuring diversity in a phylogenetic context can be used, for example, by incorporating morphological, developmental, or behavioral information into branches or by defining OTUs as functional guilds. We suggest that PD metrics provide a more complex view of diversity patterns in the fossil record, and can serve as a complementary data set to other diversity measures.

Poster Session II (Thursday, November 3)

A NEW MIOCENE LOCAL FAUNA FROM THE SIERRA MADRE ORIENTAL AT SAN LUIS POTOSÍ, CENTRAL-EAST MEXICO, AND ITS PALEONTOLOGIC SIGNIFICANCE

FERRUSQUÍA-VILLAFRANCA, Ismael, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico; RUIZ-GONZÁLEZ, José, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico; TORRES HERNÁNDEZ, José Ramón, Instituto de Geología, Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico

The area lies in central San Luis Potosí State, within the Sierra Madre Oriental Morphotectonic Province, between 22o11'-22o19' N Lat. and 100o30'-100o39' W Long. The 220 m thick Tertiary sequence overlies 1200 m of Cretaceous carbonate rocks. It consists of an Oligocene unnamed meso- and fine-grained unit interbedded by basaltic lava flows and rhyolite ignimbrite sheets. This in turn is unconformably covered by a fluvio-lacustrine sequence that preserves vertebrates, mainly in the flood plain facies. This unit is overlain by a coarse-grained and volcanic sequence of Plio-Quaternary age

The vertebrate fossils include turtle, equid and cervid remains, here named the Tolentino local fauna. The equid material consists of isolated teeth and a half of a skull with left I 1-M3 and right P2-M2. The muzzle is long, and wide, the premaxillae robust. The maxillae bear a prominent, shelf-like facial crest, and a well developed dorsal preorbital fossa (DPOF) above P4. Cheek teeth are hypsodont, curved, with strong styles.

Within the Neogene horses, the Tolentino specimen suite of characters compares best with that of *Pliohippus*, in having a deep DPOF, upper cheek teeth of same size (lower part of range), and sharing significant features: hypsodont condition (M1-M3 height = > 50 mm), strongly curved cheek teeth (ROC > 40 mm); protocone connected to protoloph, smooth fossette borders, absent pli caballine. It differs from it in having a persistent hypoconal groove and protocone not connected to the hypocone. In these features, the Tolentino specimen approaches the conditions observed in *Dinohippus.*

Conservatively, it appear that the Tolentino specimen represents at least a new *Pliohippus* species, seemingly progressing toward *Dinohippus*.

Besides the abundant horse material, scarce remains of a cervid (small) and a camelid (large) were found. Dating the Tolentino l.f. largely hinges upon the odontographic development degree of *Pliohippus* n. sp., which is comparable with that of the North American Late Clarendonian-Hemphillian equines.

In México, Hemphillian equines are known from the central and northwest, thus the Tolentino l.f. adds to the meager Miocene mammal record of central-east Mexico.

Poster Session III (Friday, November 4)

A NEW MARINE TETRAPOD ASSEMBLAGE FROM THE EOCENE OF WESTERN SAHARA

FIELD, Daniel, Yale University, New Haven, CT, USA; RACICOT, Rachel, Yale University, New Haven, CT, USA; UHEN, Mark, George Mason University, Fairfax, VA, USA

Late Eocene basilosaurid archaeocete whales in Africa have been reported from Egypt, Libya, Tunisia, and Senegal. Recently, they have also been reported from the Samlat Formation, which outcrops in coastal Western Sahara. On the basis of its shark fauna, at least part of the formation has been roughly assigned to the late Eocene, approximately 37 to 34 million years before present. Fieldwork in March 2011 yielded numerous marine tetrapod fossils, in addition to a single ? *Numidotherium* tooth, a single basilosaurid tooth, and abundant selachian remains that have already been described. Tetrapod remains include several specimens of both large and small archaeocete whales (tentatively identified as *Basilosaurus* sp. and *Dorudon* sp., as well as an additional even smaller basilosaurid), marine crocodiles and rare turtles. On the basis of preliminary results from ongoing analyses, the marine tetrapod as-

semblage appears to be similar to that from late Eocene beds of the Fayum, Egypt. Although we are awaiting detailed biostratigraphic results from analysis of marine dinoflagellates, the Samlat Formation's tetrapod fauna supports its referral to the late Eocene as indicated by the selachian fauna. The excellent quality of preservation and abundance of the vertebrate material from this region make these poorly understood fossil beds extremely promising, and have the potential to yield new insights into the paleobiogeography and diversity of late Eocene archaeocetes.

Poster Session II (Thursday, November 3)

A FOURTH SPECIES OF *APATEODUS* (TELEOSTEI: AULOPIFORMES) AND ITS IMPLICATIONS TO THE DIVERSITY OF *APATEODUS*

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Apateodus is a Late Cretaceous aulopiform fish genus of the suborder Ichthyotringoidei previously known by only three species, the North American *A. busseni* and the European *A. glyphodus* and *A. striatus*. Here, we describe a second North American species of *Apateodus* based on a partial skeleton (AMNH FF 11560) from the Smoky Hill Chalk Member of the Niobrara Formation of western Kansas, which is housed in the American Museum of Natural History, New York. We place AMNH FF 11560 within the *Apateodus* based on the diagnostic presence of a diastema between the first and second palatine teeth that is filled by teeth from the dentary when occluded. This unique feature is not found in any other fossil aulopiform taxa. It is a new species based on the large hyomandibula and metapterygoid. It shares several features of the mandible with *A. busseni* that differ from conditions in *A. striatus*. These include a more slender mandible, thinner dentary teeth, the angular only making up about 20% of the mandible, and a more prominent retroarticular process. Like *A. busseni*, this new species was slender fish. Whereas *A. busseni* is known from Kansas, *A. glyphodus* and *A. striatus* are from the UK and Belgium, isolated bones and teeth of *Apateodus* have been reported from localities worldwide including Germany, southwestern Russia, India, western Canada, western USA, and Bolivia. Additionally, there is an isolated mandible, also from the Smoky Hill Chalk, that is likely to be another species of *Apateodus*. The recognition of the fourth species of *Apateodus* is significant because it provides a reasonable assertion that the genus, which geologically ranged from the Albian to Maastrichtian, was likely much more speciose than what is known today.

Poster Session II (Thursday, November 3)

A NEW SPECIMEN OF *ARARIPESUCHUS* (MESOEUCROCODYLIA) WITH SOFT TISSUE PRESERVATION FROM THE LOWER CRETACEOUS ROMUALDO FORMATION (ARARIPE BASIN), BRAZIL

FIGUEIREDO, Rodrigo, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The Araripe Basin is famous worldwide for its two fossillagerstätten: the Lower Cretaceous (Aptian-Albian) Crato and Romualdo Formations of the Santana Group. Of those, the Romualdo Formation has shown several vertebrates with soft tissue preservation, particularly observed in fishes but also very rarely in dinosaurs and pterosaurs. Here we report a new specimen of the crocodyliforms *Araripesuchus* sp. that shows soft tissue in several portions of the skeleton. The specimen (MN 7061-V) is almost complete, including skull, lower jaw, partial fore and hind limbs, and most of the vertebral column, which is covered by two rows of osteoderms. The morphology of the rostrum is alike that of other *Araripesuchus* species allowing the assignment of this material to that genus. The orbit size and its proportions in MN 7061-V are similar to *A. gomesii*, but rather smaller than in *A. wegeneri*, *A. patagonicus*, *A. buitreraensis*, and *A. tsangatsangana*. MN 7061-V has long and slender limbs, which are also reported in *A. gomesii*, *A.wegeneri* and *A. tsangatsangana*. This is consistent with the current idea of araripesuchids as cursorial animals. The main feature of this specimen is the preservation of large portions of soft tissue close to the abdominal region and along the axial skeleton. It is preserved as a white substance and is most likely phosphatized, similarly to what has been observed in other reptiles from this deposit. Preliminary studies under UV light shows that most of the soft tissue is composed of muscle fibers, but in some parts the epidermis is also visible. A large mass of white substance is observed anterior to the pelvic region, but no stomach contents could be identified yet. To our knowledge, MN 7061-V shows the best soft tissue preservation in an extinct member of the Crocodyliformes.

Poster Session III (Friday, November 4)

MAMMALIAN FAUNAL DYNAMICS IN NORTH AMERICA OVER DEEP TIME

FIGUEIRIDO, Borja, Brown University, Providence, RI, USA; JANIS, Christine, Brown University, Providence, RI, USA; PÉREZ-CLAROS, Juan, University of Málaga, Málaga, Spain; PALMQVIST, Paul, University of Málaga, Málaga, Spain

We show here that the North American fossil record of large Cenozoic mammals can be summarized by six evolutionary faunas, each characterized by the predominance of a cluster of associated taxa (subfamilies) over sequential time intervals. These faunal groupings were determined by a *Q*-mode factor analysis of taxonomic presence/absence data. The data were binned into 26 subequal time intervals, and we selected those factors with eigenvectors greater than one, which were subsequently extracted and rotated by the interative procedure of VARIMAX. Also, these factors were statistically coherent. This resulted in six significant factors, signifying six sequential episodes of faunal associations over the past 65 million years.

This methodology shows that 85% of the complexity of the Cenozoic North American mammalian fossil record can be summarized in six successional evolutionary faunas each composed by a specific association of taxa. Following their temporal distributions we recognize these faunas as follows: *(i)* Paleocene fauna; *(ii)* early-middle Eocene fauna; *(iii)* middle-late Eocene fauna; *(iv)* the "Oligocene fauna"; *(v)* Miocene fauna; and *(vi)* Plio-Pleistocene fauna or Modern fauna .These evolutionary faunas fit well with previously proposed "Chronofaunas" based on qualitative assessments.

We also show, in a more qualitative fashion, that the rise and fall of each fauna is associated with changes in the paleotemperature curve, allowing us to infer climatic influences on changing faunal dynamics over Cenozoic mammalian evolution.

Technical Session XVI (Saturday, November 5, 9:30 am)

RE-DESCRIPTION OF THE SKELETAL ANATOMY OF *CHONDRENCHLYES PROBLEMATICA* AND ANCESTRAL CONDITIONS IN THE HOLOCEPHALI

FINARELLI, John, University of Chicago, Chicago, IL, USA; COATES, Michael, University of Chicago, Chicago, IL, USA

Recent sequencing of the elephant shark genome has increased interest in holocephalans as model systems in early gnathostome evolutionary biology. As such, fossil holocephalans have the potential to provide important tests to hypotheses derived from extant taxa. For example, a recent study of the dentition of the Mississippian (Viséan) holocephalan, *Chondrenchelys problematica*, overturned hypotheses of toothplate formation in holocephalans and provided critical understanding of the evolution of the developmental mechanisms in early gnathostome teeth. Here we re-describe the skeletal anatomy of *Chondrenchelys*, taking advantage of three new and exceptionally-preserved specimens.

Modern holocephalans display a suite of distinctive morphologies. While *Chondrenchelys* does possess key features of holocephalans (e.g., toothplates, a holostylic palatoquadrate), the new specimens preserve features not observed in extant holocephalans (e.g., claw-like denticles lining the rims of the pectoral fins). *Chondrenchelys* also lacks the polyspondylous axial skeleton and sub-otic gill basket characteristic of extant holocephalans.

Chondrenchelys' skull has a jaw articulation posterior to the orbit, prominent occipital angles, foramina for the superficial ophthalmic nerve on the dorsal aspect of the skull, and widely separated orbits without an interorbital septum. Additionally, there is no ethmoid canal and the orbits are not displaced dorsal to the neurocranium. Therefore, in overall form, the skull of *Chondrenchelys* appears more similar to elasmobranchs than holocephalans. However, the large orbits, short postorbital region, and high-walled rostrum imply an adductor mandibularis muscle inserting on the rostrum, as in extant holocephalans. Thus, the new specimens demonstrate that the unique holocephalan masticatory apparatus and the position of the gill arches under the skull are not causally linked as has been hypothesized. *Chondrenchelys* demonstrates that modern holocephalans are highly apomorphic and represent a relatively recent radiation. Extant morphological diversity in this clade cannot be assumed as primitive for chondrichthyans, or more generally, gnathostomes.

Symposium 3 (Thursday, November 3, 8:00 am)

CRETACEOUS DINOSAURS OF ALASKA: IMPLICATIONS FOR BIOGEOGRAPHY IN ANCIENT BERINGIA

FIORILLO, Anthony, Museum of Nature and Science, Dallas, TX, USA; TYKOSKI, Ronald, Museum of Nature and Science, Dallas, TX, USA

The latest Cretaceous continental rocks of Alaska contain the richest record of sub-polar and polar dinosaurs found anywhere in the world. The vertebrate record, known primarily from northern and south-central Alaska and to a lesser extent from other correlative sections around the state, comprises both body and trace fossils. The dinosaurian record includes small and large theropods, ankylosaurs, hypsilophodontids, hadrosaurids, pachycephalosaurs, and ceratopsids. In addition to these taxa, fossil fishes and mammals are also represented. Radiometric dating (69 Ma – 70 Ma) and biostratigraphy suggest this fauna is Early Maastrichtian in age. The combined fauna shows that ancient Alaska contained significant vertebrate biodiversity during the Cretaceous. Rather than being oddities within present geography, plate tectonic reconstructions of the microplates containing these fossiliferous sections show that Late Cretaceous fossil vertebrates from Alaska were animals that actually lived in the high latitudes. The accretion of terranes in the region between Asia and North America created a land bridge, sometimes referred to as Beringia, by approximately 100 Ma, thus connecting the two continents and generating the pathway for faunal exchange between previously disconnected landmasses. Though many taxa likely used this land bridge, the known record of Alaska shows that neoceratopsians were among the first to cross Beringia. Additionally, the fossil bird footprint record suggests that Cretaceous birds from Asia and North America may have used Cretaceous Beringia in a manner similar to modern migratory birds in Alaska. Though aspects of the fauna show adaptation to life in an environment that experienced extreme seasonality, adaptation does not warrant the establishment of a new faunal province at this time.

Poster Session I (Wednesday, November 2)

NEW OPHTHALMOSAURIDS FROM EUROPE AND RUSSIA BROADEN THE BIODIVERSITY OF EARLY CRETACEOUS ICHTHYOSAURS
FISCHER, Valentin, RBINS, Brussels, Belgium

Ophthalmosauridae is a successful clade of ichthyosaurs that rapidly diversified during the Middle Jurassic. By Late Jurassic, Ophthalmosauridae were diverse, widespread, and formed an important component of the marine trophic webs. By contrast, the record of Berriasian-Aptian ichthyosaurs is extremely poor, and all ichthyosaurs from that interval have been referred to a single genus, *Platypterygius*, until recently. This apparent diversity drop led numerous authors to recognize a severe ichthyosaur extinction at the end of the Jurassic that left ichthyosaurs as a small group on the decline. New specimens from poorly sampled time periods (late Valanginian, late Hauterivian and late Barremian) in Europe and Russia contradict this latest Jurassic extinction hypothesis and show that new and highly derived as well as typically 'Late Jurassic' ichthyosaurs roamed the Eurasian archipelago during the Early Cretaceous. Moreover, these new forms occupied ecological niches markedly different from that of *Platypterygius*, significantly broadening the disparity and ecological diversity of Cretaceous ichthyosaurs.

Romer Prize/Technical Session 5 (Thursday, November 3, 10:30 am)

SNOWMASS: PROBOSCIDEAN PALEOBIOLOGY BEFORE THE BEGINNING OF THE END
FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; ROUNTREY, Adam, University of Michigan, Ann Arbor, MI, USA

The Snowmass site in west-central Colorado preserves a diverse, high-elevation Pleistocene biota spanning an interval from about 150,000 yrBP to > 45,000 yrBP. Snowmass proboscideans include at least four mammoths and more than eight mastodons. The best-preserved mammoth, a partly articulated young-adult female, was found in peat near the top of the sequence of lacustrine deposits. Her dental traits are typical for *Mammuthus columbi*, with none of the "*M. primigenius*-like" traits that occur in late Pleistocene mammoth populations in the Great Lakes region, often referred to *M. jeffersonii*. The mosaic intermediacy seen in this nominal species may reflect hybridization between *M. columbi* and *M. primigenius*, but we see no morphologic evidence of such interaction in this earlier Rocky Mountain population.

Snowmass *Mammut americanum* occur mostly in the lowest levels at the site and include multiple adult males, one adult female, and at least two juveniles represented by a dp2, a dp3, and a deciduous mandibular tusk (the latter two could derive from one individual). The permanent upper tusks of Snowmass mastodons have a strongly "fluted" dentin-cementum interface, with regularly spaced grooves that spiral about the tusk axis. Both the amplitude of fluting and the degree of twist are accentuations of features normal for later Pleistocene mastodons of the Great Lakes region. Both the dp2 and the di2 (and possibly the dp3) have accentuated incremental features in the coronal dentin that we identify as neonatal lines, and in each case, they are in positions consistent with recently documented neonatal lines in comparable teeth in mammoths. These observations suggest that Snowmass mastodons had a dental formation and eruption schedule that at least started off in a manner similar to that of mammoths. Proboscidean life history data from Snowmass (especially on growth rates and seasons of death) will establish a baseline from a time well before the end-Pleistocene extinction, against which life history changes associated with the extinction may be better interpreted.

Preparators' Session (Thursday, November 3, 12:00 pm)

A TUTORIAL ON TIME-LAPSE PHOTOGRAPHY FOR ONLINE DISSEMINATION OF PALEONTOLOGICAL SCIENCE: FOSSIL PREPARATION, SKELETAL MOUNTING, AND FLESH MODEL RESTORATION AS EXAMPLES
FITZGERALD, Erin, University of Chicago, Chicago, IL, USA; SERENO, Paul, University of Chicago, Chicago, IL, USA; KEILLOR, Tyler, University of Chicago, Chicago, IL, USA

The use of photography to create time-lapse movies has the potential to vividly capture important sequential activities in paleontology, such as fossil preparation, skeletal mounting, and flesh model reconstruction. These common activities, which are often depicted much less effectively in still photos, can be brought to life in movie for lecture, exhibit, film, or online dissemination. The expenses involved are minimal and the benefits are long-term. We created a time-lapse tutorial which will be posted online to outline best practices in the creation of time-lapse movies. This tutorial covers image framing, stage and lighting, camera settings (shutter speed, aperture, etc.) and incorporation of static graphics, computed-tomographic animation, and sound. We also discuss strategies during preparation, modeling and mounting that will result in the most effective time-lapse movies. The time has come to bring fellow scholars and the public common sequential activities in paleontological laboratory work via effective cost-efficient media productions.

Poster Session I (Wednesday, November 2)

A NEW BOMBINATORID FROG FROM THE EARLY EOCENE OF VASTAN, GUJARAT, INDIA
FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; RANA, Rajendra, H.N.B. Garhwal University, Srinagar, India; ROSE, Kenneth, Johns Hopkins University School of Medicine, Baltimore, MD, USA; KUMAR, Kishor, Wadia Institute of Himalayan Geology, Dehradun, India; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The rich vertebrate assemblage of the lower Eocene (Ypresian) Cambay Shale Formation at Vastan Lignite Mine, located north-east of Surat in Gujarat, western India, has recently received particular attention. This fauna includes the earliest modern mammals and oldest birds of the Indian subcontinent. The herpetological fauna is represented by snakes, lizards and amphibians.

Among the amphibians that have been reported from Vastan, the most numerous remains belong to a bombinatorid frog. All the bones have been grouped together based on their morphology, relative size and abundance, allowing identifying a juvenile and an adult form. Within the Discoglossoidea, the family Bombinatoridae includes only the extant genera *Bombina* and *Barbourula*. The three-dimensional isolated fossil vertebrae present a particular pattern of articulation similar to a zygosphene-zygantrum complex that makes the Vastan taxon close to these extant genera. However, the position and shape of the tuber superius on the ilium, the shape of the diapophyses on the sacral vertebrae and the size of the adult form prevent the attribution to both *Bombina* and *Barbourula*. The specimens referred to this Vastan taxon are therefore attributed to a new genus and species.

The Bombinatoridae are aquatic toads known from Eurasia. *Barbourula* is restricted to Borneo and the Philippine Islands, and no fossil record is known for this genus. *Bombina* occurs mainly in Europe and Eastern Asia, and its earliest record is from the Miocene of Germany. The new Vastan genus and species thus represents the earliest record of the family. Moreover, the presence of a bombinatorid frog in India suggests a Gondwanan origin for this group, with dispersal to Eurasia via Greater India, as suggested by molecular phylogenies.

Technical Session XIX (Saturday, November 5, 2:00 pm)

A NEW LATE OLIGOCENE ARCHAIC SQUALODONTID FROM NEW ZEALAND
FORDYCE, Robert, Dept Geology, University of Otago, Dunedin, New Zealand

Species of Squalodontidae (Cetacea: Odontoceti) are reported widely from the Late Oligocene to Middle Miocene, but most are fragmentary and enigmatic. A new long-jawed archaic species from New Zealand is revealing for morphology and relationships, and adds to the diversity and disparity of Oligocene squalodontids. The specimen is OU22457, Geology Museum, University of Otago: an adult skull of condylobasal length 74.5 cm, and part skeleton; Milburn Limestone, Waitakian local stage, Late Oligocene. The skull has robust jaws, procumbent incisors, and close-spaced emergent cheekteeth (11 post-canines) with strongly denticulate crowns carrying prominent, anastamosing and nodular/papillate ornament; posterior maxillary teeth have a third lingual root. Teeth are worn, both on apices and denticles (possibly from a durophagous diet) and on labial and lingual faces (from occlusion). The long symphysis is unfused; the panbone and mandibular fossa are large. The facial fossa for nasofacial (echolocation) muscles does not expand far over the temporal fossa, and there is an intertemporal constriction. The supraoccipital is primitively subrectangular. The forelimb shows features attributed to Platanistoidea: vestigial coracoid, prominent acromion, reduced supraspinous fossa. Some tooth and periotic features appear intermediate between Squalodontidae and *Prosqualodon* (supposed Prosqualodontidae), blurring putative family distinctions. The new skull is topotypic with, and phenetically close to, prominently ornamented teeth attributed to "*Squalodon*" *andrewi*, but whether conspecific is uncertain. In conventional taxonomy, OU22457 represents a new genus. The record of squalodontids, which is mostly patchy and poorly-documented beyond the North Atlantic, shows that the clade was established by the start of the Late Oligocene, and was widespread by the start of the Miocene. Its extinction later in the Miocene is still perplexing.

Poster Session IV (Saturday, November 5)

ECOLOGICAL SEGREGATION OF THE LATE JURASSIC ORNITHISCHIAN DINOSAURS *STEGOSAURUS* AND *CAMPTOSAURUS* (MORRISON FORMATION, NORTH AMERICA): WAS IT PRONOUNCED OR SUBTLE?
FOSTER, John, Museum of Western Colorado, Grand Junction, CO, USA

The Upper Jurassic Morrison Formation of western North America has yielded a number of specimens of the ornithischian dinosaurs *Stegosaurus* and *Camptosaurus*, and many of these specimens come from channel sandstone deposits. Six new specimens from western and central Colorado (four stegosaur, two camptosaur) are recorded mostly from channel sandstones as well. Indeed, early analyses of site occurrences (reducing the effects of large single-site samples) suggested that *Stegosaurus* and *Camptosaurus* were more often found in channel sandstone deposits than other common dinosaurs of the Morrison Formation such as *Camarasaurus* or *Diplodocus*. This also indicated the possibility of ecological segregation of the former two genera from other herbivorous dinosaurs of the Morrison; this pattern suggested that these ornithischians may have been restricted to drier, upland areas from which their remains would have been washed into channels and transported to more lowland localities. Revisiting this question with additional data suggests the pattern may not be as strong as it once appeared. Analysis of occurrence data indicates that *Stegosaurus* and *Camptosaurus* occur in channel sandstone deposits slightly more frequently than the two sauropods (*Ca-*

marasaurus and *Diplodocus*), but statistical analysis of this pattern by either localities or individuals indicates little significance to the trend. However, *Camptosaurus* appears more strongly associated with channel sandstone deposits relative to other dinosaurs than does *Stegosaurus*. These results suggest that any ecological segregation of these genera was moderate, but that, if present, it was more pronounced in *Camptosaurus*.

Poster Session IV (Saturday, November 5)

NEW LAGOMORPH MATERIAL FROM THE EOCENE-OLIGOCENE BOUNDARY OF WYOMING AND IMPLICATIONS FOR THE PHYLOGENY OF *CHADROLAGUS* AND *LITOLAGUS*

FOSTOWICZ-FRELIK, Lucja, American Museum of Natural History, Division of Paleontology, New York, NY, USA; MENG, Jin, American Museum of Natural History, Division of Paleontology, New York, NY, USA

Stem lagomorphs from late Early Eocene to Late Miocene are a diverse group with over 20 genera. Among North American lineages, *Chadrolagus* and *Litolagus* were proposed as sister taxa on the basis of some dental characters, including full hypsodonty and acceleration in the development of the occlusal enamel pattern. Recent reexamination of the lagomorph material from the classic Eocene-Oligocene fossiliferous sites in Wyoming (Flagstaff Rim, Douglas, and Lusk vicinities) revealed new excellently preserved cranial material of *Litolagus molidens* and remains of a new species of, so far monotypic, *Chadrolagus*. The skull of *Litolagus* is characterized by a larger basicranial angle and significantly shortened palate with reduced palatine portion; the orbits are enlarged due to the elevated frontal and the lowered zygomatic arch. A phylogenetic analysis based on 40 cranio-dental characters of 12 lagomorph taxa indicates that *Litolagus* is not an immediate descendant of *Chadrolagus*, but is more closely related to *Archaeolagus* and *Lepus*. In terms of morphology, *Litolagus* is the most advanced Oligocene lagomorph known, which may be directly related to extant Leporidae. The new species of *Chadrolagus* is significantly larger than *C. emryi* and has a more molariform P3 and a deeper mandible body. Finally, the results of our analysis suggest a paraphyly of *Palaeolagus* as currently understood.

Poster Session IV (Saturday, November 5)

REASSESSING CERATOPSID DIVERSITY USING UNIFIED FRAMES OF REFERENCE

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A "diversity first" approach to dinosaur taxonomy interprets morphological variation as diagnostic of unique taxa, leading to an explosion of species. Description of differing morphologies is useful and important for our understanding of evolution; however, disparity is not always indicative of diversity. An alternative to "diversity first" is "Unified Frames of Reference" (UFR): a method that analyzes morphology in context with ontogeny, stratigraphy, phylogeny, geography and taphohistory. Using UFR, work on *Triceratops* (Ceratopsidae) shows that 18 historically described taxa instead represent ontogenetically variable morphologies within chronospecies of a single unbranching lineage. Similar cases have been presented for Lambeosaurinae (Hadrosauridae) and Centrosaurinae (Ceratopsidae). Here we show that several newly described ceratopsids are more parsimoniously interpreted as ontogenetic morphs of existing taxa, with important implications for paleobiological interpretation. Predictable ontogenetic changes in cranial morphology (including more pointed frill episossifications; short broad squamosals; unresorbed postorbital horns) suggest that *Mojoceratops* and *Kosmoceratops* represent immature individuals of stratigraphically equivalent taxa *Chasmosaurus* sp. and *C. irvinensis* (respectively). *Titanoceratops* presents the opposite case, exhibiting characters expected of a mature *Pentaceratops* (extensive cornual sinus; anteriorly directed postorbital horn cores; broad, blunt episquamosals). Other recently described ceratopsids are problematic in that they are based on incomplete material, but it is likely that at least some pertain to already recognized species. A subtle north-south biogeographic signal in ceratopsids is supported, but extreme faunal endemism dissolves through application of UFR. This revision also suggests that cladogenesis in Ceratopsidae is limited to the Middle Campanian (80.6-76.4 Ma), after which there is currently no evidence of further branching. Why this short period should correspond to an unusual burst of cladogenesis is unknown, but it helps focus the search for potential geographic or other barriers that drive speciation.

Symposium 1 (Wednesday, November 2, 10:15 am)

HOX GENE EXPRESSION AND ANATOMICAL DIFFERENCES IN ARCHOSAURIA

FOWLER, Donald, Redpath Museum and Department of Biology, McGill University, Montreal, QB, Canada; DE BAKKER, Merijn, Department of Integrative Zoology, Institute of Biology, Leiden University, Leiden, The Netherlands; RICHARDSON, Michael, Department of Integrative Zoology, Institute of Biology, Leiden University, Leiden, Netherlands

Developmental and genetic studies hold promise to establish a mechanistic basis of anatomical differences. The Hox gene clusters have provided rich results to study these developmental differences that result in different anatomies. Changes in axial Hox gene expression are at least partly responsible for the loss of forelimbs in snakes. The function of the posterior HoxD cluster genes in the limb from mutational mice experiments provides the basis for hypotheses on their effect on adult limb proportions. HoxD11 is hypothesized to increase zeugopodial and autopodial length with increased expression, reducing this expression should reduce these lengths proportional to the stylopod. Here, the expression patterns of HoxD11 were analyzed using *in situ* hybridization of six archosaurs, from Nile crocodiles to zebra finches. The expression data was compared to the limb proportions in adult specimens of the species and other archosaurs. The resulting comparisons do not show any clear correlations between expression data and limb proportions, providing little indication in the way the developmental systems of other birds or ancestral theropods have changed to produce their diverse anatomies. This highlights the difficulty in making these hypothesis statements. The hopeful correlations between genes and anatomy must find the intervening systems acting in a way that facilitates such reasoning. Lengths and proportions, unlike other phenotypic characters, typically confound these types of studies with many genes partially responsible for their adult phenotype. But beyond finding the responsible genes, is organizing them into a mechanism that can create real anatomy. Models using regulatory state networks have provided some data that indicate further hypotheses of the nuances through which Hox genes influence limb anatomy. With these, the promise of developmental studies on understanding anatomy can start to be fulfilled.

Poster Session IV (Saturday, November 5)

COMPARING CLIMATE CHANGE AND MAMMALIAN TAXONOMIC RICHNESS IN THE NEOGENE OF THE GREAT PLAINS, USA

FOX, David, University of Minnesota, Minneapolis, MN, USA; MARCOT, Jonathan, University of Illinois, Urbana, IL, USA

Climate is hypothesized to be a major driver of biotic evolution. Previous studies generally show a weak relationship between past global temperature (from benthic foram δ18O) and mammalian richness, possibly because forams do not faithfully reflect local continental climate. We examine the relationship between climate and richness in the Great Plains using δ18O of pedogenic carbonates and mammalian tooth enamel from Neogene localities in Nebraska and Texas as climate proxies and sampling-standardized estimates of mammalian taxonomic richness from the same regions. We use published and unpublished isotopic data that include 184 pedogenic carbonates from measured sections, 181 teeth of large-bodied ungulates, and 196 teeth of glires from 64 distinct localities. Isotopic and fossil occurrence data were aggregated into 1.5 My bins from 0-15 Ma to provide a common timescale and to allow for sampling standardization; not all bins in each region have isotopic or richness data. Based on modern climatic and mammalian richness gradients, we predict a positive correlation between δ18O values and richness. Paleosol and ungulate δ18O values preserve reasonable latitudinal gradients through time, although slopes vary. Paleosol δ18O in Nebraska is highest in the Early Miocene and lower in the Late Miocene, and ungulate values are highest in the Middle Miocene and lower in the Plio-Pleistocene, which is broadly consistent with Neogene cooling; values for glires have no obvious temporal trend. Isotopic records in Texas are relatively invariant through time. Sample-standardized richness in Nebraska was consistently higher than in Texas, likely due to fewer localities in Texas. In Nebraska, δ18O of ungulates and glires have positive correlations with generic, but not species, richness; surprisingly, both generic and species richness have negative correlations with paleosol δ18O values. Richness in Texas is invariant in relation to all isotopic records. Our results are consistent with minimal climate change in Texas and climatic sensitivity of richness if tooth enamel δ18O is the more reliable record of local climate at localities in Nebraska.

Poster Session IV (Saturday, November 5)

DENTAL AND CRANIAL STRUCTURE OF LAINORYCTES (MAMMALIA: EUTHERIA; PALAEORYCTIDAE)

FOX, Richard, University of Alberta, Edmonton, AB, Canada; SCOTT, Craig, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Lainoryctes was described based on a maxilla with P3-4, M1-3, from the late Paleocene Paskapoo Fm., near Red Deer, Alberta, Canada. The upper molars are short and wide, paracone and metacone are connate, and the main cusps and crests are tall and sharp, characters of early Tertiary Palaeoryctidae. Lainoryctes is now represented by skull, lower jaws, and near-complete upper and lower adult dentitions, including features not known before in palaeoryctids. The dental formula is ?/3, 1/1, 3/3, 3/3. The premolariform C1 is two-rooted, P2 is one-rooted, the three-rooted P3 can have a small lingual lobe (or not), P4 is submolariform, with an incipient metacone; i1 is small, i2 the largest lower incisor, i3 is tiny, c1 caniniform and one-rooted, p2 one-rooted, p3 two-rooted, p4 is submolariform; the molars have high trigonids and narrow, skewed talonids. The Lainoryctes rostrum is short and high, the infraorbital canal long, and the lacrimal is covered externally by the maxilla; the frontal overlaps the maxilla; the lacrimal, maxilla, and palatine meet in the orbit. The zygomatic arch is incomplete, the jugal absent. Posterolaterally, the squamosal forms a lambdoid plate, convergent on that in Apternodus. The middle ear is partly shielded by the entotympanic and by the petrosal rostral process; the epitympanic recess is greatly expanded. The internal carotid artery divides into stapedial and promontorial branches, not enclosed in bony tubes; a groove on the petrosal for the promontorial branch is individually variable in occurrence. The dentary is slender, the coronoid process tall, the condyle transversely widened, and the angular process hooked. Lainoryctes most closely resembles Palaeoryctes, Eoryctes, and Ottoryctes in shared, derived features. It shows no special resemblance to Pararyctes, sometimes included in Palaeoryctidae, nor to "Cimolestidae", often purported to be ancestral to palaeoryctids. Instead, our preliminary analysis suggests that contrary to traditional opinion, these three lineages convergently evolved a faunivorous protozalambdodont dentition.

Poster Session I (Wednesday, November 2)

STASIS IN LATE QUATERNARY BIRDS FROM THE LA BREA TAR PITS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

FRAGOMENI, Ashley, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA

The emphasis on gradual evolution in response to climatic change, as typified by the studies on Galapagos finches, suggests that birds should respond with changes in body size and shape to significant changes in climate. We examined the most commonly fossilized birds at Rancho La Brea to see if there were measurable changes during the last glacial-interglacial cycle. Measurements of the tarsometatarsi of the common birds, such as the bald eagle (*Haliaeetus leucocephalus*), the extinct California turkey (*Meleagris californica*) and the caracara (*Caracara plancus prelutosus*) showed complete stasis for the last 35,000 years, with no statistically significant size or robustness changes even during the peak glacial interval at 20,000 years ago, when the climate at Rancho la Brea was dominated by closed-cone coniferous forests and snowy winters. Even though birds such as the bald eagle and caracara show a strong Bergmann's rule effect, with larger body sizes in colder climates, the bald eagles and caracaras at Rancho La Brea did not change in size during the coldest period of the glacial maximum. These results, along with previously documented examples of La Brea condors and golden eagles, suggest that birds are not as sensitive to long-term changes in climate as is traditionally thought.

Technical Session XIII (Friday, November 4, 2:15 pm)

MODEL SELECTION AND THE PHYLOGENETIC COMPARATIVE METHOD: RUMINANT GRAZERS DO NOT HAVE LARGER MASSETER MUSCLES

FRASER, Danielle, Carleton University, Ottawa, ON, Canada

Non-phylogenetically controlled analyses have shown that the masseter muscle is largest in ruminant grazers due to their requirement for powerful lateral translation of the mandible during mastication. To illustrate the effects of evolutionary model choice on the phylogenetic comparison of traits, I used ruminant cranial morphology as a test case. I tested the hypotheses that masseter mass is correlated with percent dietary grass and that linear measurements of the masseteric attachment sites (length of the superficial masseteric scar, width of the masseteric insertion area, height of the jaw glenoid) could be used to predict muscle mass using phylogenetic generalized least squares regression. Four different evolutionary models were applied including Brownian motion, Grafen's scaling of branch lengths, Blomberg's model of variable evolutionary rates, and the Ornstein–Uhlenbeck model of stabilizing selection. Standard selection techniques (Akaike Information Criterion) were used to evaluate model fit. The Brownian motion model was best-fitted (lowest AIC values) to the cranial metrics. Only the length of the superficial masseteric scar (origination site of the masseter) showed correlated evolution with masseter mass, suggesting that the other two cranial metrics cannot be used to estimate masseter size in ruminants. Blomberg's model, which did not show correlated evolution of masseter mass and percent dietary grass, was best-fitted. Grafen's model provided the poorest fit in all cases. Type I error rates and thus the biological interpretation of the data also varied among models. These results suggest that the ruminant activity of chewing cud has relaxed selection for larger chewing muscles in grazers. Alternatively, a positive relationship between body mass and percent dietary grass suggests that body mass is a more important determinant of digestive efficiency than chewing muscle size. Further, these results highlight the importance of phylogeny in comparative analyses and of using model selection techniques in testing evolutionary hypotheses.

Poster Session IV (Saturday, November 5)

A QUANTITATIVE CLADISTIC RECONSTRUCTION OF CRANIOFACIAL ONTOGENY IN *PROTOCERATOPS ANDREWSI*

FREDERICKSON, Joseph, University of Wisconsin-Milwaukee, Milwaukee, WI, USA

Protoceratops andrewsi, a small neoceratopsian dinosaur from the Late Cretaceous of Mongolia, is known from multiple specimens that represent a growth series ranging from hatchling to adult. Prior to this study assessment of maturity level for *P. andrewsi* has been based largely on the size and shape of the skull, which is complicated by the presence of two skull morphologies in the largest skulls. These two skull morphologies are hypothesized to represent sexual dimorphism, where the hypothetical males have a deep skull and the hypothetical females have a shallow skull. The goal of this study was to reconstruct the ontogenetic changes that occur in the skull of *P. andrewsi* through a quantitative cladistic analysis and to independently test the hypothesis of the presence of sexual dimorphism. Seven specimens were analyzed (three hypothetical females, two hypothetical males and two juvenile skulls) using 96 hypothetical growth characters that were culled from the primary literature. The analysis resulted in 1 most parsimonious tree, of 70 steps with a CI of 0.71. This analysis of growth in *P. andrewsi* demonstrates that size roughly correlates to maturity level. Only one specimen, a small hypothetical male, was found to be relatively more mature than specimens larger in basal skull length. This study shows that as the animal matures the skull of *P. andrewsi* deepens, the nasal horn becomes taller, and the frill becomes highly inclined. The sexual dimorphism hypothesis is not clearly falsified from this analysis. The hypothetical female specimens grouped together near the middle of the ontogram, indicating the possibility that these specimens represent a subadult growth stage instead of sexual dimorphism. The results could also be interpreted as a case of sexual dimorphism, where the hypothetical males demonstrate a derived condition that is not present in the juveniles or hypothetical females.

Symposium 4 (Friday, November 4, 9:00 am)

VERTEBRATE DIVERSITY ACROSS THE END-PERMIAN EXTINCTION - SEPARATING BIOLOGICAL AND GEOLOGICAL SIGNALS

FRÖBISCH, Jörg, Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin, Berlin, Germany

The greatest mass extinction in Earth's history at the end of the Permian had a major impact on ecosystem composition in the oceans and on land alike. The current study focuses on diversity patterns of Permian-Triassic terrestrial vertebrates at the regional scales of the South African Karoo Basin and the Russian fore-Ural region. Previous studies clearly established that specifically the diversity of synapsids, the dominant terrestrial tetrapods of their time, is significantly biased by heterogeneity in the Permian-Triassic terrestrial rock record. This has been demonstrated by revealing a positive correlation between taxonomic diversity estimates (TDEs) and varying sampling proxies: (1) number of formations and (2) outcrop area. Recently, these proxies have been criticized to be non-independent variables and (3) number of localities or (4) number of specimens has been suggested as more reliable proxies. In the present study, I tested the relevance of the latter proxies with respect to vertebrate diversity in South Africa and Russia. On these regional scales, log-transformed and generalized differenced TDEs of vertebrates at varying taxonomic levels are not significantly correlated with the number of localities or specimens for the complete time series. To eliminate the impact of the end-Permian extinction event, the earliest Triassic time intervals were excluded from all data series. Thereafter, vertebrate TDEs show statistically significant strong positive correlations with both the number of localities and specimens. Nonetheless, diversity residuals, resulting from modeled diversity estimates, exhibit clade-specific patterns with varying support for a mid-Permian event and strong support for an end-Permian extinction. The results imply that, although vertebrate diversity patterns in South Africa and Russia are at least partially biased by the Permian-Triassic terrestrial rock record, they still preserve genuine biological signals. Thus, despite the obvious bias, the end-Permian extinction maintains a major impact on vertebrate diversity and its role in shaping the composition and structure of terrestrial ecosystems remains unquestioned.

Symposium 1 (Wednesday, November 2, 9:30 am)

DEVELOPMENT AND EVOLUTION OF THE URODELE LIMB — INTEGRATING MORPHOLOGY, GENES, AND THE FOSSIL RECORD

FRÖBISCH, Nadia, Museum fr Naturkunde, Berlin, Germany; SHUBIN, Neil, University of Chicago, Chicago, IL, USA; SCHNEIDER, Igor, University of Chicago, Chicago, IL, USA

The pattern of skeletogenesis in the development of the tetrapod limb follows a highly conservative pattern despite the great diversity of forms and functions of the adult structure. It is characterized by a general proximo-distal progression in the establishment of skeletal elements and a postaxial polarity in digit development. Salamanders are the only exception to this pattern among extant tetrapods and display an early establishment of distal autopodial structures, specifically the *basale commune* (an amalgamation of distal carpal/tarsal 1+2) and digits I and II, and a distinct preaxial polarity in digit development. All salamanders share this fundamental pattern of limb skeletal development, but the data at hand also indicate a high degree of variation within salamander limb development with respect to overall timing as well as specific patterns of skeletogenesis. Our new data on the skeletogenesis of the limb skeleton in the basal salamander *Cryptobranchus* and the highly derived, direct developing plethodontid *Bolitoglossa* highlight the diversity within salamander limb skeletogenesis within the common framework of preaxial polarity and affirm that the variation is correlated with life history pathways. Moreover, new data on gene expression patterns in salamander limb development show that *Bmp4* has a late preaxial expression domain during autopodial development not present in amniotes. *Bmp4* is thought to play a central role in autopodial differentiation and digit identity and may play a role in the establishment of preaxial polarity. Importantly, key features previously believed to be highly derived in salamander limb development have been identified in Paleozoic amphibians: preaxial polarity of digit development in branchiosaurids and a *basale commune* in the derived amphibamid *Gerobatrachus*, both nested within a clade frequently suggested to include modern amphibians. The deep time perspective highlights the antiquity of this distinct pathway in tetrapod limb development, but its evolutionary history and phylogenetic significance remains elusive, until more fossil data becomes available and the developmental basis of preaxial polarity is fully understood.

Poster Session II (Thursday, November 3)

PATTERNS OF POSTCRANIAL PNEUMATICITY IN THE LATE CRETACEOUS TITANOSAUR *ALAMOSAURUS SANJUANENSIS*

FRONIMOS, John, Texas Tech University, Lubbock, TX, USA

New specimens of the Late Cretaceous titanosaur *Alamosaurus sanjuanensis* provide an opportunity to document the pattern of skeletal pneumaticity in titanosaurian sauropods. The camellate pneumatic features were documented in each skeletal element during preparation by creating scaled images of surfaces exposed by natural breaks. These reveal substantial variation in the size, form, orientation, and connectivity of camellate chambers throughout the skeleton. Within dorsal vertebral centra, the camellae are regularly arranged, cylindrical, elongate anteroposteriorly, and originate from deep and narrow pleurocoels. Chambers in dorsal neural arches are generally larger but much more variable in size, shape, and orientation. Openings on the ventral surfaces of the transverse processes may provide additional points of entry for pneumatic diverticulae into the neural arches. Pneumatization is so complete in dorsal vertebrae that "normal" spongiosa persists only at the articulation surfaces of the centrum and zygapophyses. Although the neural arches of the anteriormost caudal centra

are camellate, the centra of these and at least some of the sacral vertebrae are composed of normal spongiosa. Pneumaticity is also extensive in the dorsal ribs, sacral ribs, and in the ilia and entirely absent from the forelimbs, shoulder girdle elements, hindlimbs, pubes, and ischia. Within the ilia, pneumatic chambers are greater in size than in the vertebrae, irregular in form, and absent from the anteroventral edge of the preacetabular lobe, the pubic peduncle, and the acetabulum.

Technical Session VIII (Thursday, November 3, 4:00 pm)

ELBOW ADDUCTOR MOMENT ARM AS AN INDICATOR OF SPRAWLING POSTURE OF THE FORELIMB IN QUADRUPEDAL TETRAPODS

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Determining forelimb posture (sprawling/sagittal/creeping) in terrestrial horizontal locomotion has been a major issue in skeletal reconstructions of extinct quadrupedal tetrapods (e.g., ceratopsid dinosaurs, desmostylian mammals). Humeral orientations have mainly been estimated based on shoulder morphologies, although both the orientation/position of the pectoral girdle and range of shoulder motion are difficult to determine reliably because of postmortem decay of soft tissues and because reconstruction methods have seldom been validated in various extant species. Here, I report a new forelimb posture indicator, which is applicable to a majority of extant tetrapods. First, the degree of elbow joint adduction/abduction movement was determined in some lizard specimens. This step revealed that the carpal flexors also function as elbow 'adductors,' which may play a major role during the stance phase in sprawling postures. This function is different from sagittal and creeping (against surface friction: e.g., sloths) limb postures, which respectively depend more on elbow extensors and flexors for propulsion. Measurements of elbow muscle moment arms in 288 extant tetrapod skeletons (Anura, Synapsida, and Reptilia: 32 orders, 116 families, and 243 genera) revealed that sprawling, sagittal, and creeping tetrapods respectively emphasize elbow adductor, extensor, and flexor over muscle functions over others. Furthermore, scansorial taxa possess relatively larger flexor moment arms than in non-scansorials. Thus, forelimb postures of extinct tetrapods can be reconstructed based on quantitative index, and both *Triceratops* (ceratopsids) and desmostylian mammals were categorized as sagittal non-scansorials based on this indicator. The totality of prevailing evidence supports the hypothesis that these large tetrapods did not typically use forelimb postures that would be classified as sprawling.

Poster Session III (Friday, November 4)

NEW FOSSIL REMAINS OF *LANTANOTHERIUM* (ERINACEIDAE, MAMMALIA) FROM THE VALLESIAN (LATE MIOCENE) OF VILADECAVALLS (NE SPAIN)

FFURIÓ, Marc, Institut Català de Paleontologia, Barcelona, Spain; ALBA, David, Institut Català de Paleontologia, Barcelona, Spain; CARMONA, Raül, FOSSILIA Serveis Paleontològics i Geològics, Sant Celoni, Spain; RIFÀ, Eudald, FOSSILIA Serveis Paleontològics i Geològics, Sant Celoni, Spain

The erinaceid *Lantanotherium* has been reported in several Miocene localities from Europe, Asia, North America and Africa, although the only record in the latter continent has been recently challenged. Uncertainties remain regarding the phylogenetic position of this taxon: it has been considered the earliest representative of the Echinosoricini (Recent moonrats and gymnures), currently distributed in Southeast Asia, by some previous authors, while others found insufficient morphological evidence supporting this hypothesis, merely considering *Lantanotherium* as a plesiomorphic genus within galericines. In the European fossil record, *Lantanotherium* is the only known genus of Galericinae not included in the tribe Galericini. The last occurrences of this genus in that continent correspond to late Vallesian and early Turolian (Late Miocene) localities, being mostly attributed to *Lantanotherium sanmigueli*, the smallest species of the genus. The holotype of *L. sanmigueli* (a mandibular fragment with m1-m2) is currently lost, there is no more material from the type locality (Can Purull), and the latter cannot be re-excavated in order to recover additional topotypic remains. Here we report new abundant fossil remains attributed to this species, recently recovered from a new locality (B40OV/S5C) within the same area than the type locality (Viladecavalls, Vallès-Penedès Basin). The study of these newly-recovered remains shows that intraspecific variability was higher than previously thought, so that most of the previous assumptions regarding evolutionary trends within this genus must be reconsidered. Our results also show that the alpha-taxonomy of *Lantanotherium* species in Europe is in need of revision, since some of the nominal species hitherto described in this continent are likely to be junior subjective synonyms of a fewer number of valid species, leading to the conclusion that the diversity of *Lantanotherium* species had been previously overestimated. The newly-recovered material from Viladecavalls will further contribute to the understanding of the phylogenetic relationship of *Lantanotherium* with extant gymnures, and other recent and fossil erinaceids.

Technical Session XVI (Saturday, November 5, 8:00 am)

THE TRUE TRABECULAE CRANII IN STEM-GNATHOSTOME GALEASPIDS (AGNATHA)

GAI, Zhikun, The University of Bristol, Bristol, United Kingdom; DONOGHUE, Philip, The University of Bristol, Bristol, United Kingdom; JANVIER, Philippe, Muséum National d'Histoire Naturelle, Paris, France

The trabeculae cranii and derivative structures represent a major developmental and evolutionary advance over agnathans. Although the 'trabeculae' of cyclostomes have been reported, their homology has long been controversial. Using Synchrotron Radiation X-ray Tomography, the derivative structures of the trabeculae have been clearly identified in galeaspids, a 435 - 370 million year old 'ostracoderm' group from China and Vietnam. Like that chondrichthyans, the orbitonasal lamina of galeaspids forms the postero-lateral wall of the nasal capsules; the supraorbital crest is developed and penetrated by a row of supraorbital foramina; the suborbital shelf floors the orbital cavity ventrally. More strikingly, the orbitonasal lamina extends rostrally as a small ethmoid process just rostral to the hypophysial opening. Compared with that of chondrichthyans, the ethmoid process is not developed enough to form the internasal wall, which separates the paired nasal sacs in gnathostomes. This indicates that the gnathostome-like trabeculae cranii were likely present in the jawless galeaspids, and partly in osteostracans. The presence of trabeculae cranii in stem-gnathostomes provides further evidence that the assembly of gnathostome characters accrued piecemeal before the origin of jaws rather than as bursts of innovation.

Technical Session XIII (Friday, November 4, 2:30 pm)

QUANTIFYING CHEWING EFFICIENCY OF RUMINANT DENTAL PATTERNS—AN APPROACH USING THREE-DIMENSIONAL METROLOGY SYSTEMS

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Understanding the complex masticatory system of ruminants has led research to focus on the mechanical interactions between occlusal tooth morphology and biomechanical food properties. Occlusal morphological traits have successfully been linked to feeding categories (e.g. browser, mixed feeders and grazers). However, the underlying mechanics behind these morpho-ecological interrelations are still poorly coupled to functional biological interpretations. Former works studied one tooth position only, the second upper molar (M2); we extend our investigation to the third and fourth premolars (P3, P4) as well as to all molars (M1, M2, M3) and test for diet-related adaptations of the post-canine tooth row as a functional unit within the masticatory system.

Three-dimensional (3D) models of upper cheek teeth of eleven extant bovid species (Bovidae, Cetartiodactyla) are generated using a topometric digitization system. We then implement high precision 3D engineering techniques to quantify 3D linear, surface and volume parameters of the enamel and dentin components of the occlusal topography.

The relative complexity of the inner enamel structures (*eL*) on each tooth position reveals a consistent pattern for all grazer species from the P3 to the M3. This pattern is characterized by an abrupt increase in *eL* from premolar to molars, contrasted to homogeneity between premolars and between molars. With the exception of a difference detected between P3 and P4, the frugivore species displays a pattern similar to the grazers. We interpret this functional differentiation between premolars and molars to be induced by greater masticatory loads towards the back of the tooth row related to tough and hard diets.

There is however no consistent pattern along the tooth row for the leaf browsers. The pattern recognition along the tooth row for grazers and frugivores therefore indicates that the abrasiveness and hardness of grass and fruits are the primary selective pressures driving to an optimized functional unity of the post-canine dentition.

Poster Session IV (Saturday, November 5)

VERTEBRATE FOSSIL ASSEMBLAGES AND IRIDIUM CONCENTRATIONS IN THE CRETACEOUS-PALEOGENE SECTION OF THE NEW JERSEY COASTAL PLAIN

GALLAGHER, William, Rider University, Lawrenceville, NJ, USA; MILLER, Kenneth, Rutgers University, Piscataway, NJ, USA; SHERRELL, Robert, Rutgers University, Piscataway, NJ, USA; FIELD, Paul, Rutgers University, Piscataway, NJ, USA; OLSSON, Richard, Rutgers University, Piscataway, NJ, USA

A program of continuous core drilling in the Cretaceous-Paleogene (K/P) marine sequence in the Atlantic Coastal Plain of New Jersey has produced iridium excursions at the K/P boundary at six well sites. Several of these cores were drilled at or near historically important vertebrate fossil localities that yielded important specimens of Late Cretaceous and Early Paleogene vertebrate fossils for Cope, Marsh and others. At Meirs Farm, old mines in the New Egypt and Hornerstown Formations produced a number of type specimens for O.C. Marsh, including mosasaur, crocodile, and bird material. An iridium anomaly of 0.5 ppb was detected in the core from this site in the Hornerstown Formation at the level of the fossil concentration in the base of the formation. Below this the Late Maastrichtian New Egypt Formation yielded the types of the mosasaurs *Halisaurus platyspondylus* and *Mosasaurus princeps* (= *M. hoffmanni*). At the Inversand Pit, a source of fossils for modern collectors and close to historically important sites, a modest iridium anomaly was directly associated with the basal Hornerstown fossil concentration that continues to produce numerous specimens of vertebrate fossils. The Ir excursion at Inversand is 279 ppb, an order of magnitude over background levels above and below this horizon. The Ir anomaly shows a Pt/Ir ratio of 1.35, suggesting an extraterrestrial source. Directly below this level is the New Egypt Formation, the 'chocolate marl' of Cope and Marsh, which has yielded dinosaur specimens such as the *Dryptosaurus aquilunguis* (Cope) and "*Hadrosaurus minor"* Marsh. This formation also produces mosasaur material, including *M. maximus, Prognathodon rapax,* and *H. platyspondylus*. The assemblage in the basal Hornerstown Formation includes chondrichthyes, osteichthyes, chelonians, crocodylians, mosasaurs, and birds. Direct association of the Ir excursion with this bed suggests that it represents mass mortality in the aftermath of environmental

disturbances associated with large asteroid impact. Dinoflagellate biostratigraphy constrains the Ir anomalies at these several sites to the K/P boundary. Taphonomic evidence suggests that this is not a reworked lag deposit, but rather contains many multi-element specimens in associated or partially articulated condition. Mass mortality and diversity suppression in the oceans after the K/P event was protracted due to Strangelove Ocean effects, shown by a continuing C isotope negative excursion in cores and a depauperate fossil assemblage in the middle of the Hornerstown Formation. However, crocodylians did radiate into marine environments during this interval to become apical marine predators after mosasaurs went extinct, and more modern lamnoid sharks bagan to appear in this section in Danian time.

Poster Session I (Wednesday, November 2)

A NEW SKELETON OF THE LATE CRETACEOUS BONY FISH, *MICROPYCNODON KANSASENSIS*, FROM THE NIOBRARA CHALK OF KANSAS, USA

GALLUZZI, Carmela, DePaul University, Chicago, IL, USA; SHIMADA, Kenshu, DePaul University, Chicago, IL, USA

Micropycnodon kansasensis is a poorly known pycnodont fish that lived in the Late Cretaceous Western Interior Seaway of North America. Here, we report a second partial skeleton of the species that occurred in the Smoky Hill Chalk Member of the Niobrara Chalk in Gove County, Kansas. The new specimen, KUVP 127042 housed in the University of Kansas Museum of Natural History, Lawrence, is well preserved and consists of the anterior three-fifths of the fish, including a nearly complete skull with incisiform teeth and a set of tooth plates suited for durophagy. The specimen is significant because it reveals that the entire head and the anterior rim of the body are covered with numerous small (up to 3 mm high), posteriorly-directed hook-like, pointed dermal denticles that likely served as protection against predation. Although the posterior end of the body is missing, the preserved portion indicates that the fish is deep-bodied and nearly circular in lateral view, measuring approximately 24 cm in estimated standard length (SL) and 23 cm in estimated maximum body depth excluding the fins. The estimated total length (TL) of the fish is approximately 30 cm. The anteroposterior length of the lower tooth plate is 7% of the SL. Another partial skeleton of the species, KUVP 7030, is a slightly larger individual with an estimated SL of 31 cm, but the ratio of each lower tooth plate length to the SL is similar to KUVP 127042. The fossil record of *M. kansasensis* includes isolated tooth plates that are slightly larger than the tooth plates in KUVP 7030, but the species likely did not generally exceed 35 cm SL. The body shape and size range of *M. kansasensis* suggest that the fish was likely fed only on small, inactive shelled invertebrates, such as cirripeds and bivalves that were no larger than a few centimeters.

E&O Poster Session

ALLIGATORS NEAR AND FAR: USING THE MAPS IN MEDICINE: INSIDE ALLIGATORS HIGH SCHOOL WORKSHOP AND 3D ALLIGATOR WEBSITE AS EDUCATIONAL TOOLS IN ANATOMY AND EVOLUTION

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We present two related educational modules developed at the University of Missouri that use alligator biology to broaden participation of local schools and the general public in anatomical and evolutionary sciences. Alligators are familiar, easily obtainable, large-bodied, charismatic reptiles that not only have evolved unique adaptations to their environment but also provide numerous comparative insights into mammalian, dinosaur, and reptile anatomy in general, making them excellent model animals for vertebrate evolution education and outreach. First, the Holliday Lab collaborated with the Howard Hughes Maps in Medicine program at Mizzou to coordinate a day-long "Inside Alligators" workshop for students and their teachers from four Missouri high schools. First attending a public scientific seminar introducing current topics in crocodilian evolution, 30 students and teachers then participated in 4 workstations covering state-outlined curricular topics in biology with focuses on animal relationships, mathematics, comparative anatomy, and scientific inquiry. Workstations staffed by undergraduate, graduate and veterinary medicine students included: tooth morphology and diet; sense organs and skull anatomy; measuring and estimating skull length; and gross anatomy. Second, the Holliday Lab paired with the Witmer Lab to co-launch the "3D Alligator", two online modules directed at the broader internet audience with general and scientific Alligator content using a mix of 3D pdfs, movies, and Javascript-embedded interactive models to explore head anatomy. The Holliday Lab 3D Alligator presents individual elements of an adult skull with dedicated pages including labeled images, brief descriptions of major features, and embedded Wirefusion models of each element. Additional modules including mandibular symphysis anatomy; limb articular cartilage models, and 3D jaw muscle models will be uploaded to the 3D Alligator site in the near future. These ongoing collaborations with universities, local schools and the public are critical to fostering increased awareness of biological principles and the basics of scientific inquiry.

Poster Session I (Wednesday, November 2)

SKELETOCHRONOLOGY OF THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*): THE UTILITY OF VARIOUS ELEMENTS FOR DETERMINING GROWTH PATTERNS AND LONGEVITY

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Neontological studies of reptilian skeletochronology are important as the results can be used with confidence to make inferences about growth and longevity in extinct relatives. While most skeletochronology studies have focused on lines of arrested growth in major long bones, especially the femur, the utility of other elements for deducing growth and age is for the most part unexplored. Modern archosaurs such as crocodilians, and in particular the American alligator (*Alligator mississippiensis*), allow for not only an interesting modern system but a proxy to the past given their close evolutionary ties to fossil archosaurs such as crocodiles and dinosaurs. We conducted a histological analysis of six, known-age, chemically labeled alligators previously in the care of the Florida Fish and Wildlife Commission. Every type of bone was sectioned at multiple points and growth line counts and tissue type characterizations were then made. Aside from long bone elements commonly used in histological studies, other skeletal structures such as ribs and phalanges exhibit areas of LAG deposition and make them potentially useful in histological analysis. From this a "map" of the alligator skeleton was constructed regarding where along skeletal elements researchers are likely to find unobstructed deposition of LAGs. The results of this study elucidate which bones are best suited for growth analysis, as well as where along those bones information is preserved. Because histological analysis is a destructive technique, this information will allow researchers to make more informed decisions with regards to which element(s) to sample, thus reducing the potential for damaging more elements than is necessary or the likelihood of success when limited skeletal material is available.

Technical Session II (Wednesday, November 2, 2:30 pm)

CRANIAL ANATOMY IN THE BASAL DIAPSID *YOUNGINA CAPENSIS* AND ITS RELEVANCE TO HIGHER RADIATIONS OF PERMO-TRIASSIC NEODIAPSIDA

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Although the archaic diapsid *Youngina capensis* is represented by several complete skulls, it has never been the subject of a detailed anatomical review. While previous work described the mosaic nature of its braincase, a more thorough description of its general cranial anatomy is needed to better understand its position within early diapsid phylogeny. In this study, we use MicroCT data from the holotype skull to reveal a well-preserved and articulated palate. These data, when combined with examination of other referred cranial material, permits a thorough redescription of *Youngina* cranial anatomy. Several characters present in *Youngina* demonstrate their appearance along the diapsid stem lineage, rather than being apomorphies of crown-Diapsida as previously thought. These include: 1) a paroccipital process-suspensorium contact; 2) loss of the sphenethmoid ossification; 3) a lacrimal that is taller than it is long; and 4) incipient basal tubera on the basioccipital. Additionally, *Youngina* exhibits a derived palatal morphology that is highly conserved in more derived diapsids, such as the pan-archosaur *Prolacerta*. Their palates are quite similar, differing most notably in that *Youngina* retains an epipterygoid participation in the palatobasal contact, unlike crown-diapsids which exclude the epipterygoid entirely. As in many primitive diapsids, the palatobasal and otic joints are rounded and well-developed, suggesting the potential for cranial kinesis. However the maintenance of a complete lower temporal bar and a robust epipterygoid suggest a lack of kinesis in *Youngina*. Its small, unserrated teeth and limited gape suggest it ate prey that was smaller than its head, relying on puncturing its prey against its palatal teeth to aid in oral processing. This superficially lizardlike pattern of feeding was widespread among basal diapsids. *Youngina*'s possession of several derived diapsid characters, while retaining an akinetic skull, demonstrates that the taxon is a critical model for understanding the subsequent evolution of diapsid cranial anatomy.

Poster Session IV (Saturday, November 5)

THE MAXILLAE OF *IGUANODON BERNISSARTENSIS* FROM MORELLA: NEW INFORMATION ON UNKNOWN FEATURES

GASULLA, José, Uam, Madrid, Spain; SANZ, José, Uam, Madrid, Spain; ORTEGA, Francisco, Uned, Madrid, Spain; ESCASO, Fernando, Uned, Madrid, Spain

The Arcillas de Morella Formation, early Aptian in age, has yielded a diverse tetrapod fauna including amphibians, turtles, squamates, plesiosaurs, crocodyliforms, pterosaurs and dinosaurs. To date, the Mas de la Parreta quarry is clearly the most representative fossiliferous area of this Lower Cretaceous Formation. The Mas de la Parreta quarry is located at the southwest of the locality of Morella (Castellón, Spain). Most of the vertebrate fossil remains from the Mas de la Parreta fossil sites correspond to ornithopod dinosaurs. In 2008 several cranial and postcranial bones belonging to ornithopod and theropod dinosaurs and crocodiles were found in the Mas de la Parreta quarry site CMP-11. Among other ornithopod bones, is noteworthy the discovery of two right maxillae belonging to two *Iguanodon* individuals. The analysis of these two maxillae and, more specifically, the features from the best-preserved maxilla, related these bones to the large-sized European ornithopod *Iguanodon bernissartensis* and allow adding new information on this taxon. Maxilla features shared with *Iguanodon bernissartensis* include the relatively long and low construction of this bone and the presence of a rostroventral process that is rostroventrally curved, a subtriangular and

rostrocaudally broad and ascending process, a jugal process that is caudolaterally projected that show a "finger-in-recess" contact with jugal, an antorbital fossa that is a small elongate elliptical depression rostrocaudally elongated and a concave ventral margin of tooth row, in lateral view. As in this taxon, maxillary teeth share an elongate lozenge crown shape and mammillate marginal denticles. Besides these, other maxillary features, previously unknown in *Iguanodon bernissartensis*, such as a rostrodorsal process and a straight shape both in the maxilla and in tooth row when viewed dorsally and ventrally, respectively, are described for the first time. Thus, the specimens reported from the Mas de la Parreta quarry could add new and valuable information on the anatomy of this European large-sized ornithopod and confirm its presence in Iberian synchronous levels.

Symposium 3 (Thursday, November 3, 11:45 am)

LATITUDINAL BIODIVERSITY PATTERNS DURING THE CAMPANIAN OF WESTERN NORTH AMERICA

GATES, Terry, Field Museum, Chicago, IL, USA

The North American Cretaceous Western Interior Basin (WIB) records a remarkably complete Campanian rock record spanning a distance of over 2000 km from Canada through northern Mexico. An increasingly detailed fossil record is emerging that allows for intracontinental comparisons of contemporaneous vertebrate faunas at various time intervals. A genus-species level presence-absence dataset was compiled for all discernible taxa within Campanian formations of the WIB. Multivariate tests performed on the data include diversity curves, correspondence analysis (CA) and cluster analysis (CLA). These analyses demonstrate a disparity in species diversity between lower and upper Campanian localities, with the latter having a greater abundance of species. This is considered to be largely associated with greater sampling of upper Campanian localities. CA confirmed previous assertions that the faunas within the WIB likely conformed to a latitudinal diversity gradient, both in lower and upper Campanian formations. Other major axes of the CA suggest that a more complicated pattern may underlie faunal distribution through time. Notably, earlier faunas tended to group closer together compared to faunas dating between 76–75 mya from equivalent geographic areas. CLA tended to group formations into north/south geographic regions primarily, indicating some level of endemism, but depending on the distance measure used CLA also produced groupings of similar environmental setting, irrespective of latitude. Even though latitude may have been a major driver of vertebrate geographic distribution within Campanian WIB ecosystems, changes in topography such as sea level rise and mountain building seems to have had a large effect on dinosaur diversity by briefly dividing the WIB into centers of endemism during shifting tectonic regimes. The WIB endemic centers are evidenced by increased dinosaur diversity and decreased geographic ranges between 76–75 mya. Therefore, it appears that dinosaurs were susceptible to speciation as a result of geographic changes to the WIB whereas the remainder of the Campanian faunas demonstrates minimal levels of endemicity and localized turnover.

Symposium 1 (Wednesday, November 2, 9:15 am)

LIMB DISPARITY, COORDINATION, AND THE EVOLUTION OF TERRESTRIAL LOCOMOTION

GATESY, Stephen, Brown University, Providence, RI, USA; POLLARD, Nancy, Carnegie-Mellon University, Pittsburgh, PA, USA

Tetrapod limbs exhibit diverse postures and movements during terrestrial locomotion. The history of kinematic evolution should be accessible to reconstruction within a phylogenetic framework, but limb disparity (proportions, degree of crouch) hampers meaningful comparison of angular data among species. If different limbs can't move exactly the same way, any joint by joint or segment by segment assessment of angular data becomes an apples to oranges comparison. We have developed a simple, non-angular method of describing the coordination among segments as the limb reconfigures each stride. Using a ternary diagram, we create a theoretical configuration space of all possible poses a limb can achieve during the stance phase. By plotting data from extant forms in this common space, coordination patterns can be directly compared and transferred among disparate taxa. For example, we can make *Tyrannosaurus* move using the coordination of a guineafowl, or human, or cat. But not all coordination patterns are appropriate for all limbs. Proportions and degree of crouch appear to bias limbs to follow geometrically sensible paths within the space of coordination alternatives. Using mid-stance poses identified by constraint-based exclusion, we reconstruct potential stance phase motions of the hind limb of *Tyrannosaurus* using these geometric "rules". Alternative parameterizations of limb movement and a coordination-based perspective have great potential for elucidating locomotor evolution.

Technical Session IV (Wednesday, November 2, 4:00 pm)

PHYLOGENETIC ANALYSIS OF THE SLOTH FAMILY MEGALONYCHIDAE (MAMMALIA, XENARTHRA, FOLIVORA) BASED ON CRANIAL DATA

GAUDIN, Timothy, University of Tennessee-Chattanooga, Chattanooga, TN, USA; MCDONALD, H. Gregory, National Park Service, Fort Collins, CO, USA; RINCÓN, Ascanio, Inst Venez. Invest. Cientificas (IVIC), Centro de Ecologia, Caracas, Venezuela

Megalonychids are the only family of sloths that includes both extinct and extant taxa. It first appears in South America in the Oligocene, yet is poorly known from the Plio-Pleistocene of that continent relative to other sloth families. The family is characterized by early dispersal to North America, becoming geographically widespread in the Pleistocene, and encompassing an endemic West Indian radiation that persists well into the Holocene. Despite the family's paleobiological significance, megalonychid phylogeny has remained poorly understood. The goal of the present study is to reexamine phylogenetic relationships within the family based on a detailed study of cranial skeletal anatomy. We examined representatives of the sole extant genus, *Choloepus*, along with 11 extinct genera from North and South America and the West Indies. A matrix of 54 discrete osteological characters and 13 taxa was constructed and analyzed using PAUP 4.0b10. Characters were polarized via comparison to a single monophyletic outgroup, *Hapalops*, an early, relatively plesiomorphic megatherioid sloth. All characters were equally weighted and 15 of the 20 multistate characters were ordered along numerical, positional or structural morphoclines. A branch-and-bound analysis resulted in four most parsimonious trees (TL = 190, CI = 0.549, RI = 0.503). In the strict consensus tree, the South American Santacrucian taxa *Megalonychotherium* and *Eucholoeops* formed successive sister taxa to other megalonychids. The remaining late Miocene – Recent taxa fell into a basal multichotomy that included the South American *Pliomorphus*, the continental North American taxa *Pliometanastes* and *Megalonyx*, a clade including two newly discovered taxa from the South American Pleistocene, and a crown clade. The crown clade united *Choloepus* with the endemic radiation of West Indian sloths. *Choloepus* nested inside this clade, in an unresolved trichotomy with the small bodied genus *Acratocnus* and the Megalocninae, a monophyletic grouping of large bodied Antillean sloths.

Technical Session XI (Friday, November 4, 3:15 pm)

SAUROPOD HERBIVORY DURING LATE JURASSIC TIMES: NEW EVIDENCE FOR CONIFER-DOMINATED VEGETATION IN THE MORRISON FORMATION IN THE WESTERN INTERIOR OF NORTH AMERICA

GEE, Carole, University of Bonn, Steinmann Institute of Geology, Mineralogy, and Paleontology, Bonn, Germany

Because the Morrison Formation has yielded such a great abundance and diversity of sauropods and other dinosaurs, the vegetation growing in the Western Interior of North America during Late Jurassic times must have supported heavy herbivory by the gigantic plant-eating reptiles. Yet, it is still unclear what sorts of plant communities dominated the landscape and would have thus provided fodder for the vast numbers of herbivores in this widespread area. It has been estimated, for example, that a 70-ton sauropod with the scaled-up energy requirement of a modern elephant would have needed a daily intake from 237 to 394 kg of dry plant matter, depending on food quality; this equals 1000 to 2000 kg of fresh material daily. Previous reconstructions of the Morrison vegetation have ranged from open "fern prairies" to semi-arid "savanna-like" vegetation, hypothetical habitats in which trees are restricted in quantity and distribution, despite the abundance of fossil wood and huge logs in Morrison sediments and the common co-occurrence of wood and dinosaur bone. Recent discoveries of several new species of fossil conifer cones in Utah, Wyoming, and Colorado offer evidence for a re-evaluation of the Morrison flora and suggest that it was dominated by a diversity of forest-forming trees. This is supported by pollen samples taken throughout the Morrison, from Montana to New Mexico, that also indicate a conifer-dominated vegetation. New collections of fossil leaf floras from Montana and Colorado document moisture-loving ferns and fern allies in locally mesic or even hydric environments. Widespread conifer forests and fern wetlands, as interpreted from these multiple lines of new evidence, would have provided more extensive sources of fodder than a semi-arid or mostly treeless vegetation. With regard to the nutritional analysis of the nearest living relatives of the Mesozoic flora, a steady diet of araucarian foliage, horsetail shoots, and some mesic ferns would have served the daily dietary requirements of the sauropods well, supporting their need for high energy intake for rapid growth and maintenance of their huge sizes.

Technical Session XIX (Saturday, November 5, 3:00 pm)

EVOLUTION OF HIGH-FREQUENCY HEARING IN ODONTOCETES (MAMMALIA: CETACEA)

GEISLER, Jonathan, New York College of Osteopathic Medicine, New York, NY, USA; MARTINEZ, Manuel, Museum National dHistoire Naturelle, Paris, France; LAMBERT, Olivier, Museum National dHistoire Naturelle, Paris, France; BOESSENECKER, Robert, Montana State University, Bozeman, MT, USA

Acoustic data and cochlear morphology have been used to divide extant odontocetes into two groups: 1) type I odontocetes produce echolocation vocalizations above 100 kHz, have a cochlea with 1.5 turns, a proportionally long secondary lamina, and an expanded basal cochlear turn; 2) type II odontocetes have a cochlea with more than 2 turns, a narrower basal turn, a relatively short secondary lamina, and produce echolocation clicks below 90 kHz. Porpoises and the Amazon River dolphin (*Inia*) are type I whereas the bottlenose and pantropical spotted dolphins, among others, are type II. Efforts to resolve the evolution of high frequency hearing in odontocetes have been hampered by the absence of a well-supported phylogeny for Odontoceti as well as the small number of taxa for which cochlear morphology is known. We report here microCT scans from 8 fossil and 6 extant odontocetes, including all taxa informally referred to as "river dolphins", and have mapped aspects of cochlear morphology on a recently published, supermatrix, cetacean phylogeny. The majority of taxa CT scanned do not fall within the morphospace delimited by type I and type II cochleae, indicating that this classification scheme is an artifact of limited sampling of extant taxa. For example, the stem, Miocene delphinoid *Kentriodon pernix* has approximately 1.75 turns, in between type I and type II odontocetes. Other delphinidans, like the narwhal, have relatively high cochleae, indicating that the low and wide cochlear morphology in porpoises and *Inia*, both type I, are convergent. It has been hypothesized that the long secondary lamina in type I odontocetes is functionally related to hearing > 100 kHz echolocation echoes, an ability

that would be useful in turbid fluvial and coastal waters. We can confirm that the secondary lamina is long in *Inia* and *Platanista*, which inhabits the Indus and Ganges rivers, as well as *Pontoporia*, which occurs in coastal South American waters; however, the cochlea of the Yangtze River dolphin is much like those of oceanic dolphins of the Family Delphinidae.

Poster Session III (Friday, November 4)

COMPARISON OF IDENTIFICATION TECHNIQUES FROM QUATERNARY DEPOSITS USING FOSSIL SHREWS (SORCIDAE: MAMMALIA)
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Methods for identifying small mammals from Quaternary sites traditionally rely on either similarity of morphological characteristics or quantitative measurements. Those characteristics may only be effective at discriminating species when they are applied to specimens from a narrow geographic region. The utility of apomorphies for the identification of Quaternary small mammal fossils remains largely unexplored. I examined the impact of using apomorphic characters for the identification of shrews. I chose to examine shrews because they are common in Quaternary sites, generally considered identifiable, and often used to reconstruct paleoecology. The specimens come from Pit 1E of Hall's Cave, Kerr County, Texas, a stratified deposit accumulated over the last 20,000 years. The shrews previously identified from Hall's Cave include *Cryptotis parva*, *Blarina carolinensis*, *Notiosorex crawfordi*, and a few, rare specimens of *Sorex*. To test whether apomorphic identification would yield the same species identifications, I assembled characters from a variety of sources, discretized them for use in a phylogenetic analysis, and then ran an analysis to determine which characters were synapomorphies. Many specimens previously identified to the species level were too fragmentary to permit species identifications using apomorphies. However, apomorphic characters could differentiate some specimens as *Blarina hylophaga* or *Blarina brevicauda*. Those taxa were unrecognized because originally the specimens were identified to genera based on morphology, and then were assigned to species based on modern geographic ranges. Thus, confidence in identified species was often overstated, and species diversity was underrepresented. Using apomorphies to identify shrews has a significant impact on taxonomic resolution. If this approach is applied to other small mammals, it is likely to have far-reaching effects on paleoecology, biogeography, and biostratigraphy.

Poster Session II (Thursday, November 3)

TRIGEMINAL NERVE MORPHOLOGY IN *ALLIGATOR MISSISSIPPIENSIS*: IMPLICATIONS FOR INFERING SENSORY POTENTIAL IN EXTINCT CROCODYLIFORMS
GEORGE, Ian, University of Missouri, Columbia, MO, USA; HOLLIDAY, Casey, University of Missouri, Columbia, MO, USA

One of the most intriguing adaptations of crocodylians is their derived sense of face touch, in which trigeminal nerve-innervated dome pressure receptors speckle the face and sense mechanical stimuli. However, the ontogeny and morphology of this system, and its relationship with other cranial tissues is poorly known hampering hypothesis testing on the origin of the modern crocodylian trigeminal system. A cross-sectional study integrating histological, morphometric, and 3D imaging analyses was conducted to identify patterns in neural and bony structures in *Alligator mississippiensis*. Nine individuals were variably imaged followed by histomorphometric sampling of mandibular and maxillary nerves. Endocast volume, trigeminal fossa volume, and maxillomandibular foramen size were compared to nerve counts from proximal and distal regions of the nerves to identify scaling relationships of the structures. These variables were also then collected from several similarly-sized fossil crocodyliforms from disparate habitats to test for ecomorphological relationships with the trigeminal system. Nerve fiber density is greater in smaller alligators and total nerve count significantly correlates with skull size. Maxillomandibular foramen diameter, endocast volume, and trigeminal ganglion all scaled significantly and negatively with skull length. Maxillomandibular foramen scaled isometrically with endocast volume and ganglion volume whereas ganglion volume scaled with positive allometry with endocast volume. These data suggest that trigeminal nerve morphology can be accurately inferred among living crocodilians. Metrics from fossil taxa indicate that whereas the eusuchian *Leidyosuchus* and the dyrosaur *Rhabdognathus* both have trigeminal ganglia similar to that of similarly sized alligators, the peirosaur *Hamadasuchus*, a putatively terrestrial species had a much smaller ganglion suggesting a dome-pressure system was not as well developed. These findings suggest that neural osteological correlates of the trigeminal system are informative features useful for investigation of crocodyliform as well as archosaur somatosensory evolution.

Poster Session I (Wednesday, November 2)

ALONE ON GONDWANA: THE STOR Y OF THE MOROCCAN DIPLOCAULID
GERMAIN, Damien, MNHN, Paris, France

Diplocaulus minimus, a diplocaulid lepospondyl from the Late Permian of the Argana Basin (Morocco) is revised based on a redescription of the type material, together with a description of recently found specimens. The revised specimens, previously attributed to *Diplocaulus*, prove to be more closely related to the genus *Diploceraspis*. However, recent observations of North American specimens raise doubts about the validity of the genus *Diploceraspis*. They are the only known Gondwanian lepospondyls and their unique co-occurrence with pareiasaurs strengthens the hypotheses of climate-controlled endemism in the end-Permian Pangea. This unique association is not congruent with the age of other diplocaulids and implies a long ghost lineage. Moreover, two paleobiogeographic scenarios about the timing and the ways of migration on Gondwana are considered. These animals exhibit a peculiar asymmetry of the skull. Some hypotheses about the function of its peculiar skull are tested and discussed, but none appear to be conclusive.

Preparators' Session (Thursday, November 3, 9:00 am)

COLLECTION, PREPARATION, AND MOUNTING OF TWO LARGE, ORIGINAL GRYPOSAUR SKELETONS FROM THE KAIPAROWITS FORMATION OF GRAND STAIRCASE ESCALANTE NATIONAL MONUMENT, FOR THE NEW UTAH MUSEUM OF NATURAL HISTORY, SALT LAKE CITY
GETTY, Mike, Utah Museum of Natural History, Salt Lake City, UT, USA; LUND, Eric, Utah Museum of Natural History, Salt Lake City, UT, USA

In November 2011, the Utah Museum of Natural History (UMNH) will reopen to the public in a brand new home at the Rio Tinto Center on the University of Utah's campus in Salt Lake City. This facility will exhibit a number of new paleontology exhibits, including one featuring vertebrate specimens collected from the Upper Campanian Kaiparowits Formation of Grand Staircase Escalante National Monument (GSENM) over the past twelve years. This exhibit will display mounted original skeletons of two of the most complete gryposaur specimens collected in the Kaiparowits thus far. These specimens, discovered in 2001 and 2007, each took three seasons to excavate in more than one hundred large field jackets, several weighing in excess of 1000 lbs. Preparation of this material has taken a team of more than 80 volunteer preparators 10,000 man hours to complete over nearly a decade. In both specimens, preparation was complicated by exceedingly hard matrix, and skin impressions which needed to be preserved.

One specimen (UMNH VP12665) had skin impressions covering nearly all of its articulated tail and was prepared and mounted in a manner to exhibit the association of skin and bone. This specimen is mounted into the floor in an "*in situ*" style, recreating how the skeleton was preserved in the field. The second specimen (UMNH VP 20121) is the most complete large hadrosaur ever collected in Utah, and was prepared out entirely from its matrix and by UMNH volunteers and ultimately mounted in a life position by a paid contractor. This mounted specimen is nearly 40 feet long, 12 feet high, and consists of more than 80% original skeletal material. The collection and preparation of the specimens for these two mounts highlights the extremely effective collaboration between the UMNH and the BLM administered GSENM, as well as the significance of a highly motivated and dedicated team of volunteers in the field and lab.

Poster Session III (Friday, November 4)

FAECAL LIPID BIOMARKERS FROM MODERN AND ANCIENT HERBIVORES
GILL, Fiona, University of Leeds, Leeds, United Kingdom

Biomarkers are molecules that can be unequivocally attributed to a specific biological source or process on the basis of their chemical structure. The potential of lipid biomarkers preserved in coprolites to reveal unique details of the diet, digestive processes and digestive tract microbiota of extinct animals has already been demonstrated. However, in order to fully exploit the benefits of this approach it is necessary to investigate further the controls on faecal biomarkers in modern animals and on preservation of lipids in coprolites.

Faecal lipids were analysed from a range of modern herbivorous mammals with varying digestive physiologies. Foregut fermenters were found to have a distinctive faecal lipid signature featuring the isoprenoid lipid archaeol, interpreted to derive from methanogenic archaea in the digestive tract. Results from subsequent research supported this hypothesis, as a correlation was found between faecal archaeol concentration and methane emissions in modern cattle. Archaeol has been detected in a 2500 year old ovi-caprid dung pellet, raising the possibility that this method may be used to identify and potentially quantify methane emissions from ancient fauna.

However, a recent survey of over 20 coprolites, including material attributed to Cretaceous dinosaurs (e.g. Maiasaura), Miocene perissodactyls and a range of Pleistocene megaherbivores (e.g. *Nothrotherium shastensis*, *Euceratherium collinum* and *Mammuthus primigenius*), has shown that the preservation of lipids in herbivore coprolites is highly variable and is related to factors including age, mode of preservation and diagenetic history of the material. Ancient faeces preserved by desiccation have been found to contain concentrations of lipids order of magnitude higher than those recovered from lithified coprolites. This suggests that further research efforts should focus on desiccated coprolites or exceptionally well preserved lithified coprolites with high organic carbon content.

Poster Session IV (Saturday, November 5)

MORPHOLOGY AND MORPHOMETRIC AFFINITIES OF THE FIRST KNOWN CALCANEUS OF *PROTEOPITHECUS SYLVIAE* FROM THE LATE EOCENE OF EGYPT
GLADMAN, Justin, The Graduate Center, City University of New York, New York, NY, USA; BOYER, Doug, Brooklyn College, City University of New York, New York, NY, USA; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Duke Lemur Center, Durham, NC, USA

The phylogenetic position of the late Eocene anthropoid *Proteopithecus sylviae* is currently unclear. A well-preserved calcaneus referable to this taxon from Quarry L-41 in the Fayum Depression, Egypt, provides new evidence that might help to clarify this issue. We pres-

ent a 3D geometric morphometric (GM) analysis that includes a comparative sample of over 110 primate calcanei representing most major extinct and extant radiations. Complex shape differences that reflect key aspects of systematic variation in the calcaneus (e.g. facet outline shape) are difficult to quantify using traditional linear measurements, and this study highlights the benefits of using new 3D GM methodologies to capture such information. Our morphometric analyses reveal that *P. sylviae*'s calcaneal morphology is most similar to that of a younger Fayum anthropoid, the parapithecid *Apidium*. Principal components analysis places *Apidium* and *Proteopithecus* in an intermediate position between primitive euprimates and crown anthropoids, based primarily on landmark configurations corresponding to a moderate amount of distal elongation, a more distal position of the peroneal tubercle, and a relatively unflexed calcaneal body. *Proteopithecus* and *Apidium* are similar to cercopithecoids and some omomyids in having a more tightly curved ectal facet with a larger degree of proximal elongation, whereas other Fayum anthropoids, platyrrhines and adapiforms have a more open facet with less proximal elongation. This latter similarity to cercopithecoids is most plausibly interpreted as convergent based on a more open ectal facet found in stem catarrhines. The only similarities between *Proteopithecus* and platyrrhines are in the moderate distal elongation and position of the peroneal tubercle, features shared by other euprimates. *Proteopithecus* and *Apidium* exhibit derived anthropoid features, but also a suite of primitive retentions, and are best placed as stem anthropoids. The calcaneal morphology of *Proteopithecus* is consistent with cladistic analyses that place proteopithecids as the sister group of Parapithecoidea.

Poster Session III (Friday, November 4)

ENVIRONMENTAL INFLUENCES ON MAMMALIAN UNGULATE GUILD COMPOSITION IN THE LATE PALEOGENE: A TAXON-FREE APPROACH USING DENTAL MEASUREMENTS

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The relationship between Cenozoic environmental change and mammalian evolution has typically focused on either taxonomic richness or morphologic evolution. For example, many previous studies examine the relationship between global climate and mammalian richness on several geographic scales, and the relationship between ungulate dental evolution and the spread of grasslands is a classic example of environmental change forcing morphologic evolution. The influence of environmental change on the composition structure of mammalian communities, guilds and populations is typically treated in a more qualitative manner. Here we characterize the mammalian ungulate guild through a 25 My interval between the late Eocene and early Miocene. We take a "taxon-free" approach in which we characterize constituent taxa by dental measurements. Such measurements have previously been demonstrated to faithfully reflect ecologically relevant parameters such as body size and diet. We compiled published measurements of cheek teeth of more than 200 species of artiodactyls and perissodactyls from the literature. We use published regression equations to estimate body size for each species. We then determine the distributions of taxon body size within 1.5My time intervals between 40 and 15Ma. A multivariate ordination of these distributions indicates substantial changes in ungulate body mass distributions immediately after the Eocene/Oligocene boundary and immediately before the Oligocene/Miocene boundary, coincident with rapid global cooling and warming, respectively. When compared with intervals in the late Eocene and early Miocene, body size distributions throughout the Oligocene have smaller means and ranges. These results highlight the Oligocene as a unique interval in mammalian history, and underscore the role of climatic and environmental change on the ecological composition of mammalian communities.

Poster Session III (Friday, November 4)

SKELETAL ELEMENT AND BOVID ABUNDANCE ANALYSES IN PALEOENVIRONMENTAL RECONSTRUCTION OF THE CHEMERON FORMATION, TUGEN HILLS, KENYA

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The Baringo Paleontological Research Project (BPRP) has focused recent research on the Chemeron Formation, Tugen Hills, Kenya (5.6 to 1.6 million years (My)). Many sites are located within the time interval from 5.5 to 2 My and are an appropriate comparison to other reconstructions of hominin paleoenvironments as well as filling in gaps in the record. The majority of specimens of any family, 74%, are isolated teeth although Baringo has been reconstructed as a fluctuating lacustrine environment rather than fluvial channel deposits. Only 15 sites of 110 are not dominated by isolated teeth and many of those are sites with complete skeletons. In the Chemeron the bovid specimens outnumber other families in terms of number of specimens for the formation and constitute about 27% of the specimens. The majority of bovids in the formation are overwhelmingly tragelaphines followed by alcelaphines and antilopines. Analyses of paleosol carbonate from the Tugen Hills have previously demonstrated that the entire sequence, including the Chemeron, consistently contains both C3 and C4 vegetation and there is no indication of an aridification trend at 2.5 My. Instead the data suggests mosaic environments throughout the sequence. The Chemeron Formation bovid specimens support this complicated picture with a high diversity of tribes for most of the time interval of the formation. There is an increase in the number of alcelaphines at the younger sites including the interval from 2.73-2.63 My and after 2.5 My. Some of these ecological differences may be due to the fluctuating lake levels in Baringo as evidenced by diatoms and the large numbers of hippopotamids which make up approximately 25% of the assemblage. Perhaps the fluctuating lake levels cause enough habitat fragmentation to alter migration or home range patterns and change the abundances of bovid tribes. This is the first paleoenvironmental reconstruction of the Chemeron Formation at multiple levels incorporating faunal analysis. Previous reconstructions have been based on paleosol carbonates and diatoms and fauna have been simply been described.

Poster Session II (Thursday, November 3)

CRANIAL ANATOMY AND ONTOGENY OF *GAVIALIS GANGETICUS* USING COMPUTERIZED AXIAL TOMOGRAPHY: IMPLICATIONS FOR GAVIALOID PHYLOGENY

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The phylogenetic position of the Indian gharial (*Gavialis gangeticus*) remains contested, with molecular and morphological data resulting in different tree topologies. Molecular data (nuclear DNA, proteins, mitochondrial DNA) place *G. gangeticus* as the sister taxon to *Tomistoma schlegelii*, within Crocodylidae. This would mean that the putatively plesiomorphic traits seen in *G. gangeticus* are secondary reversals. However, morphological data place *G. gangeticus* as the basal living member of Crocodylia, implying independent derivation of the tubular snout. Ontogenetic changes within *G. gangeticus* may be obscuring phylogenetically informative traits; therefore, examining a hatchling or near-hatchling specimen is critical to teasing apart the hypotheses of phylogeny. This study describes the cranial anatomy of a hatchling *G. gangeticus* skull based on high-resolution computed tomographic (CT) data in comparison with an adult specimen and with stem gavialoids. Ontogenetic changes include re-orientation of the orbits to a more dorsal position, lengthening of the rostrum, and posterodorsal extension of the angular. In addition, the skull table becomes more angular at the caudolateral corners. Examination of the braincase reveals that the basisphenoid rostrum reorients during growth to a more dorsally pointed structure. The median Eustachian system stays relatively compact vertically and expanded anteroposteriorly during growth. In comparison, fossil relatives (e.g., the 'thoracosaurs') of *Gavialis* have Eustachian systems outwardly similar to those of other living crocodylians. While these features have yet to be tested phylogenetically, these data support a secondarily reversed state for *Gavialis*.

Poster Session II (Thursday, November 3)

TAXONOMIC REVISION OF THE GLYPTODONTIDAE (MAMMALIA, XENARTHRA) PROPALAEHOPLOPHORINAE AND A PHYLOGENETIC ANALYSIS OF THE GLYPTODONTIDAE HOPLOPHORINI

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The family Glyptodontidae (late Eocene-early Holocene) represents one of the most conspicuous taxa in South America, reaching North America during the Great American Biotic Interchange. From a morphological point of view, these herbivores are characterized by having cephalic, dorsal and caudal armor. More than 65 genera have now been recognized. However, previous studies were conducted in a strict typological/morphological taxonomic context, without a precise morphological characterization. This situation led to an obvious overestimation of the actual diversity of this clade, and thus a taxonomic update is clearly necessary. Until now, the few cladistic analyses carried out have failed in having badly characterized taxa in most cases. This situation is especially true for two of the most diverse groups, the Propalaehoplophorinae and the "Hoplophorinae" Hoplophorini. The Propalaehoplophorinae (late Oligocene, Deseadan SALMA- middle Miocene, Colloncuran SALMA) are one of the most basal Glyptodontidae, while the Hoplophorini (late Miocene, Huayquerian SALMA-early Holocene, Lujanian SALMA), probably represent its sister group, and retain many primitive characters. Here we present the first taxonomic update of both groups (and in fact for all South American Glyptodontidae), and a comprehensive cladistic analysis of the Hoplophorini, including the Propalaehoplophorinae as an outgroup. The result shows that the Propalaehoplophorinae are represented by three well defined genera: *Propalaehoplophorus* (three species), *Cochlops* (one species) and *Eucinepeltus* (one species), and two additional controversial genera ("*Asterostemma"* and "*Metopotoxus"*). In turn, the Hoplophorini includes two genera: *Eosclerocalyptus* (three species) and *Neosclerocalyptus* (four species). On the other hand, the cladistic analysis suggests that the Glyptodontidae Hoplophorini is a natural group, characterized by six unambiguous synapomorphies. This result does not agree with previous analyses suggesting that the Hoplophorini is a paraphyletic group.

Technical Session XIV (Saturday, November 5, 10:45 am)

OXYGEN ISOTOPIC VARIABILITY AND PRESERVATION IN TYRANNOSAURUS REX, MODERN RATITES AND CROCODYLIANS: REVISITING THE THERMOPHYSIOLOGY OF T. REX USING δ18O

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Relying exclusively on the δ18O composition of fossil bone to distinguish between endothermy and ectothermy in *Tyrannosaurus* remains uncertain due to previous limited sampling, and potential diagenesis. Earlier assessments compared the δ18O of trabecular and

cortical bone and evaluated the degree of δ18O covariation between bone phosphate, carbonate, and diagenetic calcite. In this study, millimeter-scale sequential microsampling of a core removed from cortical bone in two femora and a tibia of *Tyrannosaurus* increased the known value of intrabone δ18Ophosphate from <1.0‰ to 1.3–3.0‰. These values increase the range in *Tyrannosaurus* body temperature from <4.3°C to 5.2–12.9°C, if the δ18O (or offsets) reflect relative body temperature at the time of hydroxyapatite formation as postulated previously. This range in temperature falls within acceptable levels for a mass homeotherm (endothermic or ectothermic).

A comparison of δ18Ophosphate versus δ18Ocarbonate indicates oxygen isotopic equilibrium is preserved in *Tyrannosaurus*. Oxygen isotope cyclicity and amplitude, and the minimum age of bone deposition estimated from cortical thickness, is suggestive of a seasonal (non-annual) isotopic signal in *Tyrannosaurus*. Interestingly, the Δ18Ocarbonate-phosphate of ~6.0‰ is 2.0 – 3.0‰ less than the theoretical 8.0 – 9.0‰ expected for unaltered modern bone apatite. This offset may reflect taxonomic, behavioral or physiological differences between *Tyrannosaurus* and the limited modern mammal sample from which this regression is calculated. Alternatively, diagenesis has altered the absolute δ18O values, but the ~6.0‰ offset is useful as an indicator of isotopic equilibrium in *Tyrannosaurus*.

δ18Ophosphate vs. δ18Ocarbonate analysis of modern crocodylian and ratite species indicate the Δ18Ocarbonate-phosphate relationship in these extant archosaurs is statistically significant. However, the scatter about the best-fit line is greater than observed in modern mammals. In *Tyrannosaurus,* the regression of δ18Ophosphate vs. δ18Ocarbonate does not correspond to that of modern mammals, ratites or crocodylians. Thermoregulatory strategies may be one of a variety of factors responsible. As an endothermic heterotherm, *Tyrannosaurus* could obtain large size and maintain a variable, but limited body temperature range compared to its environment.

Poster Session II (Thursday, November 3)

A BASAL TITANOSAURIAN FROM THE MIDDLE CRETACEOUS GALULA FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA

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Sauropods reached peak diversity during the Late Jurassic, with a decline in diversity by the Early Cretaceous. Titanosaurians represent the most diverse clade of Cretaceous sauropods, with a near-cosmopolitan distribution. Despite this widespread occurrence, titanosaurians are rare components of Cretaceous African faunas. Two representatives are currently recognized, *Malawisaurus* from the Lower Cretaceous Dinosaur Beds (DB) of Malawi and *Paralititan* from Upper Cretaceous deposits near Bahariya Oasis, Egypt. Recent expeditions in the Rukwa Rift Basin (RRB) of SW Tanzania have resulted in the recovery of a semi-articulated titanosaurian sauropod from the middle Cretaceous Galula Formation. Elements recovered thus far include components of the postcranial axial (e.g., cervical and caudal vertebrae, ribs) and appendicular (e.g. scapula, humerus, ulna, ilium, and pubis) skeletons. Ongoing preparation of this material now allows an initial character evaluation of several key regions of the skeleton. A preliminary phylogenetic analysis incorporating the new specimen with 34 taxa was conducted to assess the relationship of the RRP form among sauropods. The strict consensus tree places the RRB specimen as the sister taxon to a clade consisting of *Malawisaurus* and all other titanosaurians. A suite of characters supports this relationship including procoelous anterior caudal vertebrae, the absence of anterior and posterior projections on the chevrons, and a squared corner on the proximolateral humerus. The RRB specimen differs from *Malawisaurus* in having complex and divided pleurocoels on cervical vertebrae, the absence of a ventral longitudinal groove on anterior and middle caudal vertebrae, and a long proximal anterior condylar process of the ulna. Additional comparative work on materials collected from the RRB and the DB of Malawi is necessary for differentiating these potentially contemporaneous faunas. A detailed survey of these assemblages offers the best opportunity for characterizing sub-equatorial terrestrial faunas and is essential for developing paleobiogeographic comparisons with Cretaceous faunas known from circum-Saharan Africa and elsewhere in Gondwana.

Technical Session III (Wednesday, November 2, 2:45 pm)

THE RATE AND CESSATION OF FACIAL GROWTH IN CARNIVORANS

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Understanding the relationship between allometric growth and morphological diversity is hindered by the paucity of comparative allometric data. One noteable example is the topic of facial allometry in carnivorans, in which the facial growth patterns of carnivorans are primarily extrapolated from studies of domestic species. Here, we present analyses of facial allometry in 52 carnivoran species, represented by 719 juvenile and adult specimens, and including fossil taxa ranging from the Oligocene (e.g. *Hesperocyon*) to Pleistocene (e.g. *Smilodon fatalis, Canis dirus*). Four facial length and four skull length measures were analysed. Results suggest that the common generalisations are inaccurate, as isometric and allometric patterns were found interspersed throughout Carnivora. When family-level clades were compared, Canidae was significantly different from other clades, with all canid species studied showing strong positive allometry. Felidae and Viverridae surprisingly also displayed positive allometry, while the mustelid clade Lutrinae was the only clade to display negative allometry. Ancestral state reconstructions of allometric coefficients suggest that both magnitude and direction of facial allometry are highly variable across Carnivora, but allometry may be the ancestral growth style. These data suggest that hypotheses linking diversity and allometry across Carnivora based on domestic species are likely incorrect.

We also scored timing of suture closure, grossly approximating termination of cranial growth, in 370 extant carnivorans, representing 25 species. Amount of suture closure is negatively correlated with body size, and facial sutures are consistently among the last to close. In contrast to facial allometry, suture closure is relatively conservative across carnivorans. Similarly, previous studies show little heterochrony in onset of cranial ossification across Laurasiatheria, although there is little comparative data within Carnivora. Combined, these results suggest that rate of growth (i.e. allometry), rather than heterochronic shifts in onset or termination, is the key variable for linking development and diversity in the carnivoran cranium.

Poster Session I (Wednesday, November 2)

FIRST FOSSIL RECORD OF A SERRASALMINE TELEOST (PACUS AND PIRANHAS) ON THE WESTERN SIDE OF THE ANDES, FROM THE LATE MIOCENE OF CHILE

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A single well-preserved tooth recovered from an upper Miocene (Tortonian) horizon in the Bahía Inglesa Formation, north-central coast of Chile, represents the first fossil occurrence of a serrasalmine teleost west of the Andes. In overall morphology the specimen resembles the teeth of some iguanian lizards, but analysis of the tooth's ultrastructure confirms a fibrous, branching, non-uniform pattern typical of fish teeth. The tooth has a raised and slightly apically rounded central cusp flanked by narrower, coarsely serrated cutting edges. The labial surface below the crown is somewhat inflated and bulbous. The lingual surface is more trenchant, with a dorsoventrally oriented rounded medial ridge that separates anterior and posterior shallowly concave surfaces. In occlusal view, the tooth is labiolingually compressed, with the cutting edges of the crown curving slightly lingually at the tooth's anterior and posterior margins. The lingual surface of the tooth bears fine crenulations and ridges, while the labial side is relatively smooth. The tooth is somewhat more compressed than but otherwise strikingly similar to mandibular teeth of some pacus (e.g., *Myleus*), particularly in crown and labial view, but like piranha teeth it has sharp, serrated cutting edges. This suggests a morphology intermediate between the two specializations within serrasalmines – herbivory, including tough nuts and seeds, in broad-crowned pacus, and flesh-slicing carnivory in piranhas with blade-like teeth. The presence of the specimen in the Late Miocene of Chile indicates at least some level of biotic exchange between freshwater faunas of Amazonia, where serrasalmines are endemic today, and the western side of the Andes, a contention that is supported by the presence of crocodyliforms and hydrochoerine rodents in the Bahía Inglesa Formation.

Poster Session II (Thursday, November 3)

CONSTRUCTING A ROBUST ECOMORPHOLOGICAL INDICATOR OF LOCOMOTOR MODE FROM THE DISTAL FEMORAL ARTICULAR SURFACE MORPHOLOGY

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To make reliable inferences about the ecology of fossil animals, we need to know which morphological metrics are consistently related to function rather than other factors. The form of a joint surface is the result of different influences on the organism, such as body size, phylogeny and locomotor specialization. I collected six linear measurements from the distal femora of 45 genera of living mammals from the orders Carnivora, Rodentia, Artiodactyla, Perissodactyla and Hyracoidea. Body size range was 0.3kg to about 300kg. Each taxon was placed into one of six locomotor categories (arboreal, scansorial, terrestrial, semi-aquatic, semi-fossorial, and cursorial) based on the literature. Linear measurements were highly correlated with each other and with body size. Thus they were regressed against body size for all taxa and residuals were taken for further analysis. Three ratios were calculated from the linear measurements; none were highly correlated with each other or with body size. Multivariate ordination techniques (principal components analysis, canonical variates analysis) and statistical analyses (MANOVA, discriminant function analysis) were used to test the hypothesis that locomotor mode explains most of the variation in these size standardized metrics. Locomotor mode was a significant predictor of variation in femoral morphology both in the analysis of residuals (λ=0.149, F (30, 666)=13.489, df=30, p=0.01) and the analysis of ratios (λ=0.173, F (15, 527.67)=31.259, p=0.01). The discriminant functions were also highly significant, but success rates in the classification stage varied widely (cursorial taxa 78.6% success rate, semi aquatic taxa 27.8% success rate). Closer examination reveals that those taxa most frequently misclassified are those documented as engaging in several of the identified behaviors, or whose classification is equivocal. Arboreal taxa are also often recovered as scansorial. Linear metrics of the distal femur do reflect locomotor specializations, but are only diagnostic of them for certain specialized behaviors. This has implications for using the distal femur to infer the locomotor behavior of fossil groups.

Technical Session XIX (Saturday, November 5, 3:15 pm)

EARLY PLIOCENE (5MA) SHARK—CETACEAN INTERACTION AT LANGEBAANWEG, WEST COAST, SOUTH AFRICA

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Numerous Early Pliocene fossils have been recovered from 'E' Quarry at Langebaanweg on the West Coast of South Africa. This river channel deposit would have been located close to the river mouth during the Early Pliocene, and is unique in that it preserves both terrestrial and marine animals. The terrestrial component of the deposit has been extensively studied and has provided a reconstruction of the palaeoecology of this area during the Early Pliocene. Although the marine taxa from the deposit have been known since the 1960s, until recently, they have been relatively under studied.

Phocid seals as well as mysticete and odontocete cetaceans represent the marine mammals at 'E' Quarry. The fragmentary remains of the cetaceans consist of cranial (cranium & mandible) and postcranial elements. Previous studies of the taphonomic agents involved in the Langebaanweg deposit failed to account for some of the damage evident on the cetacean remains. Damage on the cetacean bones consists of numerous superficial and penetrating scrapes, grooves and ridges on the bones. A comparative analysis with other studies in the literature suggested that this damage resulted from shark feeding activity. The shark responsible for most of the bites is the white shark, *Carcharodon sp.,* the remains of which have also been recovered from LBW. This is the first documented case of prehistoric shark and cetacean interaction off the South Africa's West Coast.

Technical Session XIX (Saturday, November 5, 2:15 pm)

NEW FOSSIL WHALES FROM ANGOLA

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Ongoing field work in Angola, under auspices of Projecto PaleoAngola, has yielded fossil cetaceans from deposits of Miocene age, providing new insights into the early diversification of cetaceans along the western African coast. Here two new taxa of mysticete whales are described. PA 165 comprises a partial articulated skull, an unfused cervical vertebra, and a partial thoracic vertebra. The skull includes the nasals, proximal premaxillae and maxillae, the supraoccipital shield, left squamosal, exoccipital, periotic, and frontal. Portions of both dentaries are present. PA 166 comprises a partial articulated skull including the region posterior to and including the nasals. The proximal portions of the maxillae and premaxillae are present. Both specimens were recovered from what appears to be the Luanda Formation, a calcareous sandstone of late Miocene age. Phylogenetic analysis indicates these fossils represent two new taxa nested with *Caperea marginata*, the pygmy right whale, in the Neobalaenidae, a family currently restricted to one species inhabiting cold temperature Southern Hemisphere waters. Five characters unite the new Angolan taxa with *Caperea,* including the line joining the anterior points of the orbital processes of the frontals positioned anterior to the posterior extremity of the nasals, the posterior edge of the ascending process of the maxilla situated anterior to the orbit, the posterior edge of the nasal positioned just anterior to the anterior edge of the supraorbital process of the frontal, and the anterior point of the supraoccipital being in a transverse line with the anterior edge of the supraorbital process of the frontal. Three characters distinguish the Angolan taxa from *Caperea*, including the base of the rostrum being narrow, the zygomatic process of the maxilla underlying the supraorbital process of the frontal, and the lateral edges of the maxilla being parallel. Neobalaenidae is a sister group to Eschrichtiidae and Balaenopteridae. These new taxa are the only known fossil representatives of the family, they triple its known diversity, and they extend its range into the Miocene phase of the Benguela Large Marine Ecosystem.

Romer Prize/Technical Session 5 (Thursday, November 3, 11:15 am)

TIME AVERAGING AND AMS RADIOCARBON DATING OF LATE QUATERNARY VERTEBRATE ASSEMBLAGES: IMPLICATIONS FOR HIGH-RESOLUTION ANALYSES

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Advances in AMS physics and organic geochemistry have revolutionized our ability to establish absolute chronologies on vertebrate fossils for the late Quaternary. Highly purified collagen, which provides extremely accurate ages, can be extracted from single bones and teeth as small as 50 mg (individual rodent teeth). Combined with measurement precisions of ±15 to ±25 years for ages < 20,000 yr, the direct AMS 14C technique enables fossil deposits to be chronologically dissected at the level of individual specimens.

Analysis of hundreds of AMS 14C dates on individual taxa from a variety of sites and depositional environments indicates that most sites, and even excavation levels (analysis units) as small as 10 cm, can be time averaged by several thousand years at a minimum, even with the greatest care in excavation and processing of sediments. Time averaging of this magnitude has important implications for fine-scale paleoenvironmental resolution of faunas, especially when compared to high-resolution (decadal to centennial) climate records like those derived from speleothems, ice cores, or marine cores. To this end, we propose saturation dating of indicative taxa and plotting dates of individual specimens against high-resolution climate records rather than analysis of complete faunas or faunules. These types of analyses are critical for faunas that contain non-analog species pairs, those that have allopatric distributions today. Obviously, for faunas beyond 14C dating (~ 50 ka), high-resolution temporal analyses of individual taxa cannot be done.

Poster Session I (Wednesday, November 2)

DECIPHERING THE PERIODICITY OF GROWTH INCREMENTS IN THE TUSKS OF LATE TRIASSIC DICYNODONTS (THERAPSIDA: ANOMODONTIA)

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Dicynodonts were a diverse clade of non-mammalian therapsids that thrived amidst the ever-changing environments of the Permian and Triassic periods. Many dicynodonts had a pair of enlarged, caniniform teeth (tusks) that were ever-growing without replacement or remodeling. Thus, tusks may record a more complete growth history than skeletal elements that are subject to primary tissue turnover (e.g., bone). As such, growth records derived from tusks may enhance our understanding of life history and adaptation in Permo-Triassic dicynodonts. However, periodicity of growth increments in tusk dentine must be established before growth patterns can be analyzed. This study tests the hypothesis that increments in dicynodont tusks correspond to lines of von Ebner, which are daily growth lines in the dentine of living vertebrates. Partial longitudinal sections were taken from two isolated dicynodont (sp. indet.) tusks [North Carolina Museum of Natural Sciences (NCSM) specimens 19585 and 21735] from the Pekin Formation in North Carolina (Deep River Basin, Upper Triassic). Thin-sections were prepared using standard histological techniques and were analyzed at 100X magnification. Thickness of growth increments was measured from digital images using Axiovision software. Dentine growth lines in dicynodont tusks were visible as alternating dark and light bands oriented perpendicular to odontoblastic tubules. Increments with a mean thickness of 18.79 µm were identified in NCSM 19585, which is consistent with the thickness of daily dentine lines in living vertebrates. This result supports the hypothesis herein and is promising because it provides a measure of relative growth rate in dicynodonts. However, poor preservation in NCSM 21735 precluded accurate measurement of incremental thickness, so estimating the periodicity of growth lines in this specimen was not possible. This preliminary data suggests that well-preserved dicynodont tusks should record daily incremental features. If growth lines of a consistent periodicity can be confirmed in a whole tusk, it should be possible to construct a profile of increment thickness across the entire specimen to reconstruct growth history.

Poster Session III (Friday, November 4)

A NEW, PRIMITIVE SPECIES OF THE FLAT-HEADED PECCARY *PLATYGONUS* FROM THE LATE HEMPHILLIAN (LATEST MIOCENE) OF KANSAS, NEBRASKA, AND TEXAS

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In the Frick Collection of the American Museum of Natural History are specimens of new species of the Miocene-Pleistocene flat-headed peccary, *Platygonus*. It occurs in the latest Hemphillian East *Pliohippus* Draw locality (the latest Hemphillian ZX Bar local fauna), Sioux County, Nebraska, as well as the latest Hemphillian Edson Quarry, Sherman County, Kansas, and the late Hemphillian Coffee Ranch local fauna, Hemphill County, Texas. It can be diagnosed from other species of *Platygonus* by a maxillopalatine labyrinth which has a relatively small posterior atrial aperture, a distally-rounded wing-like zygomatic process; its cheek teeth are bunodont to subzygodont; the talon and talonid cusps are retained on the premolars of most individuals, and the mandibular symphysis lacks a median keel-like structure. In these characters, it is the earliest and the most primitive species of *Platygonus* known. It is more primitive than the typical Blancan species, *Platygonus pearcei* from Hagerman in Idaho, or any of the many named species from the Pleistocene.

Poster Session I (Wednesday, November 2)

TOOTH INITIATION FOLLOWS AN ALTERNATE ONTOGENETIC CLOCK IN PROMETAMORPHIC PIPID TADPOLES

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Tadpoles in the fossil record provide a window into the ontogeny of anuran species and particular insight into how earlier life history demands can impact adult morphologies. Thyroid hormone (TH) triggers the development of some adult structures leading up to and during metamorphosis, and this process can be directly influenced by environmental cues. The Nieuwkoop and Faber (NF) normal table is the standard for comparing development in *Xenopus laevis* and other pipid tadpoles, including fossils. Prometamorphic NF stages are defined by hindlimb morphology, with suites of characters which may or may not develop in concert with the hindlimb, which is quite TH-responsive. Documenting ossification sequences has supplemented the NF system, but a clear sequence for comparison remains elusive, both within and between taxa. To examine the possibility of mosaic development within pipid tadpoles, I constructed a developmental series of *Silurana (Xenopus) tropicalis* tadpoles for NF stages 55-58. The dentition was assessed due to its quantifiable, well-described, and long-lasting development. Position and morphology of developing teeth were triangulated in the first generation of adult teeth using histological sections taken from 3 per-

spectives. Overall, the sequence and histomorphology of tooth initiation are consistent with previous studies in *X. laevis* and *S. tropicalis*, but the timing is less so. The presence of lone mineralizing germs at NF 56, in contrast to a row of tooth germs reported at NF 55, suggests that NF stages may be too coarse for the comparison of some morphologies. Histology of developmentally arrested tadpoles shows that tooth initiation does not arrest when hindlimbs do, suggesting an alternate, less TH-sensitive timeline of development in pipid tadpoles which may also account for the variability in ossification sequences. These data emphasize the need to identify morphological traits which are TH-responsive and those which are less so. Identification of covarying traits will lead to a more refined understanding of mosaic evolution and development, and may allow us to infer environmental effects on development in extant and fossil tadpoles.

Poster Session II (Thursday, November 3)

THE EFFECTS OF WEATHERING ON RARE EARTH ELEMENT (REE) UPTAKE: A STUDY FROM THE PLEISTOCENE TARKIO VALLEY AND EOCENE BONES GALORE FOSSIL SITES

GRIMM, Brittany, The Pennsylvania State University, University Park, PA, USA; GRAHAM, Russell, The Pennsylvania State University, University Park, PA, USA

Rare earth element (REE) geochemistry has been used as a tool for several decades to determine age, provenance, degree of reworking, and depositional environment in paleontological deposits. Previous studies have found depth-related variations in REE patterns in bones, but there is little research regarding the impact of weathering on REE signatures. This study presents REE signatures from a rib of the Tarkio Valley late Pleistocene ground sloth, *Megalonyx jeffersonii*, from western Iowa, as well as from brontothere and rhinoceros specimens collected at the Eocene Bones Galore site in northeastern Colorado. After assigning a weathering stage to each bone or bone section, powdered samples were taken and analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The Pleistocene sloth rib shows a systematic increase in weathering from its proximal to distal end, and a corresponding increase in normalized REE concentrations is observed. The most weathered section on the medial side of the rib (weathering stage 5) is approximately four to six times more enriched in REEs than the least weathered section (stage 0.5). This may be due to increased collagen degradation and mechanical breakage before burial, creating greater void space in the bone. Then, during burial and recrystallization, there is greater surface area interaction with REE-bearing pore waters. Even with an increase in concentration, however, the ratios between each element vary only slightly regardless of weathering stage. Differentially weathered specimens from Bones Galore, a latest Eocene site, are analyzed in the same way for a temporal comparison. This study has significant implications for interpreting REE signatures in fossil bones. Historically, REE signatures in bone were considered to be a function of depositional environment and time, but these are not the only governing factors. Uptake also seems to be a function of weathering. Thus, taphonomic process must be considered before drawing conclusions from REE data.

Poster Session III (Friday, November 4)

NEW GIRAFFID FOSSILS FROM KALODIRR (WEST TURKANA, KENYA): IMPLICATIONS FOR OUR UNDERSTANDING OF THE DIVERSITY OF EARLY GIRAFFIDAE

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Early giraffid diversity in the early Miocene of Africa remains poorly studied despite the increasing number of fossils from numerous localities. New giraffid specimens from Kalodirr led to re-analysis of early giraffid fossils from North and East Africa, as well as comparisons with early Miocene material from Pakistan. We identified the lower second and third molars as those elements that could be directly compared among giraffids from Gebel Zelten (Libya), Moruorot and Kalodirr (Kenya), and Zinda Pir and Bugti (Pakistan). We then used non-metric characters to compare these elements using the fossils from these localities. Our comparisons of the lower second and third molars of the giraffids from the different regions indicate that primitive giraffids were much more numerous early in their evolutionary history than previously recognized. At Gebel Zelten we recognize that *Canthumeryx* and *Zarafa* are distinct taxa. The fossils from both Moruorot and Kalodirr represent distinct taxa as well. *Zarafa* was most similar to *Progiraffa* from Pakistan, while *Canthumeryx* was more similar to the giraffid from Moruorot. The giraffid from Kalodirr is a new genus. These results suggest that early giraffids must have evolved from primitive pecoran stock, most likely in Asia or Africa. An Asian origin would indicate a possible migration into Africa in the earliest Miocene followed by an explosive adaptive radiation. An African origin would suggest early immigration into Asia as part of a large adaptive radiation originating in Africa during the early Miocene.

Poster Session IV (Saturday, November 5)

MOSAIC EVOLUTION IN PRIMITIVE EOCENE CHIROPTERAN DENTITIONS *ARCHAEONYCTERIS TRIGONODON* (LUTETIAN, GERMANY) AND *ONYCHONYCTERIS FINNEYI* (WASATCHIAN, WYOMING)

GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA; HABERSETZER, Joerg, Senckenberg Forschungsinstitut, Frankfurt am Main, Germany; SCHLOSSER-STURM, Evelyn, Senckenberg Forschungsinstitut, Frankfurt am Main, Germany; SIMMONS, Nancy, American Museum of Natural History, New York, NY, USA; SMITH, Thierry, Royal Belgian Institue of Natural Sciences, Brussels, Belgium

Bats from the Messel Oil Shales (MP 11) and Green River Formation (Wa 7) are represented by some of the most complete skeletons known for fossil chiropterans. However, one of the great ironies of such exquisite preservation is that anatomical features are often obscured because skeletons are articulated. Advances in CT-scanning technology have permitted digital reconstruction of dental anatomy even where upper and lower jaws are in occlusion. This has allowed study of the complete dentitions of two of the most primitive known bats, *Archaeonycteris trigonodon* and *Onychonycteris finneyi*. Both taxa have a dental formula of 2.1.3.3/3.1.3.3. *Archaeonycteris* differs from *Onychonycteris* in having: I1-2 similar in size and aligned mesiodistally; C1 more elongate and labiolingually compressed; P2-3 homodont and more mesiodistally appressed; upper molars with broader stylar shelves, weaker parastylar hooks, and M1 with a much deeper ectoflexus; M3 with much more elongate parastylar region, a weaker metacone, and lacking a postmetacrista; p2-3 similar in size and morphology and both unreduced; c1 relatively larger and more projecting; p4 with distinct para- and metaconids; molar trigonids undifferentiated; cristid obliqua joins postvallid more lingually producing deeper hypoflexid. These differences pose problems for establishing the primitive bat morphotype. *O. finneyi* lacks a paraconid and metaconid on p4 while *A. trigonodon* has both – which (if either) is primitive for bats? In general, bat taxa with a tribosphenic pattern (hypoconulid centered on postcristid) are viewed as primitive, those showing a nyctalodont pattern (hypoconulid lingual, connected to hypoconid) as more derived and those with a myotodont pattern (hypoconulid lingual, isolated, postcristid connects hypoconid to entoconid) as most derived. Both taxa appear to fit the primitive tribosphenic pattern although it is difficult to be certain for *O. finneyi* in which the hypoconulid could be more lingual. These observations suggest that the early evolution of the chiropteran dentition was mosaic in nature, and that assumptions about the primitive chiropteran dental morphotype need to be carefully evaluated.

Technical Session X (Friday, November 4, 8:00 am)

STUDIES IN TAPHONOMY OF EXTANT AND MESSEL BATS

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The unique assemblage of fossil bats at the Messel pit and its extraordinary preservation still require a taphonomic explanation. How the bats died and became deposited in the sediments of the Eocene lake is a matter of ongoing discussion. Most of the approximately 700 excavated specimens are complete, articulated skeletons. However, bone preservation differs markedly.

Beginning with bones in their natural 3D state, progressive osteolysis occurs when one sees increasing degrees of fracturing, plastic deformation, and collapse of compacta and spongiosa. Ultimately, the bone decays completely, leaving only thin layers of amorphous osseous substance. These stages are represented by numerous bat fossils, which show a distinct centrifugal pattern of decay originating from the abdominal region and spreading to thorax, shoulder region, neck and head, and finally including long bones of wings and legs.

Actualistic experiments on dead bats were conducted in the laboratory for comparison. Their lungs were filled with water or air and the carcasses were subjected to different temperatures. Stages of decay were documented with µ-radiographs. The majority of carcasses whose lungs were filled with water sank immediately to the bottom and became disarticulated faster than carcasses whose lungs were filled with air. In all experiments at different water temperatures, a centripetal disarticulation of the skeleton was observed. Only disarticulation but no osteolysis occurred during these experiments up to 762 days.

Observations on early mummification and putrefaction of extant bats during hours after death provide valuable clues to how long bats were floating on the water surface and how quickly they sank to the bottom of former Lake Messel. We conclude that most of the Messel bats did not drift on the water surface either primarily or secondarily, but sank into deep water immediately after death. This is consistent with the fossil record; approximately 87% are more or less complete skeletons. The remainder are isolated bones, e.g., skulls or partial jaws. These less common states of preservation should also be taken into consideration for a complete description of this fossil site.

Technical Session XII (Friday, November 4, 3:00 pm)

FLIGHT PERFORMANCE OF GIANT PSEUDODONTORN BIRDS

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Some pseudodontorn species reached enormous size, with Miocene specimens possessing wingspans of nearly six meters. The group existed from the Paleocene through the Pliocene, with a nearly worldwide distribution (New Zealand, Europe, Africa, South America and North America). Despite their size and wide distribution, little work has been done on the

flight performance of pseudodontorns. We have estimated flight speed and launch ability for the largest Miocene pseudodontorn birds by combining bone strength metrics with quasi-steady aerodynamic analysis.

Glide angle depends on wing efficiency and is independent of body mass; using measured lift coefficients from living seabirds along with the reconstructed wing shape for *Osteodontornis* specimens that include feather impressions, we calculate an average best glide ratio of 27:1 for *Osteodontornis* and *Pelagornis*. This would have made large pseudodontorns the most efficient gliders among known birds (1.35x an average albatross glide ratio, 2.0x an average vulture glide ratio). Scaling pseudodontorn body mass from regressions on living procellariiform wingspan predicts a body mass of 55-60 kg for the largest specimens. Applying this estimate to beam model calculations suggests that pseudodontorns possessed relatively weak forelimbs, with similar relative hind limb strength to that seen in *Diomedea*. However, recent body mass estimates using a relatively complete Chilean specimen are much lower, just under 29 kg. This discrepancy appears to result from the fact that pseudodontorns had proportionately longer wings than albatrosses. Under the lower body mass estimates, the relative cantilever failure force (RCFF) value for the femur of the largest *Pelagornis* specimen is 2.95, which is nearly double that for a 9 kg wandering albatross. Launch in birds is hind limb driven; therefore, this high RCFF value suggests powerful launching ability in pseudodontorns. A low body mass would allow for slower flight, but would reduce wind penetration and may have precluded the use of some forms of dynamic soaring. A lighter mass would not improve overall soaring efficiency, but would improve launch performance.

Poster Session III (Friday, November 4)

A DIVERSE DINOSAUR TOOTH ASSEMBLAGE FROM THE UPPER JURASSIC OF ETHIOPIA: IMPLICATIONS FOR GONDWANAN DINOSAUR BIOGEOGRAPHY

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Dinosaur-bearing Gondwanan Upper Jurassic deposits are under represented in the fossil record and thus signify a gap in our understanding of the biogeographic radiation of several non-avian dinosaur clades. Here we present an analysis and description of dinosaur teeth from the Upper Jurassic (Tithonian) Mugher Mudstone Formation, Ethiopia, collected during several expeditions by the University of California Museum of Paleontology, Berkeley. Significantly, several teeth are referable to the Dromaeosauridae and represent the oldest skeletal remains of this group in Gondwana. Teeth referrable to the stegosaur *Paranthodon africanus* extend the stratigraphic range of this taxon into the Late Jurassic and expand the geographic range of African stegosaurs north beyond the Tanzanian record at Tendaguru. The presence of hypsilophodontids is confirmed. With the description of these dinosaur teeth from the Late Jurassic of Ethiopia, the Mugher dinosaur fauna approaches the taxonomic diversity represented by the historically important and rich Tendaguru deposits of eastern Africa. Future exploration of this formation and the northwestern plateau of Ethiopia is ongoing, and critical to deciphering evolutionary and biogeographic patterns in Jurassic non-avian dinosaurs across Gondwana.

Technical Session I (Wednesday, November 2, 11:45 am)

ANATOMY OF *JEHOLOSAURUS SHANGYUANENSIS* AND A PHYLOGENETIC ANALYSIS OF BASAL ORNITHISCHIANS

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Jeholosaurus shangyuanensis is a small ornithischian collected from the Lower Cretaceous Yixian Formation of the Lujiatun Locality, Liaoning Province, China. Seven specimens, including the holotype, are described in detail, revealing new information pertaining to the skull and postcranial skeleton. Four autapomorphies and the presence of a unique combination of character states support the validity of *Jeholosaurus*. The autapomorphies include: the presence of a row of small foramina on the lateral surface of the nasal, immediately dorsal to the premaxillary articulation; grooves and ridges present on the anterolateral surface of the frontal; parapophysis absent in dorsal vertebrae 1 and 2; and a narrow, deep, mediodorsally extending fossa is present on the lateral side of the anterior ascending process of astragalus. Other notable characters that contribute to the unique combination defining *Jeholosaurus shangyuanensis* include: six premaxillary teeth; presence of a quadratojugal foramen; presence of small nodes on the lateral surface of the jugal; presence of a deep concavity on the medial side of the nasal; caudal process of the jugal bifurcated distally; external mandibular foramen absent; a long axial neural spine that extends posteriorly to reach the distal end of cervical 3; presence grooves and ridge on the ventral surface of sacral and anterior caudal vertebrae

A phylogenetic analysis based on 42 taxa and 420 characters was carried out in order to establish the position of *Jeholosaurus* among basal ornithischians. Both parsimony and Bayesian methods were used in the analysis. The results suggest that *Jeholosaurus shangyuanensis* and *Changchunsaurus parvus* are more closely related to Marginocephalia than to Ornithopoda, maybe providing new evidence for the early evolution of ceratopsians. The results also support heterodontosaurid monophyly, the monophyly of Marginocephalia, and monophyly of Thyreophora, within which the positions of *Scutellosaurus*, *Emausaurus*, and *Scelidosaurus* are unstable. The Bayesian method strongly supports ornithopod monophyly, and produced a better-resolved phylogenetic tree than parsimony. In contrast to other phylogenetic analyses, the results suggest that *Psittacosaurus* represents the most basal ceratopsian dinosaur and that *Yinlong* and *Chaoyangsaurus* form a clade. There are also some topological differences between the results gained from the two methods, for example, in the positions of *Lesothosaurus*, *Pisanosaurus*, and *Eocursor*. Moreover, the positions of the most basal ornithischians are unstable in the topologies produced by both methods, and more work is needed to address this problem.

Poster Session IV (Saturday, November 5)

ASHES TO ASHES, DUST TO ECM; PROTEOMIC ANALYSIS OF VERTEBRATE SAMPLES FROM THE SNOWMASTODON PROJECT

HANSEN, Kirk, University of Colorado Denver, Aurora, CO, USA; HILL, Ryan, University of Colorado Denver, Aurora, CO, USA; JOHNSON, Kirk, Denver Museum of Nature and Science, Denver, CO, USA; STUCKY, Richard, Denver Museum of Nature and Science, Denver, CO, USA

Bone samples from several vertebrates were collected from the Ziegler Reservoir, Snowmastodon locality, in Snowmass, CO and processed for proteomic analysis. The specimens come from Pleistocene megafauna, *Bison latifrons, Mammut americanum and Mammuthus columbi* that are between ~45,000 and ~150,000 years old. Optimized methods were developed for processing bone and soft tissue samples which involve aqueous extractions and detergent assisted digestion. Tandem mass spectrometry (MS) was used to obtain protein sequence coverage from proteolytic and mixed chemical-proteolytic digests. A range of bioinformatic resources were used to obtain peptide identifications based on sequence homology and *de novo* methods were used to yield additional peptide sequences. Identifications were compared to recently published MS sequencing and fingerprinting results to yield considerable overlap in results. Our analysis of bone samples resulted in some of the most complete fibrillar collagens sequence reported to date from paleontological samples. Additional extracellular matrix (ECM) and non-ECM proteins have been identified for the first time in our soft tissue samples. Protein interaction analysis reveals a network of complex interactions between identified proteins and suggests the presence of a protective niche beyond fibrillar collagen structures within the fossils. These results should allow us to further the phylogenetic analysis of extinct vertebrates.

Poster Session I (Wednesday, November 2)

ENVIRONMENTALLY INDUCED PHENOTYPIC PLASTICITY IN THE JAPANESE QUAIL (*COTURNIX CORTURNIX JAPONICA*) AND ITS IMPACT ON AVIAN EVOLUTION

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Environmental change has been hypothesized to directly affect phenotypic plasticity, potentially influencing major evolutionary transitions in vertebrate history. As birds diverged from nonavian theropods and evolved during the Mesozoic, atmospheric concentrations of oxygen (O2) and carbon dioxide (CO2) were lower and higher respectively, relative to present day levels. To elucidate how changes in O2 and CO2 affected vertebrate evolution, it is necessary to empirically study how variation in the ambient concentration of these gasses impacts the development of extant taxa. This study examined the effects of different atmospheric environments upon morphological development in the Japanese quail (*Coturnix coturnix japonica*). Fertilized eggs were divided into four groups: A, constant temperature, in normoxia (the control group; ~21% O2); B, varied temperature, in normoxia (~21% O2); C, constant temperature, in hypoxic conditions, (~15% O2); and D, constant temperature, in elevated CO2 (1.5% CO2). Embryos were collected daily (from E6-16). The variation in temperature during incubation significantly stunted the rate of development. Embryos developed under conditions of hypoxia were stunted, and experienced higher rates of both morphological defect and death compared to the other experimental groups and the control group. These data support the hypothesis that changes in both temperature and composition of atmospheric O2 and CO2 concentrations have an impact on avian development and, as a result likely played a significant role in their evolution.

Technical Session XII (Friday, November 4, 4:00 pm)

FOSSIL AVIFAUNA OF THE PLEISTOCENE FOSSIL LAKE FORMATION (OREGON): CAN BIRDS BE USED AS A PROXY TO DETERMINE PALEOCLIMATIC CONDITIONS?

HARGRAVE, Jennifer, Syracuse University, Syracuse, NY, USA

Lacustrine sediments of the Pleistocene Fossil Lake Formation of Oregon, record packages of upwardly fining sequences that are fossiliferous, including a large collection of bird fossils. This paleo-lake was studied to determine whether stratigraphically collected bird fossils are a useful tool to infer broad climatic conditions of ancient lacustrine systems. Depositional environments were determined for each of the eight stratigraphic packages that were deposited from 646 ka to approximately 10 ka as the lake waxed and waned. The stratigraphic relationships suggest the lake experienced gradual in-fillings followed by abrupt shallowings. A subsample of over 350 stratigraphically collected bird fossils are divided into

3 eco-groups based upon their feeding preferences: diving birds, shallow-water birds, and terrestrial birds. The fossil avifauna recovered from the Fossil Lake Formation reveal changes in group abundances with changing water depth. Shallow-water birds are consistently the most abundant eco-group overall. Diving birds are at their most abundant in the finer-grained sediments, which are interpreted here to have been deposited in deeper water during wetter climates. The fossil avifauna is in agreement with the interpreted depositional environments. Additionally, geochemically dated tephra units within the formation allow for correlation and comparison to nearby lakes for which climate has been determined, as well as to global Marine Isotope Stages. Based on these correlations, the inferred climate of the Fossil Lake Formation was corroborated and it was determined that the formation was primarily deposited during pluvial episodes. As with many fossil collections, inferences made solely from fossil avifauna may be limited, resulting from sample size, taphonomic biases, etc. However, collections of avifauna with stratigraphic control can be combined with other datasets, such as lithologic and isotopic data, to better construct broad paleoclimatic conditions, such as warm or cold and dry or wet.

Poster Session I (Wednesday, November 2)

THREE DIMENSIONAL DENTAL WEAR ANALYSIS OF THE BISSETKY FAUNA EUTHERIANS, DZARAKUDUK REGION, UZBEKISTAN

HARPER, Tony, San Diego State University, San Diego, CA, USA

The Bissetky Formation, Dzarakuduk region, Uzbekistan (Turonian ~90 million years), produced a rich assemblage of isolated dental elements referable to 12-13 species of stem eutherians. These remains exhibit greater variation in large-scale dental wear than would be expected given the assumption that such mammals were restricted to similar, insectivorous dietary niches. This diversity has been largely unquantified because of challenges traditional two-dimensional wear analyses have with measuring areas on small, convoluted occlusal surfaces. This analysis overcomes the limitations of size and relief by measuring areas on digitally rendered volumes created from 27 micrometer micro-Computerized Tomographic (μCT) images of the Bissetky fossil material. Using this approach, several higher order groups of sympatric eutherian species can be recognized on the basis of homologous wear facet comparisons of first and second molars, and overall proportions of phase 1 versus phase 2 dental wear. These data are interpreted and visualized using the multivariate ordination and clustering techniques, Principal Component Analysis (PCA) and Discriminate Function Analysis (DFA). Characteristic differences between groups are summarized and shown to have functional interpretations that may reflect dietary specialization. One group in particular, the zhelestids, display a relatively large proportion of phase 2 dental wear, which would suggest an omnivorous or strictly herbivorous diet.

Symposium 2 (Wednesday, November 2, 10:45 am)

CONTRIBUTIONS FROM PROJECT 23 TO OUR UNDERSTANDING OF THE RANCHO LA BREA BIOTA

HARRIS, John, George C. Page Museum, Los Angeles, CA, USA; FARRELL, Aisling, George C. Page Museum, Los Angeles, CA, USA; HOWARD, Carrie, George C. Page Museum, Los Angeles, CA, USA; SCOTT, Kim, George C. Page Museum, Los Angeles, CA, USA; SHAW, Christopher, George C. Page Museum, Los Angeles, CA, USA

The Rancho La Brea (RLB) biota contains over 600 species of Late Pleistocene animals and plants ranging in age from 9,000 to 55,000 radiocarbon years BP. Isotopic studies involving this biota during the past decade have suggested that coastal Southern California experienced great aridity during the late Pleistocene and that C3 plant productivity was greatly diminished during the last glacial episode. Because of its age range, the RLB biota should document response to both global cooling and global warming. However, over half the species represented at RLB, including most of the plant, insect, and mollusk species, are known only from Pit 91 where they document the interval ~27,000 years ago. Unfortunately, the earlier 1913-15 excavations recovered very little microfauna.

Sixteen asphaltic fossiliferous deposits were recovered in 2006 adjacent to the RLB National Natural Landmark and during the construction of an underground parking structure for the Los Angeles County Museum of Art. The deposits were retrieved between 10 and 25 feet below ground surface and were crated and relocated to the Pit 91 compound for excavation and processing. Although their preparation is far from complete, 7 of the 23 boxes have to date yielded more than 16,000 bones and more than 80 species of vertebrates, invertebrates, and plants. These deposits have the potential to expand our understanding of the nature and diversity of the RLB assemblages before and after that from Pit 91. Meanwhile they are already providing information about the formation of the RLB deposits.

Asphaltic accumulations from Project 23 excavated thus far include a tabular deposit, a narrow fissure, and a meter-wide cylindrical vent extending downward for at least two meters, all packed with bones. Elements of at least some individual skeletons have clearly undergone postmortem vertical relocation within their accumulations. This in turn suggests that it may be unwise to estimate either the age or environment of individuals from any specific bone mass on the basis of their stratigraphic position within the deposit or on radiometric dates from adjacent remains of other individuals.

Poster Session II (Thursday, November 3)

INSIGHT INTO THE CENOMANIAN (LATE CRETACEOUS) TERRESTRIAL AND MARINE VERTEBRATE FAUNA OF BYLOT ISLAND, NUNAVUT

HARRISON, Luke, Redpath Museum, McGill University, Montreal, QB, Canada; VAVREK, Matthew, Royal Ontario Museum, Toronto, ON, Canada; BECKER, Michael, Department of Geography, McGIll University, Montreal, QB, Canada; LARSSON, Hans, Redpath Museum, McGill University, Montreal, QB, Canada

A diverse marine selachian fauna, represented by isolated teeth and tooth fragments, is described from the Cenomanian of Bylot Island, Nunavut, Canada. The fauna consists of at least six species, including a possible Mitsukurinid, *Notorhynchus sp*., *Archeolamna sp.*, and *Paraorthacodus jurensis*. Fragmentary tooth plates indicate the presence of further Chimerid species. At the time it was deposited, the fauna was near its present location, well above the Arctic Circle. The locality is also one of the few known from this region of Late Cretaceous North America, providing important biogeographic information about the nearby Labrador Seaway and the paths of dispersal of these species into and out of more continental portions of the Western Interior Seaway. The fauna is similar to a nearly contemporaneous fauna from Western Australia. Because many of the species are also found at lower latitudes, this could be indicative of higher water temperatures at high latitudes during this interval and the much more equable climate present at the time.

Poster Session II (Thursday, November 3)

THE DIET OF THE MIO-PLIOCENE CARNIVORES OF LANGEBAANWEG, SOUTH AFRICA

HARTSTONE-ROSE, Adam, Penn State University, Altoona, PA, USA; SIMPLER, Elizabeth, Penn State University, State College, PA, USA; HECKLER, Amanda, Penn State Altoona, Altoona, PA, USA

Recent studies have shown that intercuspid notches (ICN) and cusp radius-of-curvature (ROC) of post-canine dentition can be used to differentiate the diets of modern carnivorans along a spectrum from hypercarnivory to durophagy. These studies examined the dietary breadth of the Plio-Pleistocene carnivorans from the Sterkfontein Valley, South Africa, and found that the guild from that time and region significantly overlapped the modern carnivorans in their carcass-processing abilities. In the current study, we apply these techniques to evaluate the carcass-processing abilities of the carnivores from the Mio-Pliocene site of Langebaanweg (LBW), South Africa. This site has extraordinary carnivoran diversity including numerous species of hyaenids and felids as well as large mustelids and ursids and many small carnivorans. The hyenas from this site have been described as representing a primitive dietary generalist grade, purportedly more canid in ecology. Here we evaluate these specimens to test whether they fall closer to the hyaenid or canid dental shape and we also examine the felids to determine where they fall relative to the modern sample. We found that the LBW hyaenids fall between the modern hyenas and canids in terms of the sharpness (ROC) of their teeth – though the ROC of their p3 (the best tooth for differentiating the diets of carnivorans by this measure) overlaps the range of the modern durophagous hyenas, the means are substantially different with the LBW hyenas falling slightly closer to (though statistically different from) the more flesh-adapted canids. This pattern is more dramatically confirmed when examining the ICN. Using the ICN to sum the notch scores of the p4 (the best tooth for differentiating the diets of carnivorans by this measure), the LBW hyenas are statistically more hypercarnivorous than not only the modern hyenas but most species of canids. In fact, by this measure, they appear nearly as hypercarnivorous as *Cuon* and *Lycaon* and even approach the notch scores of some of the felids. By both ROC and ICN, the LBW felids fall within the modern cat dietary range and by some measures appear nearly as hypercarnivorous as taxa like *Acinonyx* (the cheetah).

Technical Session XVIII (Saturday, November 5, 2:30 pm)

NEW PRIMITIVE CAIMANINE (CROCODYLIA, ALLIGATORIDAE) FROM THE MIOCENE OF PANAMA

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While extant caimans are geographically limited to the New World Tropics (NWT), their fossil record extends to the Paleocene of Argentina in South America and the Eocene of Wyoming in North America, both at higher latitudes, suggesting that the origin of Caimaninae might have occurred outside of the tropics. A new fossil skull from the Culebra Formation (early Miocene) of Panama has characteristics uniquely shared with Caimaninae, including a large supraoccipital exposure on the skull table, and a splenial terminating posterior to the symphysis and dorsal to the meckelian groove. It also has characteristics likely primitive to both caimans and alligators, including open supratemporal fenestrae, and exoccipitals that terminate dorsal to the basioccipital tubera. Cladistic analysis of 164 morphological characteristics scored for 26 alligatorids, the new taxon, and 3 outgroups, yielded 225 equally-most parsimonous cladograms, all of which place the new taxon from Panama as the most basal in Caimaninae. It falls out as more primitive than the oldest fossil records of the subfamily, *Eocaiman* from the Paleocene–Eocene of high latitude Argentina, suggesting that caimans originated within the NWT, entered both South and North America during the Paleogene, and persisted in the tropics into the Miocene after disappearing at higher latitudes. Alterna-

tively, caimans may have originated outside of the tropics and dispersed into Panama by the Miocene as suggested by the older records at higher latitudes. While caiman fossils have yet to be recovered from the Paleogene NWT, and no taxa as primitive as the one described here has been discovered from outside of the NWT, new fossil discoveries could test the biogeographic hypotheses presented here.

Poster Session II (Thursday, November 3)

DENTAL MICROWEAR TEXTURE ANALYSIS OF DENTIN

HAUPT, Ryan, Vanderbilt University, Nasvhille, TN, USA; DESANTIS, Larisa, Vanderbilt University, Nashville, TN, USA; GREEN, Jeremy, Kent State University at Tuscarawas, New Philadelphia, OH, USA

Inferring the dietary ecology of fossil mammals requires the use of tools such as morphological analyses, stable isotopes, and/or dental microwear. While the majority of mammals have both teeth and tooth enamel allowing for such analyses, some xenarthrans lack teeth and all lack enamel. Recent research demonstrates the potential viability of conducting stable isotope analyses on dentin. However, one must first demonstrate the lack of diagenetic alteration in dentin using tools like Rare Earth Element analysis. Instead, low-magnification dental microwear of xenarthrans has recently been shown to differentiate extant sloths and armadillos, with differences between taxa largely driven by the average number of scratches. Another microwear technique, Dental Microwear Texture Analysis (DMTA) can quantify high resolution (100x) microwear surfaces in three-dimensions and without requiring the counting of individual microwear features (e.g., pits and scratches). DMTA is useful at quantifying primate, ungulate, carnivore, and marsupial diets. Therefore, DMTA has the potential to further resolve the dietary ecology of extinct and extant xenarthrans. Our preliminary results indicate a high degree of overlap between armadillos (*Euphractus sexcinctus* and *Dasypus novemcinctus*) and sloths (*Bradypus variegatus* and *Choloepus didactylus*) in both complexity and anisotropy. Furthermore, our data appear to show that *C. didactylus* is likely feeding on harder objects than *B. variegatus*, a conclusion also supported by observational data. The extinct species *Megalonyx leptostomus* and *Paramylodon harlani* were also likely browsers, based on higher complexity values, an interpretation also supported by morphological studies. These results show the potential for dentin DMTA to yield paleoecological information. However, further tests quantifying differences in dentin and enamel microwear in functionally identical wear surfaces is currently underway.

Poster Session IV (Saturday, November 5)

ISOTOPIC RECONSTRUCTION OF MODERN SMALL MAMMAL DIETS AND IMPLICATION FOR UNDERSTANDING THE EVOLUTION OF THE C4-DOMINATED GRASSLAND OF THE GREAT PLAINS

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We reconstruct the diets of modern small mammal communities in Minnesota and western Nebraska using carbon isotopes in hair from museum specimens to determine if small mammal diets faithful record differences between environments. Modern small mammals from Nebraska should be isotopically heavier than modern specimens from Minnesota because western Nebraska grasslands have a greater proportion of C4 plants (warm season grasses) relative to C3 plants (trees, shrubs, cool season grasses) than do grasslands and more wooded biomes in Minnesota. We analyzed 149 hair samples of 15 species from Nebraska and three from Minnesota. After correcting raw data to δ13C of diet, mean δ13C value for all specimens in Nebraska (-22.0‰ VPDB) is statistically higher than for Minnesota (-25.4‰), consistent with greater consumption of C4 grasses on average by small mammals in Nebraska but indicating most individuals and most species in both states rely more heavily on C3 biomass regardless of the environment. For the three species that occur in both states, two species have diets with statistically higher δ13C values in Nebraska than in Minnesota. Separate ANOVAs of the data from Nebraska and Minnesota grouped by species indicate statistically significant differences among species in the consumption of C4 biomass in each region. These results suggest isotopic analyses of rodent communities may be used to assess relative changes in ancient environments, but may not necessarily reflect the absolute abundance of C4 biomass. To determine if small mammal diets suggest temporal change in the abundance of C4 biomass in a region, we compared the modern data from western Nebraska to laser ablation analyses (corrected to diet) of 79 teeth of 24 species rodents from the 2.4 Ma Big Springs Gravel Pit fauna in Nebraska. Mean δ13C of modern rodents is statistically higher than the mean for Big Springs rodents (-23.5‰). This could suggest an increase in the relative abundance of C4 grasses in Nebraska since 2.4 Ma, but we cannot rule out differences in food selection or possibly warmer and drier conditions today shifting the δ13C of C3 biomass relative to the Early Pleistocene.

Technical Session XV (Saturday, November 5, 8:00 am)

A NEW SMALL OPHIACODONTID (SYNAPSIDA, EUPELYCOSAURIA) FROM THE LATE PENNSYLVANIAN OF GARNETT, KANSAS

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Members of Ophiacodontidae, a clade of Paleozoic synapsids, represent the earliest record of amniote diversification, and are known from the Middle Pennsylvanian to Early Permian localities in North America (eastern and south-central United States, Atlantic Canada) and Europe (England, France, Czech Republic). *Archaeothyris,* the smallest, oldest known member of this clade, is also the oldest known clearly identifiable synapsid. Here we describe a slightly younger, small ophiacodontid from Garnett, Kansas (Rock Lake Member of the Stanton Limestone Formation, Lansing Group; Late Missourian, Late Pennsylvanian) based on multiple skeletons. Preliminary phylogenetic analysis of basal synapsids reveals that this new taxon can be confidently referred to Ophiacodontidae on the basis of nine derived characters shared with *Archaeothyris*, *Varanosaurus*, and *Ophiacodon*: elongate antorbital region more than twice the length of the postorbital region; nasal longer than frontal; supracanine buttress of the maxilla with ascending process present; paroccipital process of opisthotic short and knob-like; tabular greatly shortened ventrally so as not to extend below level of the ventral margin of supraoccipital and encloses posttemporal fenestra laterally but may contact dorsally expanded opisthotic to obliterate posttemporal fenestra; paroccipital process of opisthotic short and robust; axial neural spine expanded beyond the levels of both ends of centrum; and dorsal groove of ilium present. The Garnett ophiacodontid, characterized by two autapomorphies, occupies a sister-group position to a clade formed by *Varanosaurus* and *Ophiacodon*, sharing with these two genera the presence of the medial orbital processes of the jugal and postorbital, the long anterior process of frontal, and elongate teeth that maintain a nearly constant diameter for most of their basal length. These results agree with the trend of increasing body size within Ophiacodontidae, and suggest that the Garnett ophiacodontid represents a new genus occupying a position basal to the large-bodied, derived morphotypes represented by *Varanosaurus* and *Ophiacodon.*

Technical Session XIX (Saturday, November 5, 3:30 pm)

BONE HISTOLOGY SUGGESTS INCREASING AQUATIC ADAPTATIONS IN DESMOSTYLIA

HAYASHI, Shoji, University of Bonn, Bonn, Germany; NAKAJIMA, Yasuhisa, University of Tokyo, Tokyo, Japan; CHIBA, Kentaro, Hokkaido University, Sapporo, Japan; SAWAMURA, Hiroshi, Ashoro Museum of Paleontology, Ashoro, Japan; ANDO, Tatsuro, Ashoro Museum of Paleontology, Ashoro, Japan

Desmostylians are a group of extinct mammals known from the upper Oligocene through the middle Miocene marine strata of the northern Pacific Rim. The paleoecology of extinct desmostylians has been controversial since they were first discovered. The unique osteological and dental morphologies have hindered a consensus on their paleoecology. Bone histology can be used as a tool to infer aquatic adaptations of extinct animals. However, histological studies of desmostylians are not well known. Therefore, we compared the histology of *Behemotops*, *Paleoparadoxia*, *Ashoroa*, and *Desmostylus* using thin-sections and CT scans of ribs and humeri to better understand the desmostylian habitat and evolutionary history. With the exception of *Desmostylus,* thin-sections of cortical bones from ribs and humeri show multiple growth marks, indicating a similarity with sirenians. All desmostylians lack medullary cavities in their limb bones and ribs. In extant mammals, this has been interpreted as an aquatic adaptation. Bone histology of *Behemotops* and *Paleoparadoxia* shows osteosclerosis, while that of *Ashoroa* shows pachy-osteosclerosis. *Desmostylus* bone histology is distinctly different from that of other desmostylians in that it shows an osteoporotic-like pattern. In living taxa, high density bone (osteosclerosis and/or pachy-osteosclerosis) provides static buoyancy control suitable for a coastal habitat, while low density bone (osteoporotic-like pattern) is associated with dynamic buoyancy control suitable for a pelagic life style. Our study suggests that all desmostylians evolved aquatic adaptations, habitats, and/or aquatic locomotion throughout their evolutionary history, but bone histology suggests that *Desmostylus* was the only desmostylian to have been able to employ dynamic buoyancy control.

Poster Session IV (Saturday, November 5)

COILING GEOMETRY OF PROBOSCIDEAN TUSKS

HAYDEN, Alistair, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA

The permanent tusks of proboscideans are greatly enlarged and generally ever-growing second incisors. They typically show a spiral form that is most clearly developed in some mammoths, but that is a fundamental geometric feature of tusks in all proboscidean taxa and possibly other teeth as well. We are investigating the theoretical morphology of proboscidean tusks by developing a model that describes their 3D geometry. Our goal is to understand the variety of tusk forms found in proboscideans and to clarify how these forms might arise through modifications of an underlying growth program. In addition, we hope to use quantitative descriptors of tusk form to test a hypothesis that some late Pleistocene mammoths of the Great Lakes region (referred by some workers to *Mammuthus jeffersonii*) may be hybrids between *M. columbi* and *M. primigenius*. Tusks of putative hybrids do show qualitative hints of intermediacy, but without a model to guide selection of independent descriptors, this proposition is difficult to evaluate.

To develop our description of tusk form, tusks of *M. primigenius* from Chukotka and Wrangel Island (northeast Siberia) were digitized and fit to mathematical models using nonlinear optimization in MATLAB. The models explored were based on those developed to describe molluscan shell coiling and include approaches relying on external reference frames and familiar geometric equations as well as alternative approaches relying on internal reference frames that better describe actual biological growth. The principal structural axes of tusks, running through the tusk from the tip to the pulp cavity, were found to fit well to 3D logarithmic spirals (2D logarithmic spirals with the third dimension defined by an additional exponential function) with the free parameters for the spirals differing between tusks. Other models of coiled form were also explored with varying degrees of success. Resolution of the

taxonomic problem that inspired this project will require larger sample sizes, but we have a foundation that appears adequate to the task.

Technical Session IX (Friday, November 4, 11:15 am)

AN ENIGMATIC DERIVED SNAKE FROM THE EARLIEST EOCENE OF EQUATORIAL SOUTH AMERICA

HEAD, Jason, University of Toronto, Mississauga, ON, Canada; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; RINCON, Aldo, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; BOURQUE, Jason, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; JARAMILLO, Carlos, Smithsonian Tropical Research Institute, Balboa, Panama

Despite being the region of highest extant diversity, equatorial latitudes are poorly sampled for fossil reptiles. This is especially true for the Paleogene greenhouse, which limits our understanding of poikilothermic vertebrates during the globally warmest intervals. Fieldwork in a channel lag deposit within the earliest Eocene section of the Bogotá Formation, at Muchuelo Creek, Bogotá, Colombia has produced the first Paleogene equatorial squamates associated with a diverse vertebrate fauna including mammals, crocodyliformes, anurans, and fishes. The squamate record includes small-bodied iguanian and teiid lizards, represented by mandibular, dentary, and vertebral elements, and a snake fauna consisting of boines and possible tropidophiines, represented by vertebrae, and a derived snake represented by a single partial parietal element. The parietal possesses numerous characteristics present in caenophidian snakes: the parietal table is broad with well-defined margins extending posteriorly as a prominent saggital crest. The orbital region is narrow and the parietal contribution to the optic fenestra combined with a limited articular facet for the frontal lateral flange indicates an open interorbital space, similar to some colubroids. The presence of a derived snake in early Eocene of Colombia is the oldest New World record by approximately 19 Ma and is approximately coeval with the oldest known record globally from the Vastan Lignite Mine of northern India. This record requires either an earliest Paleogene dispersal or Cretaceous vicariance event for derived snakes based on the simultaneous occurrence in South America and Indopakistan. The presence of a modestly diverse squamate fauna consisting of extant Neotropical clades in the Bogotá Formation indicates equatorial herpetofaunal stability between the Paleogene and Neogene, despite radically different global climate regimes.

Poster Session IV (Saturday, November 5)

MICROVERTEBRATES DRAMATICALLY INCREASE THE DIVERSITY OF THE CUMNOCK FORMATION (NEWARK SUPERGROUP: CHATHAM GROUP) IN THE SANFORD SUB-BASIN, NORTH CAROLINA

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The Moncure microvertebrate locality in the Cumnock Formation, Sanford sub-basin, North Carolina, dramatically increases the known Upper Triassic vertebrate assemblage from the Deep River Basin. The ~50,000 recovered microvertebrate fossils include osteichthyans, amphibians, and numerous lepidosauromorph, archosauriform, and synapsid amniotes, making it one of the richest Upper Triassic localities in the Newark Supergroup. The majority of the fossils are of osteichthyans, principally thousands of actinopterygian scales, teeth, skull, and lower jaw fragments, some of which are referable to Semionotidae indet. Abundant, diminutive (3-8 mm long) dipnoan teeth are referable to *Arganodus dorotheae*, with less frequently recovered, equally small crushing plates possibly referable to another taxon. Temnospondyls are rare but probably represent small (juvenile) metoposaurids. Both acrodont and pleurodont jaw fragments suggest the presence of lepidosauromorphs but are otherwise indeterminate. Two fragmentary teeth are assigned to the unusual amniote *Colognathus obscurus* (Case), previously only known from the American Southwest. Among the many archosauriform tooth morphotypes are a diminutive *Revueltosaurus*-like taxon distinct from *R. callenderi* that we assign to "*Pekinosaurus" olseni,* another morphotype best assigned to *Galtonia gibbidens*, the first Newark Supergroup record of *Crosbysaurus harrisae* and several other archosauriform tooth morphotypes, as well as grooved teeth assigned to the recently named species *Uatchitodon schneideri*. Synapsids represented by teeth include the "traversodontid" *Boreogomphodon*, the "dromatheriid" *Microconodon* and other derived cynodonts. These new records are biogeographically important, as many of these records are new to at least the Cumnock Formation and, in many cases, the Newark Supergroup, but are known from other basins. In particular, *Colognathus*, *Crosbysaurus*, and *Uatchitodon* are known from basins of Adamanian age in the Chinle. Use of a 3D digital microscope vastly improves upon both light and scanning electron microscopy when imaging these microvertebrates and will facilitate more quantitative analyses in the future.

Poster Session III (Friday, November 4)

DECIPHERING THE DINOSAURIAN BODY PLAN: USING MORPHOMETRICS TO INFER FUNCTIONAL MORPHOLOGY

HEDRICK, Brandon, University of Pennsylvania, Philadelphia, PA, USA; DODSON, Peter, University of Pennsylvania, Philadelphia, PA, USA; MANNING, Phillip, University of Manchester, Manchester, United Kingdom

Geometric morphometrics were applied in this study in order to decipher the functional implications of differing dinosaur body plans. Taxa from all major dinosaurian clades (n=236) were examined with the aim of reconstructing a functional morphospace. Preliminary studies demonstrate that theropods vary in body plan, especially in forelimb proportions. This has significant implications for musculoskeletal function, and aids in understanding the functional steps leading to the origins of flight. It is apparent that different dinosaurian clades occupy distinct morphospaces on the basis of differing body segment ratios. This strongly suggests that contrasting evolutionary pressures drove adaptation in body segment geometry. Such adaptations can be visualized within a morphospace and analyzed quantitatively using statistical methods. For example, the evolution of derived ceratopsians shows an enlargement of the skull in relation to body size. Surprisingly, the Ceratopsia group statistically with non-maniraptoran theropods on the basis of skull: forelimb ratios because elongation of the skull in Ceratopsia and relative shortening of the forelimb in non-maniraptoran theropods both result in an increased skull: forelimb ratio. This difference exemplifies the importance of using a functional morphospace that includes all skeletal elements in order to help understand the whole body plan. This would also help in understanding the body form/geometry of transitional taxa such as the facultatively bipedal basal ceratopsian *Psittacosaurus* in comparison with more derived obligate quadrupedal ceratopsians. It is also possible to compare neutral position stance for different dinosaurian groups on the basis of appendicular morphometrics. Furthermore, these analyses can provide a quantitative basis for estimating the lengths of missing elements in order to more accurately reconstruct partial skeletons. Through these techniques, it is possible to evaluate the functional morphology, dinosaurian posture, and evolutionary trends in different dinosaurian clades by developing a more complete quantitative and qualitative understanding of dinosaurian body plans.

Technical Session VI (Thursday, November 3, 3:15 pm)

FROM BABY BIRDS TO FEATHERED DINOSAURS: THE ONTOGENY AND EVOLUTION OF SKELETAL FORM AND FUNCTION

HEERS, Ashley, University of Montana, Missoula, MT, USA; BAIER, David, Providence College, Providence, RI, USA; JACKSON, Brandon, University of Montana, Missoula, MT, USA; DIAL, Kenneth, University of Montana, Missoula, MT, USA

Interpreting skeletal function in transitional fossils is key to reconstructing the evolution of avian flight. Most hypotheses assume that skeletal movement correlates with skeletal morphology, and that forelimb movement of winged theropods with transitional skeletons was different from extant birds. Yet juvenile ground birds with highly underdeveloped skeletons are capable of adult-like locomotor behaviors. Though their locomotor apparatus is not well ossified and, like early birds, lacks many of the skeletal "hallmarks" of advanced flight capacity (large keel, channelized wrist, rigid trunk, fused pelvic elements, etc.), juvenile birds rely on protowings for behaviors like wing-assisted incline running (WAIR) and controlled flapping descent. Studies using feather-based markers have shown that similar wing kinematics are employed throughout ontogeny. Similarity in feather movement, however, may or may not reflect similarity in skeletal movement. To document the ontogeny of skeletal form and function, we therefore used high resolution CT scans and biplanar x-ray videos (X-ray Reconstruction of Moving Morphology) to quantify 3D skeletal kinematics during WAIR in a developmental series of a precocial ground bird, the chukar (*Alectoris chukar*). Our results demonstrate that juveniles and adults with highly disparate skeletal anatomies employ remarkably similar skeletal kinematics during WAIR, possibly due to differences in the magnitude of aerodynamic force production. These findings are important for understanding flight ontogeny and escape behavior, and may provide insight into flight evolution. As developing ground birds transition from obligately bipedal juveniles to flight-capable adults, increases in skeletal fusion / ossification of the girdles and limbs appear to mimic evolutionary changes in skeletal morphology in theropod dinosaurs and early birds. This analysis of locomotor ontogeny thus has developmental and evolutionary implications, and represents the first 3-D kinematic quantification of skeletal function in animals that rely on transitioning skeletons to locomote and survive.

Preparators' Session (Thursday, November 3, 8:45 am)

COLLECTION AND PREPARATION OF VERTEBRATE FOSSILS FROM THE EARLY PERMIAN BROMACKER QUARRY LOCALITY, CENTRAL GERMANY

HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA; BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, USA; MARTENS, Thomas, Museum der Natur Gotha, Gotha, Germany; SUMIDA, Stuart, California State University, San Bernardino, CA, USA

The Carnegie Museum of Natural History, Pittsburgh, has been working for the past 20 years in collaboration with the Museum der Natur, Gotha, Germany, California State University, San Bermardino, and other institutions to collect, prepare, and study tetrapod fossils from the Early Permian Bromacker Quarry Locality, central Germany. The fossils occur in the Tambach Sandstone of the Tambach Formation, typically within one of two sheet flood units consisting of massive siltstone to very-fine-grained-sandstone separated by an intervening unit of laminated to massive siltstone. Preservation of the fossils is excellent, with most of the skeletons being complete to nearly complete and fully or loosely articulated. The fossiliferous section is carefully quarried for fossils using hand tools such as hammers, chisels, and pry bars, and a rock saw and jack hammer are used when needed. Once a specimen is discovered, its dimensions are determined, exposing as little of the skeleton as possible to prevent loss or damage to the specimen. The fossil is then removed in one or more blocks encased in a burlap and plaster jacket.

The fine-grained, indurated matrix lends itself well to mechanical preparation. After the block is opened in the lab, removal of overburden rock is achieved with a small hammer and chisel and/or pneumatic scribe, followed by detailed exposure of the bone with a pneumatic scribe and/or small hand tools. Several problems commonly encountered during preparation of these fossils and their solutions are as follows: 1) numerous cracks run through the blocks, including the fossil bone. This is remedied by filling the cracks with polyethylene glycol. 2) Postdepositional chemical weathering of some of the bone has left it with a spongy texture that lacks surface detail and good separation from the surrounding rock. Polyvinyl butyral, cyanoacrylates, and polyethylene glycol have been used in attempts to consolidate the spongy bone, but none of them has proved to be entirely satisfactory and/or time efficient. 3) Occasionally bone is lost during the process of discovering and collecting a fossil. Casting epoxies have been applied to remaining natural molds in the rock with some success.

Poster Session II (Thursday, November 3)

HYAENIDAE: DIVERSITY AND PHYLOGENETICS IN THE LATE CENOZOIC

HENSLEY-MARSCHAND, Blaire, Indiana University, Bloomington, IN, USA

The Hyaenidae is a diverse family of carnivores that originated in the early Miocene (circa 22 million years ago) with four species surviving to the present day. The group has ranged as far north as Russia, as far south as the southern tip of South Africa, and from western Europe all the way eastward around the globe to North America. I looked at the environmental factors relating to diversification and extinction in hyenas by looking at species diversity through time, modeling the relation of living species to modern climate, and analyzing phylogenetic differentiation. To examine the diversity of this family over time, point occurrences of fossil specimens from the online Neogene Old World Database were analyzed. Although this family originated at least 22 million years ago, their diversity rose sharply between 10 and 7 million years ago, declining slowly since then. Their peak diversity was associated with onset of cooling after the Miocene climatic optimum, a period when C4 grasslands expanded, but they did not reach their full geographic diversity until the Pliocene and Pleistocene when their species diversity was beginning to decline. Geographic diversity was analyzed for extant hyenas (dated to after 1900) downloaded from the Global Biodiversity Information Facility online. The geographic range of extant hyenas is mainly restricted to the African continent with only one species (the striped hyena, *Hyaena hyaena*) extending to the Middle East. This limited distribution is in stark contrast to the aforementioned wide geographic range for the family during the Miocene, and continued climate warming is likely to reduce these habitats further based on a future climate model. Lastly, a phylogenetic analysis based morphologic characters of Hyaenidae, both extinct and extant, was conducted using Phylip. Results indicate a phylogenetic separation of the civet-like genera, the cursorial meat-and bone-eaters, and the bone-crushers. The former group was established at the onset of the Hyaenidae family, but the latter two groups appear in the later Miocene. Therefore, morphologic and ecological diversification occurred during the time of peak genera diversity.

Poster Session II (Thursday, November 3)

MESOWEAR ANALYSIS APPLIED TO LOWER MOLARS OF HORSE SPECIES

HERNESNIEMI, Elina, University of Helsinki, Helsinki, Finland; FORTELIUS, Mikael, University of Helsinki, Helsinki, Finland

It is possible to gain information about the dietary habits of fossil animals by studying the wear patterns of their teeth. Here we test whether a new wear-based reconstruction method developed by us can be used to deduce the diet of horse species from the wear patterns of their lower molars. This method, where the wear facets of buccal enamel bands are examined, is derived from classical mesowear analysis. Although both methods are based on a study of the facet development on the occlusal surfaces of the teeth, lower molars of horses are not suitable for classical mesowear analysis. In our method we digitally measure the angle between the surface of the enamel edge and the buccal side surface of the teeth from 3D reconstructions of the relevant parts of the lower molars. We compared our method to the classical mesowear method by analysing the lower molars and the upper molars, respectively, of multiple species from the middle Miocene *Anchitherium*, the upper Miocene *Hipparion* and the Pleistocene and Recent *Equus*. We also compared these results to results obtained in earlier studies of Pleistocene and Recent rhinoceros species, where we have previously used our method successfully. The results suggest that the angle between the surface of the enamel edge and the buccal side surface of lower molars approximates a combined effect of relief and roundedness of classical mesowear analysis and our method consequently appears suitable for mesowear scoring in horse species from lower molars. We find that *Anchitherium* species had the largest amount of browse in their diet, *Equus* species had the largest amount of graze in their diet and the dietary range of *Hipparion* species falls between the *Anchitherium* and *Equus* species.

Poster Session IV (Saturday, November 5)

EARLY MIOCENE TERRESTRIAL VERTEBRATE FAUNA FROM CENTRAL KUTCH (GUJARAT), WESTERN INDIA

HIERONYMUS, Tobin, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; BHANDARI, Ansuya, Wadia Institute of Himalayan Geology, Dehra Dun, India; TIWARI, Brahma, Wadia Institute of Himalayan Geology, Dehra Dun, India; BAJPAI, Sunil, Indian Institute of Technology at Roorkee, Roorkee, India

New vertebrate localities in the Khari Nadi Fm in Western India provide an opportunity for comparison with more extensively studied faunas in western Asia that span the Oligo-Miocene boundary. The new finds extend the existing faunal list for the Formation, as well as providing new comparative material of reported taxa, including suids, ruminant artiodactyls, teleocerotine rhinos, and proboscideans. Bone is found in concentrated pebble conglomerate horizons containing shark teeth, together with abundant intraformational rip-up clasts. Many of the rip-up clasts are identifiable as heavily cemented *Thalassinoides* burrow traces. The larger terrestrial vertebrate elements show varying degrees of post-fossilization wear, suggesting redeposition after transport, and extensive time-averaging. The fossiliferous deposits are tentatively identified as marine tempestites, and the terrestrial vertebrate fauna are most likely aggregated from the fan of the nearby Indus delta. Terrestrial vertebrates from the Khari Nadi Fm thus provide a concentrated sample of the fauna from the distal Indus delta in the Early Miocene. This sample provides a new point comparison with the more thoroughly studied Gaj, Manchar, and Siwalik faunas

Technical Session IV (Wednesday, November 2, 2:30 pm)

PALEODIET AND PALEOENVIRONMENT OF FOSSIL GIANT RODENTS FROM URUGUAY

HIGGINS, Pennilyn, University of Rochester, Rochester, NY, USA; CROFT, Darin, Case Western Reserve University, Cleveland, OH, USA; BOSTELMANN, Enrique, Museo Nacional de Historia Natural, Montevideo, Uruguay; RINDERKNECHT, Andrés, Museo Nacional de Historia Natural, Montevideo, Uruguay; UBILLA, Martin, Facultad de Ciencias, Montevideo, Uruguay

South America is home to many of the world's most unusual rodents. Among these is the largest extant rodent, the capybara or carpincho (*Hydrochoerus hydrochaeris*; Caviidae or Hydrochoeridae) which averages about 50 kg. The largest fossil rodents also come from South America, and several species, all dinomyids, have been recorded in Uruguay: *Arazamys castiglionii* (late Miocene), *Isostylomys* (late Miocene and Pliocene), and *Josephoartigasia monesi* (Pliocene). Among these, *Josephoartigasia* stands out as the largest-known rodent.

The goal of this study is to better understand the paleobiology of these enormous rodents using evidence from carbon and oxygen isotopes. This is part of a broader investigation of giant rodent paleobiology that is using a variety of techniques to accurately characterize their ecology and life history. We compare isotopic results from fossil tooth enamel (mostly incisors) to those from four modern capybaras collected throughout Uruguay. Although capybaras are not the closest living relatives of these extinct rodents, their biology is much better known than that of the sole living dinomyid, *Dinomys branickii*. They also are better ecological analogs in terms of body size.

Capybaras, despite being grazers and living where vegetation is dominated by plants utilizing the C4 metabolic cycle, are mixed C3-C4 feeders. Capybaras selectively eat available C3 grasses, only consuming C4 vegetation when water is seasonally scarce and C4 plants dominate. Based upon serial isotopic analysis of capybara incisors, it appears that C4 vegetation is an important component of capybara diets only during and just after dry seasons. When the wet seasons begin, C3 grasses dominate capybara diets.

Giant fossil rodents also appear to have had diets dominated by C3 vegetation, so much so that they are arguably exclusively C3 feeders. Given our capybara data, it cannot be assumed that C4 vegetation was not available. Instead, it is likely that the fossil rodents also selectively ate C3 grasses. Testing this hypothesis will require examining other fossil mammals and/or paleoenvironmental proxies to fully understand the environment in which the fossil rodents lived.

Poster Session II (Thursday, November 3)

THE EVOLUTION OF EXOSKELETAL OSSIFICATIONS IN NOTOSUCHIAN CROCODYLIFORMS

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Notosuchians are becoming increasingly well-known for their diverse craniodental specializations, many of which deviate drastically from typical crocodyliform anatomy. Postcranial apomorphies, while somewhat less bizarre, nevertheless appear to be important adaptive features of the axial and appendicular skeletons. In particular, notosuchian osteoderms exhibit great variability in surface morphology, histology, and three-dimensional structure.

Using paleohistology and microCT, we characterized osteoderm anatomy in several notosuchians and closely allied crocodyliforms in an effort to explore patterns of character evolution in the dermal skeleton. In contrast to proximate outgroups (e.g., *Araripesuchus*), notosuchians such as *Baurusuchus, Notosuchus,* and *Pakasuchus* are characterized by a general trend toward reduction of dorsal osteoderms, typically associated with an expansion of the caudal osteoderm shield. One notable exception is *Simosuchus*, in which the dorsal shield is extensively developed. Other trends in Notosuchia include reduction of surface ornamentation and increased internal cavitation of osteoderms.

Among notosuchians, *Pakasuchus* exhibits the most extreme reduction of dorsal osteoderms, but possesses a robust, articulating shield of osteoderms completely surrounding the tail. Near the dorsosacral transition, reduced osteoderms appear as elongate, fusiform elements with crenulated edges. Other ossifications are tentatively reinterpreted as ossified tendons or intramuscular septa, based on their subtriangular cross-section and incipient development of longitudinal canals. Their arrangement indicates bifurcating or intersecting fibers, as seen in the ossified tendons of other archosaurs. Another ossification is fused to a neural spine,

suggesting an origin from an epaxial enthesis. This is the first report of ossified tendons in Crocodyliformes. The trend toward osteoderm reduction may be related to the decreased mean body size and/or inferred terrestrial habitus of notosuchians, and the observed interspecific variability in this system likely pertains to biomechanical, physiological, and ecological constraints of the individual forms.

Technical Session IX (Friday, November 4, 9:30 am)

CRANIAL OSTEOLOGY OF THE EOCENE AMPHISBAENIAN *SPATHORHYNCHUS FOSSORIUM* AS REVEALED BY X-RAY COMPUTED TOMOGRAPHY

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Spathorhynchus fossorium is a middle Eocene amphisbaenian from the primitive North American clade of shovel-snouted worm lizards, the Rhineuridae. Although the holotype skull is exceptionally well preserved, the lower jaw is fused to the skull floor obscuring the palatal region. Using three-dimensional X-ray computed tomography (CT), we digitally removed the mandibles to expose this area for the first time and to explore internal spaces of the skull that were previously inaccessible. The orbitosphenoids are paired as in the Oligocene rhineurid *Rhineura hatcherii* and modern lacertids, the recently recovered sister group to Amphisbaenia, but in contrast to the fused condition found in modern worm lizards. We also confirm the presence of two separate elements, the jugal and postfrontal, forming the postorbital bar, another unique feature among both fossil and extant amphisbaenians. Contrary to the otic-occipital complex which is highly fused, the elements of the face remain discrete and connected by extensively interdigitating sutures, allowing flexibility for a burrowing lifestyle. There is no evidence of a pathway between the orbit and brain case, suggesting that the eyes were functionless as in *R. hatcherii* and modern rhineurids. Although the postcranial material of *S. fossorium* appears derived with respect to the absence of a pectoral girdle and forelimbs, our reevaluation of the skull using CT reveals several primitive cranial features representing the earliest amphisbaenian form. The shovel-snouted condition, already present by the Eocene, may have therefore appeared early in the evolution of worm lizards. The detailed description of this specimen and other early amphisbaenians will be crucial to uncovering the timing and sequence of evolutionary modifications leading to fossoriality and limblessness from a terrestrial limbed ancestor.

Poster Session III (Friday, November 4)

OLIGOCENE PIG-NOSED TURTLES (CARETTOCHELYIDAE: TESTUDINES) FROM WESTERN JAPAN

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Although previously abundant in the fossil record, carettochelyids (family Carettochelyidae) become extremely sparse after the Eocene epoch. Their Oligocene fossil record is particularly obscure. Recently, a non-marine late Oligocene (about 26 Ma) vertebrate fauna, including more than 100 chelonian specimens, was excavated from the basal part of the Fukui Formation of the Sasebo Group of Sasebo City, Nagasaki Prefecture, Western Japan. Although geoemydids and trionychids are dominant among the turtles, seven isolated shell elements including the nuchal, costal, and hypoplastron are identified as carettochelyids, based on characteristic radiated sculptures on the shell surfaces. These materials represent a rather small taxon (less than 20 cm long). The hypoplastron has a narrow plastral bridge as seen in the Eocene carettochelyids. There is no sulcus of scute on the shell surfaces. These features suggest that this species is most similar to *Allaeochelys*, an extinct genus from the Eocene of Europe.

Associated late Oligocene turtles from the Nagasaki Prefecture include the following: 1) an undescribed species of the genus *Malayemys*, known from a lower jaw and partial shell, 16 cm in length; 2) a large sized geoemydid taxon, with an estimated >30 cm long carapace, and very strong plastral buttresses as in living *Batagur*; 3) a small geoemydid taxon with a presumed hinged plastron as in *Cuora*, estimated at less than 18 cm in length; 4) a trionychid close to *Rafetus* with an estimated shell length of 50 cm, and with reduced eighth costal; 5) small testudinids reported as geoemydids ('*Geoclemys*' *matuuraensis* and '*Geoemyda*' *takasago*). This highly diversified non-marine chelonian assemblage suggests a tropical climate during the Late Paleogene when the Japanese archipelago formed the eastern margin of the Eurasian continent.

Poster Session II (Thursday, November 3)

THE PETALODONTIFORMES (CHONDRICTHYES; EUCHONDROCEPHALI) FROM THE MARINE PERMIAN (LEONARDIAN/GUADELOUPIAN) KAIBAB FORMATION, NORTHERN ARIZONA

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The vertebrate assemblage from the Kaibab Formation is rapidly becoming one of the most diverse shark faunas in the marine Permian of North America, with thirty taxa representing ten families of chondrichthyians. One of the most diverse orders is the Petalodontiformes, which includes the skate-like Janassidae, which are the most common of this order in the Kaibab. *Janassa* is represented by a small taxon, which is rare in the Kaibab assemblage and a larger taxon that is slightly more common. These may represent *J. angularis* and/or *J. unguiformis.* The teeth of "mega-janassids" (crown widths 2 cm or more) are the most common in the Kaibab Formation and represent two taxa. One taxon has well formed cusps similar to "*Janassa*" *korni* from the late Permian Kupferschiefer of Germany, with the Kaibab taxon differing in having fewer cusps and being of greater size. The largest taxon has large blunt and thick cusps, and represents a new genus and species. It is only slightly smaller than *Janassa maxima* from the Pennsylvanian of Nebraska, which lacks the large blunt cusps seen in the Kaibab taxon. The diversity of janassids suggests feeding partitioning that mirrors modern skates and rays. The smaller *Janassa* species may have fed on crinoids, bryozoans, and arthropods, as with *Janassa bituminosa*. The large, blunt-cusped "mega-janassid" may have been a generalist, feeding on both hard-shelled invertebrates and smaller vertebrates, including the large brachiopods and gastropods that are common in the Kaibab assemblage.

The Pristodontidae is represented by *Megactenopetalus kaibabanus*. Two new juvenile specimens may help shed light on the ontogeny of this taxon, and re-analysis of the morphology of its teeth suggest that it was not a specialist feeder on hard-shelled invertebrates and that the sharp cutting edges of the upper and lower cusps indicate the teeth of a predator on large vertebrates. *Megactenopetalus* may have been a slow moving ambush predator as suggested by the body form of the related *Janassa* and *Belantsea*. Fragments of other pristodontid teeth from the Kaibab Formation could represent other juvenile *Megactenopetalus* specimens or an unknown smaller pristodontid.

Technical Session XIII (Friday, November 4, 3:30 pm)

THE DISTRIBUTION OF GRIT-INDUCED MICROWEAR FEATURES ACROSS THE OCCLUSAL SURFACES OF ARTIODACTYL MOLARS

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Low-magnification microwear analysis of the occlusal surfaces of ungulate cheekteeth has been widely used to reveal information about ancient diets and environments. The method quantifies microscopic tooth abrasion (represented by scratches) caused by plant silica (phytoliths), abiotic grit (soil, dust, ash), or both. However, variability in microwear between different enamel bands on cheekteeth, and possible correlations of this variation with diet or grit, has not been quantified. This study assesses intra- and interband microwear variability on the teeth of domestic sheep (*Ovis aries*) fed controlled diets to explore the potential correlation of microwear variability across occlusal surfaces with exogenous grit.

Three sheep were fed hay diets with different size classes of added grit (180 to 250 microns and 250 to 425 microns), significantly larger than the diameters of biogenic phytoliths (<53 microns). Live animal tooth molding, along with the rapid rewriting of microwear features (the 'Last Supper Effect'), enabled the use of repeatable test subjects that were fed each diet. Resulting casts underwent low-magnification microwear analysis by tabulating microwear features within multiple 0.4 mm x 0.4 mm search fields along the enamel bands of the upper molars. Feature counts were compared for statistical differences both between search fields along enamel bands (intraband variation) and between enamel bands (interband variation).

No significant differences were found between search fields along enamel bands for any diet treatments. Furthermore, we found a significant difference in scratch counts between the control diet (no added grit) and diets with added exogenous grit, showing conclusively that exogenous grit affects microwear. Finally, for any given diet treatment, we saw no significant difference in feature counts between enamel bands on the paracone and protocone. These results support the analytical methodology of low-magnification microwear and suggest that microwear features caused by exogenous grit are distributed evenly across the occlusal surfaces of selenodont molars, similar to the distribution of diet-induced features.

Poster Session III (Friday, November 4)

REVISED PHYLOGENY OF PHOLIDOTA: IMPLICATIONS FOR FERAE

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Molecular studies support a sister-group relationship of Carnivora and Pholidota, but this has been difficult to support morphologically. To predict basal traits and possible synapomorphies of Ferae, it is crucial to understand the relationships within Pholidota, and outgroup relationships to Palaeanodonta. Previous analyses were not able to resolve unambiguously the phylogeny of Pholidota, largely due to limited information from the Miocene *Necromanis*. Fissure fillings near Petersbuch in Southern Germany have now yielded two nearly complete skeletons and more than 400 postcranial elements, which have been used for a new phylogenetic analysis of Pholidota. The analysis comprises seven of the eight extant pangolins and most of the fossil species, as well as two species of Palaeanodonta. Three outgroups, the eulipotyphlan *Erinaceus sp*., the carnivoran *Nandinia binotata,* and the basal carnivoramorph *"Miacis" uintensis*, have been used to polarize the 417 osteological characters. Palaeanodonta and Carnivora were included and excluded from the analysis to test for typologies supporting alternative ancestral state reconstructions of Pholidota. A heuristic search yielded a single MPT, thereby resolving the so far ambiguous position of *Necromanis*. According to our analysis, *Necromanis* is closely related to the American *Patriomanis* with *Cryptomanis* as sister taxon. Strong bootstrap values (80) and 16 unambiguous characters support this clade. The inclusion of *"Miacis"* improves the resolution, further supporting this alliance. Palaeanodonta is placed as the sister taxon to Pholidota diagnosed by 32 unambiguous

characters and high bootstrap values (90). When Palaeanodonta is excluded *Eomanis*, *Euromanis* and *Eurotamandua* form a clade in which most unambiguous synapomorphies have been previously associated with palaeanodonts. The crown-group Manidae resolved as the sister group to the Patriomanidae-*Necromanis* clade. The resolution within Manidae remains low leading to a polytomy at the base of Manidae, possibly related to the derived condition within the arboreal *Phataginus* and the convergent adaptions for terrestriality in *Smutsia* and Asian pangolins.

Poster Session IV (Saturday, November 5)

PALEONTOLOGY OF THE MEDORA SITE (PALEOCENE: SENTINEL BUTTE FORMATION), BILLINGS COUNTY, NORTH DAKOTA

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The Medora site is located in highly dissected badland terrain on an isolated knoll about3 km east of Medora, Billings County, North Dakota. Vertebrate, invertebrate, and trace fossils are entombed in a thin < 5 cm thick black to rust colored carbonaceous (lignitic) mudstone within the Paleocene Sentinel Butte Formation. The bone bed is 6.5 m above the top of a reddish clinker (HT Butte Bed) that marks the contact between the underlying Bullion Creek and Sentinel Butte Formations (Ft. Union Group).

Several thousand fossils of a diverse vertebrate fauna have been recovered through excavation and screen-washing of sediments. This fossil assemblage consists mostly of disarticulated remains, although two partial semi-articulated skeletons of *Champsosaurus gigas* have been recovered. Teeth, vertebrae, limb bones, and scutes of the crocodile *Borealosuchus* are abundant. Fossil size indicates that some of the crocodiles were large, perhaps up to about 4 m in length. Skull parts, teeth, spines, vertebrae, and scales document the presence of several fish taxa including bowfin (*Amia*), gar (*Lepisosteus*), and pike (*Esox*). Freshwater turtles, at least two species of birds, and the giant salamander *Piceorpeton* were also members of this freshwater community. Teeth and jaws of several species of mammals have also been collected at the site including *Titanoides*, *Neoplagiaulax*, and *Palaeoryctes cruoris*. Collectively these mammals indicate a Tiffanian (Ti3) lineage zone for the site. Abundant crocodile and fish coprolites are also preserved. Freshwater bivalve and gastropod remains are found with the vertebrate fossils.

The sedimentology of the Medora site indicates initial deposition in a paludal environment that later became a ponded water habitat. Paleobotanical evidence from other nearby sites indicates that the setting was in a subtropical forest. Abundant bones and numerous, large, well preserved coprolites indicate that this was a feeding ground for crocodiles. Numerous depressions in the bone bed, interpreted to be crocodile foot prints, and broken bones in the site indicate that these large animals trampled and bioturbated the swampy area while scavenging for food.

Poster Session II (Thursday, November 3)

ON THE PHYLOGENY OF THE CHALICOTHERIIDAE (MAMMALIA, PERISSODACTYLA)

HOLBROOK, Luke, Rowan University, Glassboro, NJ, USA; COOMBS, Margery, University of Massachusetts, Amherst, MA, USA

The Chalicotheriidae includes a number of perissodactyl genera noted for their possession of distal unguals that bore claws instead of hooves. Chalicotheriids have historically been divided into two subfamilies, Chalicotheriinae and Schizotheriinae. Several recent craniodentally-based studies have examined aspects of the phylogeny and evolution of the superfamily Chalicotherioidea, which includes Chalicotheriidae and a number of Eocene genera once included in the likely paraphyletic "Eomoropidae". These studies have focused on the relationship of Chalicotherioidea to other perissodactyls, the position of *Litolophus* from the Eocene of Mongolia, and the interrelationships among the Chalicotheriinae. Absent from this recent work is thorough examination of monophyly of either Chalicotheriidae or its constituent subfamilies, and particularly any assessment of relationships among schizotheriines. We present here an assessment of chalicotheriid phylogeny combining craniodental data from previous studies with new characters and a greater sampling of schizotheriine taxa. Our results find support for monophyly of Chalicotheriidae and for some clades within the traditional Chalicotheriinae and Schizotheriinae. On the other hand, the positions of *Chalicotherium* and of several schizotheriines are less clearly resolved on the basis of current craniodental evidence. Some of these arrangements run counter to the relationships suggested by postcranial data, suggesting that a broader approach is necessary for a fuller understanding of diversification in the Chalicotheriidae.

Technical Session XVIII (Saturday, November 5, 12:00 pm)

A NEW EUSUCHIAN CROCODYLIFORM WITH NOVEL CRANIAL INTEGUMENT AND THE ORIGIN OF CROCODYLIA

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We describe a new, giant crocodilian discovered in the coastal deposits of the early Late Cretaceous (Cenomanian) Kem Kem Beds of Morocco, a region rich with crocodyliforms and dinosaurs. The taxon, represented by cranial remains, has an extremely long, flat skull and a novel integumentary display structure previously unknown for crocodyliforms, though similar to that described for specimens discovered in the Cenomanian Bahariya Formation. The frontals are ornamented by a series of thick obliquely-oriented parallel ridges which expand caudally to form a broad, circular, rough bony integumentary boss on the parietal. The boss is surrounded by a broad, smooth, shallow fossa that communicates with deep vascular grooves which emerge from small, constricted, vertical-walled, dorsotemporal fossae. With the midline boss, this vasculature likely contributed to forming a keratinous integumentary display structure previously undocumented for crocodyliforms which also may have served a thermoregulatory function. The skull bears a massive, rostrally-situated adductor tubercle, large, sub-horizontally oriented fossae for jaw closing muscles and immense post-occipital protuberances indicating the animal had a very flat profile. The laterosphenoid bodies have small teardrop-shaped, isolated, vestigial epipterygoids allying the taxon with derived neosuchians. Applying previous regression analyses from *Alligator* skull table width and crocodyliform brain size suggest that the skull was well over 2 meters long. Separate phylogenetic analyses using crocodyliform and crocodylian matrices found the taxon to be a derived eusuchian and the sister taxon of crown-clade Crocodylia making this group the earliest eusuchian crocodyliforms known from Africa suggesting modern crocodylians may have circum-Tethyan rather than North American origins.

Poster Session II (Thursday, November 3)

A VIRTUAL PHYTOSAUR (ARCHOSAURIA: CRUROTARSI) ENDOCAST AND ITS IMPLICATIONS FOR SENSORY SYSTEM EVOLUTION IN ARCHOSAURS

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Endocranial reconstructions are rarely utilized during phylogenetic analysis. Even with the advent of modern computed tomography (CT)- based techniques to the study of the internal cranial structures of fossil specimens, very few of the new taxa described or known taxa revisited have been treated in this way. This is especially true of crurotarsan archosaurs. To date, no digitally reconstructed cranial endocast of a phytosaur has been published, and only that of *Pseudopalatus pristinus*, a derived form, has been presented. *Smilosuchus adamanensis* is a less derived phytosaur form from the Upper Triassic Chinle Formation, Arizona. The cranial endocast of a complete skull of *S. adamanensis*, USNM 17098, was imaged using CT in order to create a high-quality, digital endocranial reconstruction. *S. adamanensis* exhibits an overall endocranial morphology very similar to that of the evolutionarily convergent extant crocodilian *Crocodylus johnstoni*. The primary difference between the two is a considerable dural expansion in *S. adamanensis* that denotes an enlarged pineal body. This is consistent with the historic endocranial reconstruction of *Smilosuchus gregorii* but counter to the more recently presented endocranium of *P. pristinus*. The presence of an enlarged pineal body is the most notable and readily apparent contrast between the digitally reconstructed endocrania of *S. adamanensis*, *C. johnstoni*, and the newly described notosuchian *Simosuchus clarki*. The overall endocranial morphologies of these taxa are highly conserved; more so than in various clades of avian-line archosaurs, like theropods and sauropods, or between members of those clades and crurotarsans. This highly conserved cranial endocast morphology is consistent throughout Crurotarsi, regardless of overall body morphology or ecology, with a trend of pineal body size reduction from the enlarged basal condition to a reduced crown condition. This reduction trend mirrors that seen in theropods and sauropods.

Poster Session II (Thursday, November 3)

THE OSTEOLOGICAL ONTOGENY OF THE *MEGALONYX JEFFERSONII* MATERIAL FROM ACB-3 CAVE, COLBERT COUNTY, ALABAMA

HOLTE, Sharon, East Tennessee State University, Johnson City, TN, USA

Excavations of ACb-3 Cave by the Red Mountain Museum of Alabama began in June of 1985 and continued off and on until the end of the summer in 1987. ACb-3 Cave is located in Colbert County of northwestern Alabama. Excavations of the site uncovered the remains of numerous Pleistocene species from multiple genera. This includes large herbivores such as deer, mastodon, and giant ground sloths. The Jefferson's ground sloth (*Megalonyx jeffersonii*) material, which is the focus of this study, was reported as sixteen individuals by the excavation team. Recent research has revealed that the number of *M. jeffersonii* individuals recovered was seven. Although these sloths were excavated in the late 1980's, a large proportion of the material remained in plaster field jackets until the current study began. Opening these jackets revealed relatively pristine juvenile sloths of different sizes. Overall the sloths from the cave range in individual age from fetal to adult, and provide an excellent sample for studying ontogeny. Four of these sloths were examined due to the presence of comparable skeletal elements. The adult ground sloth from the sample is nearly complete and provides an ideal representative to compare to the juveniles. Ontogenetic morphological differences were discovered in the major limb elements and cranial material, and demonstrate how these ground sloths change osteologically through life.

Poster Session II (Thursday, November 3)

TOOTH MORPHOTYPES OF SAUROPOD DINOSAURS FROM THE CANADON ASFALTO FORMATION (MIDDLE JURASSIC) OF PATAGONIA

HOLWERDA, Femke, Durham University, Durham, United Kingdom; POL, Diego, Museo Paleontologico Egidio Feruglio, Trelew, Argentina; GRÖCKE, Darren, Durham University, Durham, United Kingdom; RAUHUT, Oliver, Bayerische Staatssammlung fur Palaontologie und Geologie, München, Germany

The sauropod fossil record of the Cañadón Asfalto Formation (Middle Jurassic) of Patagonia includes two described taxa (*Patagosaurus* and *Volkheimeria*) and two undescribed taxa. Both named taxa plus one of the undescribed species occur at the locality of Cerro Cóndor Sur. The taxa are mainly known from postcranial materials. For this study, cranial material and isolated teeth recovered at Cerro Cóndor Sur and isolated teeth recovered at the nearby Las Chacritas locality were used. The teeth are here described in terms of size, shape, and enamel wrinkling, presence and orientation of wear facets and microwear. The aim of this study is to present an analysis of teeth morphotypes to assess the sauropod dental diversity at these sites.

The analysis reveals the presence of three different teeth morphotypes in the sample taken from the Cerro Cóndor Sur locality, which are characterized by a unique combination of characters related to the pattern of enamel wrinkling and crown shape measurements. The presence of three dental morphotypes at Cerro Cóndor Sur matches the known sauropod diversity of this site based on postcranial evidence.

The cranial material studied included fragmentary cranial and mandibular remains that have been assigned to *Patagosaurus* in previous studies. The teeth present in the maxilla originally referred to *Patagosaurus* are markedly different to those present in the mandibular remains referred to the same taxon, and represent different morphotypes, and thus probably different taxa. The latter interpretation is supported by the association of the maxilla with postcranial remains that also differ from the postcranium of *Patagosaurus*.

Finally, statistical microwear analysis on the only tooth that has a mesial and a distal wear facet revealed different directions of the striae located on the mesial and distal facet. There are no further statistically significant differences in microwear between the wearfacets of different teeth. The low variance between them may suggest the absence of clear niche differentiation for the Middle Jurassic sauropods known from the Cañadón Asfalto Formation.

Technical Session IV (Wednesday, November 2, 2:45 pm)

ROLE OF VOLCANIC ACTIVITY IN THE EVOLUTION OF HYPSELODONTY IN APLODONTID RODENTS

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The evolution of hypsodonty has been well-studied in large herbivores, both within lineages and in ecological associations. The evolutionary course of hypsodonty in small mammals, however, remains relatively unknown. In large herbivores, the convergent evolution of hypsodonty is rampant in the mid-Tertiary. However, ever-growing teeth (hypselodonty) very rarely appear in large mammals. Small mammals, on the other hand, have several times evolved hypselodonty not only in the incisors, but also in the cheek teeth responsible for processing foliage. Driving factors hypothesized for the evolution of hypsodonty include grazing on abrasive plant parts and ingestion of exogenous grit. It is important in considering the evolution of hypsodonty in small mammals to consider the differences in how such drivers might affect them relative to larger herbivores. Ideally, a study aimed at understanding the drivers for the evolution of hypsodonty would consider all aspects of the ecological context both within a lineage and in the environment in which it occurred, with reference to phylogenetic history. While few small mammals have adequate phylogenetic data to enable such consideration, the Aplodontoidea offer an ideal study system, with well-studied ecology, phylogeny, and ecological context. Within this clade, hypsodonty has evolved in parallel twice, once in mylagaulids and once in aplodontines. Detailed study of the evolution of hypselodonty in aplodontines shows that the most extreme hypsodonty and eventual hypselodonty evolved in only a single part of the geographic range, in Oregon and Northwest Nevada during the Middle Miocene. Populations from even a small distance to the south, even in dry habitats, were characterized by much smaller degrees of hypsodonty at the same time. The origin of hypselodonty in this lineage, then, seems to have been a response to a relatively local phenomenon, possibly the extensive volcanic activity from the Yellowstone Hotspot and the Columbia River Basalts. Whether this is a phenomenon unique to this lineage or a response to volcanic activity common to a number of small mammals remains to be studied in other lineages.

Poster Session III (Friday, November 4)

NEW ASTRAPOTHERE POSTCRANIAL REMAINS FROM THE LATE MIOCENE OF VENEZUELA

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Postcranial remains of an astrapothere have been recovered from the Lower Member of the Urumaco Formation, of Late Miocene age, documenting more on the anatomy and diversity of this group in the northern Neotropics. They consist of a right femur, tibia and astragalus in anatomical association. The astraglalus is slightly larger than that of a previously discovered one from the Early Miocene of Venezuela but smaller than *Granastrapotherium* from the Middle Miocene of Colombia. The astragalus is typically astrapotherian in its lack of a neck and the dorsoventral depressed shape of the body. There is no markedly concave surface for the medial malleolus of the tibia, unlike the typical condition in other astrapotheres. The head is a dorsoventrally and mediolaterally convex surface; this is a primitive mammalian feature also present in Colombian and Venezuelan astrapotheres and it distinguishes them from Late Oligocene/Early Miocene Patagonian *Parastrapotherium* where the astragalar head is dorsoventrally flat. The trochlea is substantially deeper in the new astrapothere than in the astragalus from the Early Miocene of Venezuela. There is no distinct facet for the cuboid, however we do not discard the possibility that such contact existed and that both facets for navicular and cuboid are indiscernible from each other in the specimen. The femur and tibia resemble the same bones in *Astrapotherium* from the Early Miocene of Patagonia in that the femur is longer and much wider than the tibia. The femur is much wider than anteroposterioly deep and it displays a prominent lesser trochanter.

An analysis of the bone histology of the tibia was undertaken for an astrapothere for the first time. The trabeculae within the marrow cavity are extensively remodelled and consist only of secondary lamellar bone and secondary osteons. The compacta completely consists of Haversian bone. We calculated several compactness parameters in order to infer lifestyle for this astrapothere. The application of two discriminant functions yielded in one case an amphibious lifestyle whereas the other one was inconclusive between terrestrial and amphibious.

Poster Session III (Friday, November 4)

THE SYSTEMATIC POSITION OF *CHLEUASTOCHOERUS*

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Chleuastochoerus was a small endemic suid, widely distributed in the Late Miocene '*Hipparion* Red Clays' of China, and more recently recorded in Russia. *Chleuastochoerus* has been considered a terminal taxon of an unknown lineage, descended from the Oligocene *Palaeochoerus*. The taxonomic position of *Palaeochoerus*, however, is highly controversial, assigned either to the Suidae or the Tayassuidae. Thus the taxonomic position of *Chleuastochoerus* is also debatable. Though *Chleuastochoerus* is more commonly attributed to the Suidae, subfamilial attribution to the Hyotheriinae or Suinae is still controversial.

We studied new material of *Chleuastochoerus* from Linxia Basin, Gansu Province, China, and compared this genus with other suoids. Based on the following characters, *Chleuastochoerus* undoubtedly belongs to the Suidae: 1) incisive foramen open to the nasal cavity; 2) palato-maxillary suture clear in old individuals; 3) choana broad and round, separated from pterygoid fossa by pterygoid plate; 4) lacking pre- and postglenoid process; 5) tympanic bulla prolate, projecting antero-downwardly; 6) post-tympanic process of squamosal narrow, lower than glenoid; 7) lower border of mandible straight; 8) condyle of mandible triangular, extending postero-downwardly; 9) three pairs of upper incisors; 10) sexual dimorphism notable in upper canines and canines arched niches; 11) P1/p1 reserved, P4/p4 semimolariform; and 12) Mt III and Mt IV not fused proximally.

Chleuastochoerus is similar to *Hyotherium* in having the canines arched niches, the prezygomatic plate, and the posteriorly shifted metaconid of p4, and it differs from the Suinae in having the dorsal profile of the skull flat, stronger convergence of parietal crests, relatively short facial region, and only one lacrimal foramen. It seems more reasonable to assign *Chleuastochoerus* to the subfamily Hyotheriinae.

Poster Session II (Thursday, November 3)

A NEW, SMALL-BODIED ALLIGATOROID FROM THE HELL CREEK FORMATION (LATE MAASTRICHTIAN) OF MONTANA

HOUSEHOLDER, Mindy, Burpee Museum of Natural History, Rockford, IL, USA; WILLIAMS, Scott, Burpee Museum of Natural History, Rockford, IL, USA; TREMAINE, Katie, Burpee Museum of Natural History, Rockford, IL, USA

Crocodylian remains are relatively common within the Hell Creek Formation (late Maastrichtian) of western North America, especially within microvertebrate localities. Two crocodylian taxa are currently recognized from the Hell Creek Formation: the crocodyloid *Borealosuchus sternbergi* and the alligatoroid *Brachychampsa montana*. Ongoing excavation of a microvertebrate locality within the Hell Creek Formation of Carter County, Montana over the past three years has yielded a relatively complete, associated skeleton of a small-bodied alligatoroid. Despite its small size (~ 1 meter), the neurocentral sutures are closed in the caudal, sacral, and most of the dorsal vertebrae, and the neurocentral sutures in the anterior-most dorsal vertebrae and all of the cervical vertebrae are fused, though not completely closed. This evidence is indicative of a mature or nearly mature individual based on comparisons to extant crocodylians. While the generalized morphology of the skull (e.g., broad, robust snout) and dentition (i.e., blunt, 'button-shaped' posterior teeth) bears similarities to *B. montana*, the fourth maxillary alveolus is the largest in the tooth row, unlike in *B. montana* where the fifth alveolus is the largest. This condition is also seen in other small-bodied alligatoroids, including the middle Campanian *Albertochampsa langstoni* (Oldman Formation), the early Maastrichtian *Stangerochampsa mccabei* (Horseshoe Canyon Formation) and the Paleocene *Wannaganosuchus brachymanus* (Tongue River Formation). This new specimen also shares with *S. mccabei* a recessed groove along the maxilla/jugal suture posterolateral to the maxillary tooth row, a character previously thought to be autapomorphic for *S. mccabei*. However, the new taxon differs from *S. mccabei* in that it lacks a pronounced hypapophysis on the axis. Thus, this specimen represents a distinct taxon, increasing the crocodylian diversity within the Hell Creek Formation. This new taxon is the southern-most occurrence of a

small-bodied alligatoroid within the Western Interior Basin of North America during the Late Cretaceous.

Poster Session IV (Saturday, November 5)

APPLICATION OF NONSTATIONARY MODELS OF SEQUENCE EVOLUTION TO HIGHER-ORDER AMNIOTE AND SQUAMATE SYSTEMATICS

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Phylogenetic systematics and 'tree-thinking' are indispensible to the study of evolution and the history of life. The robustness and accuracy of phylogenetic analyses are highly dependent upon the inference methods used and on model selection. Although a large number of nucleotide substitution models exist – 64 total under the commonly used General Time Reversible (GTR) family of models – the question of whether these models and their implementations represent biological reality is not trivial. One particular limitation of current popular programs for phylogeny estimation is their inability to implement nonstationary models of sequence evolution, whereby different branches and lineages are allowed to evolve at different rates and under varying models. The use of nonstationary models is desirable, as constraining sequence evolution to a single rate over all taxa is unlikely to be representative of biological reality, particularly when dealing with questions of higher-order systematics and/or reconstruction of phylogenies that include clades with deep divergence times. Nonstationary models as implemented in the PHylogenetics And Sequence Evolution (PHASE) software under a Bayesian framework were tested using a variety of genes and taxa, in particular for determination of: 1) higher-order amniote relationships, with particular focus on the position of turtles; and 2) higher-level squamate relationships. Preliminary analyses using nonstationary models for Recombination Activating Gene 1 (RAG-1), the most well sampled nuclear gene across tetrapods, recover turtles as sister to Archosauria and place Gekkota rather than Iguania at the base of the squamate tree. These results agree with topologies from previous analyses utilizing molecular sequence data.

Romer Prize/Technical Session 5 (Thursday, November 3, 9:30 am)

MILLENNIUM PARK, A NEW RANCHOLABREAN SITE FROM CENTRAL FLORIDA: EVIDENCE OF THE ELUSIVE SOUTHEASTERN PLEISTOCENE PRAIRIE FAUNA

HULBERT JR, Richard, Florida Museum of Natural History, Gainesville, FL, USA; BOURQUE, Jason, Florida Museum of Natural History, Gainesville, FL, USA; MEYLAN, Peter, Eckerd College, St. Petersburg, FL, USA; POYER, Arthur, Florida Museum of Natural History, Gainesville, FL, USA

In 2007, many tens of thousands of vertebrate fossils were recovered along a creek in an urban park located in southwestern Pinellas County, Florida. *In situ* specimens came from a stratigraphically narrow interval and were locally concentrated to form a bone bed. Fifty-five species have been identified from the Millennium Park Local Fauna (LF) to date, including 18 members of the extinct Pleistocene megafauna, e.g., *Glyptotherium floridanum*, *Mammuthus columbi*, *Bison antiquus*, *Smilodon fatalis*, and *Hesperotestudo crassiscutata*. The presence of *Sigmodon hispidus*, *Oryzomys palustris*, *Microtus pinetorum*, *Synaptomys australis*, and *Neofiber alleni* constrain the age of the Millennium Park LF to the late Rancholabrean (ca. 120-11 ka). Overall, preservation is poor with a very high degree of fragmentation and abundant weathering cracks suggesting damage by long-term exposure in an open habitat. Fossils that survived relatively intact are those that are most robust, such as isolated teeth and carpal and tarsal elements. Palynological evidence suggests that relatively open, grass-dominated habitats (prairies) were more widespread in the southeastern US during the late Pleistocene than at present, but previously no major vertebrate site in Florida preserved an intact prairie fauna. Millennium Park is the first late Rancholabrean site from Florida in which both small (*Sigmodon*, *Sylvilagus*) and large (*Bison*, *Equus*, *Mammuthus*, *Glyptotherium*) mammals are predominantly members of the prairie fauna. Likewise, the herpetofauna is numerically dominated by terrestrial taxa (*Hesperotestudo*, *Terrapene*, Colubridae). A principle components analysis was performed on the relative abundances of 16 large mammalian herbivores at 13 Florida Rancholabrean localities. Principle component 1 accounts for about 50% of the variation, contrasts faunas dominated by browsers (*Mammut*, *Odocoileus*, *Megalonyx*, *Tapirus*) versus grazers (*Bison*, *Equus*, *Mammuthus*), and is interpreted to arrange the localities along an environmental gradient from prairie to forest. The Millennium Park LF falls out at one end of this gradient, with three Aucilla River sites and Hornsby Springs at the opposite end.

Technical Session VII (Thursday, November 3, 2:00 pm)

EARLIEST EVIDENCE FOR THE MAMMALIAN RECOVERY FAUNA IN THE PALEOGENE OF NORTH DAKOTA

HUNTER, John, Ohio State University Newark, Newark, OH, USA; PEARSON, Dean, Pioneer Trails Regional Museum, Bowman, ND, USA; BERCOVICI, Antoine, Key Laboratory of Biogeology and Environmental Geology of Ministry of Education, China, University of Geosciences, Wuhan, China

Ongoing interest in the extinctions that mark the Cretaceous-Paleogene (K/Pg) boundary has fueled collecting efforts to document mammalian faunas ever closer to the boundary. Without such faunas, it is impossible to say on direct evidence which mammalian taxa persisted until the extinction horizon or which mammalian taxa were present in the first few thousands of years of the ensuing recovery. Nevertheless, mammalian fossils in direct juxtaposition to the K/Pg boundary remain extremely rare, impeding understanding of mammalian survivorship and recovery. We describe a moderately diverse assemblage of early Paleocene mammals from the lowermost Ludlow Member of the Fort Union Formation in North Dakota. These fossils occur within one meter above the K/Pg boundary identified on recently revised palynological criteria and co-occur with the first appearance of Paleocene leaves. Based on assumed sedimentation rates, the mammalian fossils were likely deposited within a few thousands of years of the K/Pg boundary and are among the oldest, post-K/Pg mammals to have been discovered. The mammalian fauna includes a new species of *Mesodma*, and species of *Stygimys*, *Catopsalis*, *Procerberus*, *Oxyprimus*, and *Mimatuta* that are among the oldest and most primitive known. These mammalian fossils document the presence in the earliest Paleocene of North Dakota of mammalian taxa whose presumed descendents diversified during the Paleocene recovery. We discuss these mammalian occurrences within the context of the timing and geography of the recovery.

Technical Session VIII (Thursday, November 3, 3:00 pm)

GAINING UNDERGROUND: NEW RECUMBIROSTRANS (LEPOSPONDYLI) FROM THE LOWER PERMIAN OF KANSAS AND NEBRASKA AND EARLY MORPHOLOGICAL EVOLUTION OF THE GROUP INFERRED BY MICRO-CT

HUTTENLOCKER, Adam, University of Washington, Seattle, WA, USA; SMALL, Bryan, Denver Museum of Nature & Science, Denver, CO, USA; PARDO, Jason, Pittsburgh, PA, USA; ANDERSON, Jason, University of Calgary, Calgary, AB, Canada

'Microsaurs' (Lepospondyli) were likely a paraphyletic group of small tetrapods with a fossil record spanning the Visean to the Cisuralian (Early Permian). Characterized by their small body size and holospondylous vertebrae, they have at times been implicated in the origins of extant lissamphibians, especially the fossorial caecilians. Although they are especially common in the well-sampled Texas-Oklahoma redbeds, little is known of the conservative recumbirostran 'microsaurs' from the northern midcontinent (Kansas-Nebraska). Data on a new, well-preserved recumbirostran skull from the Cisuralian Eskridge Formation, Nebraska, reveals affinities to the purported gymnarthrid '*Euryodus' bonneri* from the Speiser Shale, Kansas. High resolution micro-CT reveals important endocranial data, including the presence of an ossified synotic tectum ('supraoccipital') that is apparently absent in gymnarthrids, dorsal sinus separating the synotic tectum from the dermal skull roof as in ostodolepids, ventral flanges of the frontals articulating with the dorsolateral surface of the sphenethmoid, and a tall, ossified epipterygoid, thereby providing useful comparison with derived recumbirostrans. Cladistic analysis of 59 tetrapod taxa and 220 characters supports a sister taxon relationship between '*E.' bonneri* and the new Eskridge Formation specimen in a monophyletic Recumbirostra. The analysis also supports a relationship between gymnarthrids and the burrowing ostodolepids, both derived members of the Recumbirostra clade and putative outgroups to caecilians. The studied specimens share with other gymnarthrids and ostodolepids: lacrimal dorsal process; long prefrontal extending to naris; occiput straight to convex with a large, quadrangular postparietal; parietal foramen absent; and palatal dentition reduced compared to marginals. However, as the specimens occupy a relatively basal position in recumbirostran phylogeny, they are only distantly related to *Euryodus*, a relatively derived gymnarthrid. Given the generalized cranial morphology, these forms may represent the ground plan from which more specialized, perhaps fossorial forms (gymnarthrids and ostodolepids), evolved.

Technical Session VI (Thursday, November 3, 3:00 pm)

AERODYNAMIC CHARACTERISTICS OF FEATHERED DINOSAUR SHAPES MEASURED USING PHYSICAL MODELS: A COMPARATIVE STUDY OF MANEUVERING

HUYNH, Tony, University of California, Berkeley, Berkeley, CA, USA; EVANGELISTA, Dennis, University of California, Berkeley, Berkeley, CA, USA; CHANG, Chun, University of California, Berkeley, Berkeley, CA, USA; KWONG, Austin, University of California, Berkeley, Berkeley, CA, USA; TSE, Kyle, University of California, Berkeley, Berkeley, CA, USA

Aerial maneuvering was likely a pervasive force shaping the evolution of flying animals. Regardless of how aerial behaviors might have arisen, we can analyze the physical effects of structural changes on aerial maneuvering as they present themselves in fossils and along evolutionary lineages. To accomplish this, we measured the aerodynamic maneuvering characteristics of a series of models based on Mesozoic birds and avian ancestors to determine whether or not measures of aerodynamic performance correlated with morphological changes. Maneuvering characteristics during glides were quantified by measuring static stability ($dC/d\boldsymbol{\alpha}$; the tendency to experience righting moments when deflected from equilibrium) and control effectiveness ($dC/d\boldsymbol{\delta}$; the amount of force or moment generated for each degree of movement of a limb or control surface). We found that changes in planform, such as the presence or absence of a feathered tail or of leg feathers or the reconstructed posture of the animal, can drastically alter static stability. In addition, appendage function (e.g. as an elevator, rudder, or aileron, generating control forces and torques in different directions) also depends on posture and glide angle, and the function of appendages can shift dramatically due to reversal or cross-coupling effects. We then mapped the results of our aerodynamic study onto a phylogenetic tree of Avialae, using *†Microraptor* (Dromaeosauridae) and *†Anchiornis* (Troodontidae) as outgroups, in order to test whether or not changes in maneuvering characteristics correlated with changes in morphology during early bird evolution. We specifically examined the performance effects of the shortening of the tail and control effectiveness of leg and tail plumage compared to that of the forelimb wing. We also briefly examined similar trends in the pterosaurs and bats, which also appear to show reduction in

tails in derived forms. Our analysis offers a biomechanical perspective to the evolution of avian flight that integrates morphological evidence from fossils with modeled performance in a phylogenetic framework.

Poster Session I (Wednesday, November 2)

NEW DATA ON SPINOSAURIDS (DINOSAURIA: THEROPODA) FROM AFRICA

IBRAHIM, Nizar, University College Dublin, Dublin, Ireland; SERENO, Paul, University of Chicago, Chicago, IL, USA

Spinosaurid theropods are an important, specialized component of large-bodied predatory dinosaurs in faunas on Africa throughout the Cretaceous, yet their morphology and systematics have been obscured by the destruction of original material and the absence of more complete associated specimens. Here we report on new fossil material of *Suchomimus* from mid Cretaceous horizons in Niger and of *Spinosaurus* from early Upper Cretaceous horizons from Morocco. For *Suchomimus*, complete snout and braincase material reveals for the first time the braincase and endocranial morphology of a spinosaurid. The resting orientation of the head based on the semicircular canals suggests an inclined posture for the skull. The prefrontal is large and inset into the frontal, which is in turn very narrow and deep anteriorly. The form of the frontal allows identification of isolated frontals found elsewhere as spinosaurid. The basal tubera are particularly stout. Many cranial and postcranial features settle the taxonomic controversy surrounding *Suchomimus* and *Baryonyx* in favor of their recognition as distinctive genera. New vertebral remains of *Spinosaurus* from the Cenomanian of Morocco, likewise, allow comparisons with the type material of *Spinosaurus* from Egypt. Based on these more extensive comparisons, there is no basis to distinguish spinosaurid remains at generic or specific levels from eastern and western localities in coeval Cenomanian-age rocks on Africa.

Poster Session III (Friday, November 4)

BONE BED OF BABY OVIRAPTOROSAUR AND HADROSAUROID DINOSAURS FROM THE BAYANSHIREE FORMATION (LATE CRETACEOUS) IN SOUTHEASTERN MONGOLIA

IIJIMA, Masaya, Hokkaido University, Sapporo, Japan; SATO, Tamaki, Tokyo Gakugei University, Koganei, Japan; WATABE, Mahito, Hayashibara Museum of Natural Sciences, Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia; ARIUNCHIMEG, Yarinpel, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

The Bayanshiree Formation (Cenomanian-Santonian), croping out in southeastern Mongolia, is rich in dinosaur fossils. The type locality of this formation, Bayan Shiree, has yielded ankylosaurs, ornithopods, and theropods. In 1996, Hayashibara Museum of Natural Sciences and Mongolian Paleontological Center Joint Paleontological Expedition found egg nests associated with a pair of large elongatoolithid eggs, many eggshells and disarticulated bones in an area of 1m x 1m in bluish white fine-grained sandstones of fluvial deposits at this locality. Among more than fifty bony remains, at least two individuals of baby oviraptorosaur and hadrosauroid dinosaurs for each taxon are recognized. An articular-surangular-coronoid (ASC) complex of an oviraptorosaur is preserved and shows synapomorphies of Caenagnathoidea: transversely wide and convex articular facet, which is elevated above the remaining ramus, for the quadrate in lateral view. Two left dentaries of a hadrosauroid are 25 and 30 mm long, which is smaller than that of embryonic *Hypacrosaurus stebingeri*. One dentary has five alveoli, and the other preserves the laterally offset coronoid process from the tooth row and a caudally offset primary ridge and mesially placed secondary ridge in a fully erupted tooth as seen in basal hadrosauroids. This discovery demonstrates that this is a paucitaxic baby dinosaur bone bed and the first report of caenagnathoid prior to Campanian age in Mongolia. The co-occurrence of baby caenagnathoids and paired-elongatoolithid eggs suggests that this area was an oviraptorosaur nesting site in a fluvial environment. The presence of embryonic hadrosauroids in the caenagnathoid nest indicates that adult caenagnathoids may have hunted baby hadrosauroids as preys and brought them to the nest to feed their babies.

Symposium 3 (Thursday, November 3, 10:15 am)

CAMPANIAN CROCODYLIFORMS OF LARAMIDIA: NEW INSIGHTS FROM THE KAIPAROWITS BASIN OF SOUTHERN UTAH

IRMIS, Randall, Utah Museum of Natural History, Salt Lake City, UT, USA; SERTICH, Joseph, Stony Brook University, Stony Brook, NY, USA; HUTCHISON, J. Howard, University of California Museum of Paleontology, Berkeley, CA, USA; TITUS, Alan, Grand Staircase-Escalante National Monument, Kanab, UT, USA

Recent biogeographic inferences from the non-marine vertebrate record of the Late Cretaceous of western North America (Laramidia) suggest distinct northern and southern provinces, each with a number of endemic taxa. This interpretation is largely based on large dinosaur assemblages; other tetrapod groups remain less-well studied. Crocodyliforms are ideal for testing biogeographic hypotheses because they have an abundant and diverse fossil record during the Late Cretaceous. Unfortunately, this dataset remains largely untapped, because Campanian crocodyliform assemblages from many areas are still poorly described.

A key location for understanding Campanian crocodyliform biogeography is the Kaiparowits Basin of southern Utah, an area between southern basins in New Mexico and Texas, and northern basins in Montana and Alberta. We conducted a comprehensive survey of the Kaiparowits Basin crocodyliform assemblage to understanding its taxonomy, diversity, and biogeographic signal. Except for the presence of *Deinosuchus*, crocodyliform material from the early-middle Campanian Wahweap Formation is fragmentary, and can only be assigned to large, widespread clades (e.g., Mesoeucrocodylia or Eusuchia). Conversely, the overlying late Campanian Kaiparowits Formation assemblage is abundant and diverse, including a large goniopholidid-like mesoeucrocodylian, the basal alligatoroids *Deinosuchus hatcheri* and *Brachychampsa* sp., and a small alligatoroid taxon that lacks globidont teeth. Among Campanian Laramidian basins, the co-occurrence of the mesoeucrocodylian, *Deinosuchus*, and *Brachychampsa* in the Kaiparowits Fm. indicates a clear biogeographic relationship with the San Juan Basin in New Mexico. Furthermore, both basins lack *Leidyosuchus*, a basal alligatoroid that is common in northern Laramidia. Although the presence of a small alligatoroid in Utah is mirrored by *Stangerochampsa* and *Albertochampsa* from the Dinosaur Park Formation of Alberta, there is no evidence these taxa are closely related. These new crocodyliform data from the Kaiparowits Basin strongly support the hypothesis of a distinct southern biogeographic province during the Campanian, which included southern Utah.

Poster Session II (Thursday, November 3)

INFLUENCE OF VERTISOL DEVELOPMENT ON SAUROPOD EGG TAPHONOMY AND DISTRIBUTION IN NESTING GROUND DEPOSITS

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Detailed mapping during excavation of a sauropod egg-bearing interval in fluvial overbank deposits of the Upper Cretaceous Anacleto Formation at Acua Maheuvo, Argentina reveals pedogenic features associated with vertisol development. These features include abundant, polished, randomly oriented slickensided surfaces and concave-up, low-angle curved planes that intersect at opposite angles. The resulting pattern of microhighs and microlows (gilgai) are 1.0 to 1.5 m wide. Some slickensided surfaces cut and displace portions of eggs by approximately 3-5 cm along sub-horizontal and sub-vertical surfaces; ornamentation of eggs associated with these slickensides are "sheared" in the same direction. These pedogenic processes affected changes in both individual egg morphology and three-dimensional egg distribution. These changes resulted primarily from vertical and lateral components of movement within the overbank sediments due to clay mineral expansion and contraction driven by phases of wetting and drying during paleosol development.

At the scale of individual sauropod eggs, pedogenic sediment movement produced egg and eggshell fracture and displacement, mechanical abrasion of egg ornamentation, and alteration of egg size and shape. Movement of either individual eggs or subsets of eggs along slickensided surfaces 1) modified the number and relative position of eggs within individual clutches, 2) combined eggs of one of more clutches produced by different females, and 3) combine eggs from one or more nesting horizons, producing a time-averaged deposit. Pedogenic movement (pedoturbation) facilitated by water-driven shrinking and swelling of expandable layer clay minerals during vertisol development produced egg "clusters" that are not representative, either in terms of clutch size or morphology, of the true reproductive behavior of the individual female sauropods during egg-laying. Thus, it is imperative that taphonomic and paleobiological studies of egg-bearing mudrocks incorporate analysis of their pedogenic overprint.

Poster Session III (Friday, November 4)

MAMMALIAN FAUNAL DYNAMICS OVER DEEP TIME II: COMPARISON BETWEEN CARNIVORES AND HERBIVORES

JANIS, Christine, Brown University, Providence, RI, USA; FIGUEIRIDO, Borja, Brown University, Providence, RI, USA; PÉREZ-CLAROS, Juan, University of Málaga, Málaga, Spain; PALMQVIST, Paul, University of Málaga, Málaga, Spain

A Q-mode factor analysis reveals six sequential evolutionary faunas in the fossil record of the large mammals of the North American Cenozoic. Presence/absence taxonomic data (at the level of subfamily) were binned into 26 subequal time intervals; factors with eigenvectors greater than one were subsequently extracted and rotated by the interative procedure of VARIMAX. We further explore these evolutionary patterns in considering separately the carnivorous and the herbivorous mammals.

While the large mammals combined yielded six significant faunal groupings, the herbivores alone were clustered into seven different sequential assemblages, and the carnivores were clustered into five. In both groups, the final three faunas (the first of these commencing in late middle Eocene, with a peak of diversity in the mid Oligocene) are identical, both to each other and to the faunas obtained from the entire dataset. But in the earlier Cenozoic the patterns do not coincide. The carnivores show two distinct faunas in the Paleocene and in the early to middle Eocene, while the herbivores show four distinct faunas (essentially two separate faunas for each one of the carnivores). The early Cenozoic was a time of tremendous climatic fluctuations and vegetational change in the higher latitudes, which may have affected carnivores and herbivores in different ways. Herbivores would be greatly affected by floral changes, and their teeth show profound shifts in diet over this time. In contrast, meat is meat, whatever the prey animal consumed, and a switch in the taxonomic composition of the herbivores might have little effect on evolutionary dynamics of carnivorous mammals.

Technical Session XV (Saturday, November 5, 10:15 am)

MICROSTRUCTURAL ANALYSIS AND GROWTH OF THE *TRITYLODON* MANDIBLE

JASINOSKI, Sandra, University of Cape Town, Cape Town, South Africa; CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa

Studies of bone microstructure of extant vertebrates have revealed distinctive signals that pertain to growth and biology. Applying such studies to histological surveys of nonmammalian therapsids has enabled extrapolation of various aspects of their biology. Previous studies of several nonmammalian cynodonts have mainly focused on the postcrania, which permitted an assessment of their histological variation and allowed deduction of their overall growth strategy. In the present study, the mandibular and dental histology of *Tritylodon,* a derived herbivorous cynodont from southern Africa, is described from serial thin sections. These histological features provide direct information that permit a reconstruction of mandibular growth during ontogeny.

The dentary mainly consists of fibrolamellar bone, with occasional thin layers of lamellar bone. Growth lines are not evident, indicating uninterrupted growth in this individual. The enamel has a variable thickness across the crown of the postcanine teeth, and incremental lines are evident. The dentine is also well preserved, preserving fine details such as incremental lines and dentinal fibers. The presence of Sharpey's fibers within the surrounding cementum indicates that the teeth were attached to the jaw by a periodontal ligament.

Several histological features of the mandible can be used to track the growth of the lower jaw. For example, we are able to trace how the postcanine teeth drifted medially during growth. There is also evidence of the relocation of the mental foramen which coincides with the posterior lengthening of the mandible. Our study provides a unique perspective on the histology and growth dynamics of the *Tritylodon* dentary.

Poster Session III (Friday, November 4)

INVESTIGATION INTO THE TURTLES FROM THE LATE CRETACEOUS TO PALEOCENE IN THE SAN JUAN BASIN, NEW MEXICO

JASINSKI, Steven, State Museum of Pennsylvania, Harrisburg, PA, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuequerque, NM, USA; MOSCATO, David, East Tennessee State University, Johnson City, TN, USA

Turtles are among the most abundant vertebrate fossils recovered from Upper Cretaceous and Paleocene strata in western North America. Four key formations (Fruitland, Kirtland, Ojo Alamo, and Nacimiento), ranging from Late Cretaceous (late Campanian) to early-middle Paleocene (Torrejonian) in age, are exposed in the San Juan Basin, New Mexico. Turtle fossils from these stratigraphic units can be used to investigate survivorship across the K-T boundary. Presently, at least 28 turtles are known from the K-T transition of the San Juan Basin. These include members of Bothremyidae (*Chedighaii*), Pleurosternidae (*Compsemys*), Baenidae (*Denazinemys*, *Boremys*, "*Baena*", *Palatobaena*, *Neurankylus* and *Thescelus*), Kinosternoidea (*Hoplochelys*), Adocidae (*Adocus*), Nanhsiungchelyidae (*Basilemys*), Trionychidae (*Amyda*, *Aspideretoides*, *Axestemys*, *Plastomenus* and "*Platypeltis*"), Emydidae and Chelydridae. Six genera survive from the Cretaceous into the Paleocene, whereas six other genera and two families first appear in the Paleocene. The generic level of turtles was investigated because many problems are present with several of the Paleocene San Juan Basin turtle species and these will eventually need further study. The Hunter Wash Member of the Kirtland Formation (late Campanian) and the Torrejonian interval of the Nacimiento Formation are the most diverse intervals in terms of turtles during this time span. A period of seemingly less taxonomic diversity is present across the K-T boundary (De-na-zin Member of Kirtland Formation to Puercan interval of Nacimiento Formation). The general diversity of turtles in the San Juan Basin is not considered vastly different from other turtle faunas in the Western Interior during the Late Cretaceous and Paleocene. The definite *Hoplochelys* specimens mark some of the oldest confirmed occurrences of the genus and may indicate a southerly origin of this taxon in the southern United States and Mexico with migration northward. Nevertheless, the San Juan Basin turtles, while showing significant generic survival across the K-T boundary, show high turnover as well, especially at the species level, with none of the same species found in both the Cretaceous and Paleocene.

Symposium 2 (Wednesday, November 2, 9:45 am)

INSIGHT INTO THE "BIG BLACK HOLE": VERTEBRATE REMAINS FROM ROOM 2, CATHEDRAL CAVE, NEVADA

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Recovered vertebrate remains from Room 2 of Cathedral Cave, Nevada, provide unique insight into the Pleistocene record of the east-central Great Basin. The diverse fauna recovered from the site includes mammals, reptiles, amphibians, birds, fish, and mollusks. Uranium-series ages on *in situ* flowstone indicate a maximum age for the fauna, with a range between 146.02 ± 2.584 ka and 153.7 ± 6.4 ka. Taxonomically, there are some similarities between the Room 2 fauna and other latest Pleistocene faunas occurring near the cave. Many taxa recovered from Room 2 excavations (e.g., *Marmota*, *Ochotona*) are known from other sites in the vicinity of Cathedral Cave. However, recovered fossils of *Allophaiomys pliocaenicus*, *Microtus paroperarius*, and *M. meadensis* are unique with respect to other sites and represent the youngest known occurrences of those taxa in North America. The assemblage of arvicoline rodents, along with other notable records (e.g., *Aztlanolagus agilis*, *Gopherus agassizii*), indicate that the Room 2 fauna is taxonomically distinct from all known Pleistocene faunas in the vicinity of Cathedral Cave.

Because of the maximum age and distinct taxonomic character of the Room 2 fauna, evaluation of the assemblage in a broad geographic and environmental context is challenging. No analogous faunas occur in the Great Basin, and few other North American localities allow for temporally equivalent comparisons. Abundance change across lower portions of excavated sedimentary levels may reflect faunal responses to perturbations in the local environment that coincide with the occurrence of a deep-lake event in the eastern Great Basin (i.e., Little Valley lake cycle). *Microtus* and *Lemmiscus* alternate in relative abundance across lower excavation levels. *Ochotona* and *Sylvilagus* or *Lepus* sp. also show alternating patterns of abundance at similar excavation levels. Those data indicate the need for further work on the Room 2 fauna, particularly with respect to exploring possible causes for observed abundance shifts.

Poster Session II (Thursday, November 3)

EVIDENCE OF ENDOCHONDRAL OSSIFICATION IN SPINE MATERIAL FROM THE UPPER DEVONIAN, SCAT CRAIG LOCALITY, SCOTLAND

JERVE, Anna, Uppsala University, Uppsala, Sweden

The Upper Devonian (Upper Frasnian) Scat Craig locality near Elgin, Scotland, is known for its unique and well-preserved vertebrate fossils. Among these are the diverse remains of several fish taxa, including *Holoptychius*, *Bothriolepis* and *Cosmacanthus*, in addition to *Elginerpeton pancheni*, an early tetrapod. Remains from this site usually appear as disarticulated pieces that can be incomplete but show excellent preservation, making them useful for studying morphology and histology. Of particular interest are spine-like elements that have been previously identified informally as "acanthodian" material. These specimens consist of longitudinally striated spines, several centimeters in length as preserved but invariably incomplete, which are sometimes attached to asymmetrical basal plates of smooth bone. Remarkably, both spines and bases contain well-developed endochondral ossification, which can be observed macroscopically and is confirmed by the presence of bony trabeculae in synchrotron scan data. The spines differ from the bases in having thicker cortical bone with a distinctive histology. Endochondral ossification, a defining osteichthyan feature, has not been observed in the spines of acanthodians, sarcopterygians or actinopterygians, nor in other early gnathostomes such as placoderms or chondrichthyans. Fin spines are normally composed of dentine and/or dermal bone. The Scat Craig spines appear to belong to an osteichthyan but represent a unique morphology that is difficult to accommodate within the known osteichthyan body plan, either as fin supports or as other endoskeletal elements such as branchial components.

Poster Session I (Wednesday, November 2)

PRELIMINARY RESULTS OF PHYLOGENETIC ANALYSIS OF TRIASSIC ICHTHYOSAURS

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Although research on ichthyosaurs dates back to the 18th century, Triassic ichthyosaurs had been poorly known due to the fragmentary nature of the materials and their relative scarcity until the 20th century. The phylogeny of Shastasauridae, one of the most famous Triassic ichthyosaur families, is still controversial because of the incompleteness of specimens. However, during the last decade, over five species of ichthyosaurs have been reported from the Olenekian (Early Triassic) to the Carnian (Late Triassic) of South China, of which at least two species belonged to Shastasauridae. These new taxa fill some important gaps in the previous fossil record of ichthyosaurs. We therefore tested how inclusion of these species may affect the current phylogenetic hypotheses of ichthyosaurs.

A phylogenetic analysis of 20 ichthyosaur species (18 Triassic, 2 Jurassic) based on 69 morphological characters was conducted using maximum parsimony. Inclusion of 4 Chinese species made this analysis the most inclusive of similar phylogenetic analyses. It resulted in six most parsimonious trees. The strict consensus tree supported the monophyly of Shastasauridae which formed a sister clade of a clade consisting of other Late Triassic and Jurassic species. *Cymbospondylus* appeared outside of these sister clades. The two new suspected shastasaurids from China, *Guizhouichthyosaurus* and *Guanlingsaurus*, were both included in this group while the relationship within Shastasauridae is still not strongly supported. *Qianichthyosaurus*, another taxon from China, formed a clade with *Toretocnemus* from North America, while they together are basal to Jurassic ichthyosaurs. In contrast to the previous study, *Callawayia*, which displayed some derived morphology features as the absence of maxilla dorsal lamina, presence of parietal ridge showed closer affinity to Jurassic ichthyosaurs than to Shastasauridae. The new phylogenetic hypotheses suggested close ichthyosaurian affinity between South China and North America during the Triassic.

Poster Session I (Wednesday, November 2)

THE MARINE REPTILE *SAUROSPHARGIS* FROM ANISIAN (MIDDLE TRIASSIC) OF PANXIAN, GUIZHOU, SOUTHWESTERN CHINA

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The enigmatic marine reptile *Saurosphargis volzi* from the Lower Muschelkalk (Bithynian, Anisian, Middle Triassic) of Gogolin, Upper Silesia in the Germanic Basin was originally thought to be closely related to placodonts. Some considered it a Placodontia *incertae sedi,* whereas others found it to be a nomen dubium because the lost holotype was fragmentary. A recent analysis proposed that it was a valid taxon unrelated to sauropterygians, based on the new discovery of *Sinosaurosphargis* from China.

One postcranial skeleton with scattered scalelike osteoderms, and a skull supposed to belong to the same individual were collected from Yangjuan in Xinmin of Panxian (Guizhou). Its age is the Pelsonian (middle Anisian), being slightly younger than that of *Saurosphargis volzi*.

The specimen resembles *Saurosphargis* rather than the geographically closer *Sinosaurosphargis*. The preserved postcranial skeleton is about 1.16 m long. The scattered scalelike osteoderms of a size reaching more than 1.0 cm long, similar to those of *Saurosphargis volzi*, are concentrated in the pelvic region, extending anteriorly to the level of pectoral girdle along the lateroventral body. The dorsal vertebrae bear long transverse processes, and the ribs carry a posterior uncinate process, similar to *S. volzi*. This specimen shares with Sauropterygia the curved humerus, and the clavicle contacting the anteromedial portion of scapular. It also resembles placodontoid sauropterygians for having one row of osteoderm on the top of neural spines and long transverse processes of dorsal vertebrae. However, its humerus lacks distinctive distal expansion unlike in placodonts, and the carpal and tarsal series are more complete with the centrale present. It is the first definite record of *Saurosphargis* from China, referred to as *Saurosphargis* cf. *S. volzi*.

The presence of *Saurosphargis* in the Panxian Fauna reinforces the close affinity of this fauna with the Lower Muschekalk fauna during the Anisian. *Saurosphargis* probably spread from the Muschelkalk basin to southwest China in Anisian, while *Sinosaurosphargis*, more derived having a "carapace" composed of osteoderms, was only found in southwest China so far.

Technical Session IX (Friday, November 4, 8:30 am)

THE EMERGENCE OF MARINE REPTILES DURING THE TRIASSIC RECOVERY—RECORDS FROM THE LOWER TRIASSIC OF CHAOHU, CHINA

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The Triassic saw the emergence of more than six groups of marine reptile clades, mostly during the Olenekian (late Early Triassic) and Anisian (early Middle Triassic). However, the exact timing of the appearance of these clades is unknown, let alone the environments in which they first lived. The Lower Triassic sequence exposed near Majiashan, Chaohu, Anhui, China, provides a prime opportunity to scrutinize these two questions.

We have numbered about 1000 rock beds, spanning from the Induan to the end of the Olenekian, and established a lithological correlation among different quarries. We have collected about 30 reptilian remains and a similar number of fish fossils from these rock beds, including many skeletons. The Olenekian is divided into the Smithian and Spathian subages, and it is generally accepted that the first marine reptiles did not appear until very late in the Spathian (i.e., near the Early/Middle Triassic boundary). Some of the well-known reptile beds in the area are indeed close to this boundary. However, contrary to the traditional view, we found the ichthyosaur *Chaohusaurus* from the lowest Middle Member of the Spathian Nanlinghu Formation. Also, a previously reported *Chaohusaurus* specimen from Wuwei, some 50 km south of Majiashan, is most likely from the Lower Member of the Nanlinghu Formation, judging from the abundance of very thick limestones in the quarry. Thus, marine reptiles emerged early in the Spathian, at least one million years earlier than previously thought.

Specimens of *Chaohusaurus* have been found with arthropod and small bivalve fossils. Given that this ichthyopterygian had small but rounded posterior teeth, it is likely that it fed on these invertebrates. However, given that *Chaohusaurus* had several derived features, and that the most basal ichthyopterygian lacked rounded dentition, this diet was probably not shared with the first ichthyopterygian marine invaders. Rather, it suggests that ichthyopterygians were already feeding upon diverse prey early in the Spathian. It is necessary to reconsider the rate of recovery in the Olenekian.

Poster Session IV (Saturday, November 5)

NO EVIDENCE OF CAVIOMORPH RODENTS IN A NEW, LATE EOCENE TERRESTRIAL VERTEBRATE LOCALITY IN NORTHWESTERN OAXACA, SOUTHERN MEXICO

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The hypothesis of transatlantic dispersal of the ancestors of South American rodents and primates is founded on the sister-taxon relations of living groups and the absence of fossil relatives in mid-latitude North America. Yet, it has also been argued that ancestors of these groups lived in Central America, where fossils are unknown. We report here the first rich Paleogene fossil locality in tropical North America. The fossiliferous beds pertain to the Yanhuitlán Formation, which crops out in the Oaxacan Highlands of the Sierra Madre del Sur morphotectonic province. Previous radiometric dates on intrusives associated with this formation suggested an age of around 43 Ma, but other radiometric ages and faunal composition suggest a late Eocene (Chadronian) age for this local fauna.

Twenty species (3 reptiles, 17 mammals) have been identified in the fauna thus far. The reptiles are two testudinids and a rhineurid. The mammal fauna consists of a sciurid and three geomorph rodents (Glires); a tapiroid, an amynodontid, a rhinocerotid, and a ?chalicotherioid (Perissodactyla); a leptochoerid, a tayassuid, an oreodont, a hypertraguloid, a protoceratid, and a camelid (Artiodactyla); two caniforms (Carnivora); and a hyaenodontid creodont. Geographically, the closest coeval local fauna in North America is the Rancho Gaitán l.f. of Chihuahua, northern Mexico, which is about 1500 km farther north.

The abundant rodents of this new site have exclusively North American relations, thus undermining the last argument against long-distance transoceanic dispersal. The rodents, particularly the Geomyoidea, are more typical of post-Eocene assemblages from middle latitudes and confirm an ancient history of the group in the Neotropics, long inferred to be their center of radiation. Continuation of research on this Oaxacan Eocene locality will provide further insight into species richness patterns, endemicity, and niche partitioning. It may also provide crucial new data bearing on the origin of platyrrhine primates.

Symposium 1 (Wednesday, November 2, 8:45 am)

EVOLUTION OF PAIRED FINS AND THE LATERAL SOMITIC FRONTIER

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Determining homologies between jawed vertebrate paired fins and the wide variety of fins or fin-like structures in fossil jawless vertebrates (Anaspida, Thelodonti and Osteostraci) has been problematic. Determining these homologies is important when describing the evolutionary steps by which the paired fins evolved. Paired fins (pectoral, pelvic) in the jawed vertebrates are characterized by several features; they are generally narrow-based, positioned posterior to the branchial arches and consist of basals and radials supported on a girdle. Difficulties occur because fin-like structures in the jawless vertebrates can be elongate along the flank, with no indication of a supporting girdle. The fin-like structures can also be supra-branchial in position (over the branchial arches) or extend beneath the branchial arch series. An exception is the Osteostraci. Taxa such as *Norselaspis* possess a pectoral girdle with a single fin radial articulation surrounded by depressions for muscle attachments and foramina for brachial nerves, homologous to the jawed vertebrate pectoral girdle. Recently, the vertebrate embryo has been divided into primaxial and abaxial domains, separated by the lateral somitic frontier. The primaxial domain derives from the somitic mesoderm, while the abaxial domain comprises a region where somitic cells develop in the presence of lateral plate mesoderm. Most of the pectoral girdle (except dorsal portions in some taxa) and the pelvic girdle derive from lateral plate mesoderm. As a novel interpretation of paired fin homology, it is suggested that paired fins characterizing the Osteostraci and jawed vertebrates evolved when fin competency (including girdle development) evolved in the lateral plate mesoderm, which coincided with the evolution of the primaxial and abaxial regions and the lateral somitic frontier in these groups.

Poster Session IV (Saturday, November 5)

A NEW RANCHOLABREAN (LATE PLEISTOCENE) FAUNA FROM THE SOUTHEASTERN EDGE OF THE TEXAS SOUTHERN HIGH PLAINS

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Investigations at Post Locality 100 have documented a diverse late Pleistocene (Rancholabrean) fauna. Located near the southeastern edge of the Southern High Plains, the locality has produced a fauna containing extinct and extralimital taxa. The fauna, deposited in a fluvial setting of a small drainage system, is associated with a radiocarbon date of 11,500 radiocarbon years before present, obtained from a periotic removed from a *Bison antiquus* skull.

Extinct forms include *Equus mexicanus* (stout-legged horse*)*, *Bison antiquus* (ancient bison), *Mammuthus columbi* (Columbian mammoth), *Platygonus compressus* (flat-headed peccary),

Terrapene carolina putnami (Putnam's eastern box turtle), and *Hesperotestudo* (=*Geochelone*) (giant tortoise). Extralimital extant forms include *Synaptomys cooperi* (southern bog lemming) and *Ondatra zibethicus* (muskrat). Extant forms living on the Southern High Plains today include *Trachemys scripta* (pond slider) and *Canis latrans* (coyote). A soricid and an ictalurid are extant forms that may or may not be extralimital. As yet unidentified small birds, frog, other fish, and snake also are present at the locality.

This assemblage of environmentally restricted taxa is similar to those found in the Rancholabrean faunas of Lubbock Lake and Blackwater Draw, supporting the view of a humid and equitable climate on the Southern High Plains during the latest Pleistocene. Geomorphology and wetland adapted taxa indicate a marsh-like setting, perhaps on the margin of a stream. The presence of the extinct box turtle in association with bog lemming and muskrat supports the interpretation that this subspecies inhabited marsh and low-lying grassland. Horse, ancient bison, Columbian mammoth, and peccary indicate a grassland ecosystem.

Hesperotestudo material indicates a large size species rather than the regionally expected small, smooth-shell *H. wilsoni*. Remains of the extinct box turtle *Terrapene carolina putnami* are common in the deposit, with several partial and complete carapaces being recovered. Individual shell elements are the most common of all specimens found in excavation, constituting the largest sample of *T. c. putnami* in the region.

Romer Prize/Technical Session 5 (Thursday, November 3, 10:15 am)

ZIEGLER RESERVOIR AND THE SNOWMASTODON PROJECT: OVERVIEW AND GEOLOGIC SETTING OF A RECENTLY DISCOVERED SERIES OF HIGH-ELEVATION PLEISTOCENE (SANGAMONIAN) ECOSYSTEMS NEAR SNOWMASS VILLAGE, COLORADO

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On Oct. 14, 2010 a bulldozer operator discovered a young female mammoth while excavating Zeigler Reservoir on the divide between Snowmass and Brush creeks near Snowmass Village, Colorado. Subsequent investigation by the Denver Museum of Nature & Science between Oct. 29 and Nov. 16, 2010, revealed an amazingly well-preserved sequence of high-elevation Ice Age ecosystems. In 18 days, DMNS excavated more than 600 bones comprising parts of more than 20 individuals (*Mammuthus columbi*, *Mammut americanum*, *Bison latifrons*, cf. *Odocoileus*, *Megalonyx jeffersoni*, and numerous microvertebrates) and exceptionally preserved plant, insect and aquatic invertebrate fossils. The deposit sits in a small ridgetop catchment with no inflowing streams suggesting that the Pleistocene lake filled slowly with input primarily from morainal slopewash and aeolian sediment. Lower units of the ~10m section contain isolated bones of *Mammut*, *Bison*, cf. *Odocoileus,* and *Megalonyx* in subaqueous debris flow deposits. Upper units contain articulated skeletons of *Mammuthus*, *Bison*, and cf. *Odocoileus* in a well-preserved sedge peat. As a whole, the site represents the first relatively complete sequence of Pleistocene (Ice Age) ecosystems at high elevation in the Rocky Mountains. The Ziegler Reservoir site is significant for 5 reasons: 1) it is located at 2,671 m above sea level and high elevation Pleistocene sites are rare; 2) it contains several fossil-bearing horizons, which will allow for the reconstruction of a series of ecosystems; 3) it contains a broad diversity of plant, vertebrate, and invertebrate fossils, which will allow for more complete ecosystem analyses; 4) the preservation of the fossils discovered at Ziegler Reservoir is exceptional ; and 5) radiocarbon dating indicates that all of the sediment in Ziegler Reservoir site is more than 45,000 years old and local glacial geology indicates that the lake-bounding Bull Lake moraine is 130,000 to 150,000 years old. This presents the possibility that as much as 100,000 years may be represented by the lake sediments. Extensive excavations are planned for May 15-July 1 to recover more data before the planned reservoir completion in October, 2011.

Technical Session X (Friday, November 4, 9:30 am)

PREMOLAR EVOLUTION IN THE EARLIEST EUPRIMATES OF WYOMING

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The early Eocene was a time of great faunal and climatic change in North America. The first Euprimates appear abruptly at the beginning of the Eocene as two clades: tarsier-like omomyids and lemur-like notharctid adapoids. Small-bodied omomyids likel y had frugivorous and insectivorous diets whereas larger-bodied adapoids evolved features implying increased folivory. However, as the adapoids declined in the mid Eocene, some omomyids (omomyines) developed larger body sizes. Here we document quantitatively the morphological evolution of these two groups in Wyoming, specifically testing if increased body size in omomyids is accompanied by dental convergence to adapoids. Molarization of the fourth premolar (p4) is often associated with folivorous diets. Thus we investigate if p4 shape and variability (disparity) varies between the two primate groups and how it changes through the Eocene. Shape was measured using seven 2D landmarks taken from lingual photographs of p4s (omomyid n=102, adapoid n=63) and m1 dimensions were used to calculate associated body mass estimates. First, size was removed using procrustes superimposition then shape variation was described using principal components analysis and disparity calculated using euclidean distance to mean shape. MANCOVA was used to examine the effect of group and time-bin on shape. Results indicate that adapoids exhibit an antero-posteriorly longer tooth, with a higher and wider metaconid relative to the protoconid, reflecting relative molarization of p4 with respect to omomyids (effect of family, $p<0.001$). This difference is maintained through the Wasatchian; however, appearance of large bodied omomyids in the Bridgerian results in invasion of omomyine p4s into adapoid morphospace (interaction of time and family, $p<0.001$). This is accompanied by increased disparity of omomyids at this time. This reflects the molarization of p4 in some omomyine primates during the Bridgerian, associated with increased body size and likely folivory. These results suggest that the two groups of euprimates may have been sharing resources prior to the disappearance of North American adapoids in the mid Eocene.

Technical Session IX (Friday, November 4, 10:15 am)

THE FIRST RECORD OF MIDDLE TRIASSIC LEPIDOSAURS

JONES, Marc, University College London, London, United Kingdom; HIPSLEY, Christy, Museum für Naturkunde Humboldt-Universität, Berlin, Germany; ANDERSON, Cajsa, University of Gothenburg, Gothenburg, Sweden; SCHOCH, Rainer, Staatliches Museum für Naturkunde, Stuttgart, Germany; HIPSLEY, Christy, Museum für Naturkunde Humboldt-Universität, Berlin, Germany

Lepidosauria is a diverse group of reptiles represented today by over 7000 species globally distributed and filling a wide variety of niches. Unfortunately the fossil record of this clade is frustratingly patchy. The earliest known fossil lepidosaurs are Late Triassic (Carnian) in age and include partial jaws from India and USA and natural moulds of the rhynchocephalian *Brachyrhinodon* from the Lossiemouth Sandstone Formation of Scotland. The derived morphology of this Carnian material suggests that lepidosaur origins lie in the Early or Middle Triassic, but nothing has been documented from these epochs, limiting molecular clock calibration and our ability to reconstruct early patterns of diversification, biogeography, and ancestral ecology.

Here we report two partial dentaries from the Middle Triassic Untere Graue Mergel (lower grey marls) of the Lower Keuper (Erfurt Formation) of Germany (Vellberg). The material was examined and character coded using scanning electron microscopy, computed tomography and binocular microscopy. Phylogenetic analysis places the jaws within Rhynchocephalia, with several characters indicating a close phylogenetic affinity to *Diphydontosaurus* (known from the Late Triassic of the UK but also reported from USA and Italy): a small coronoid expansion; teeth that are weakly pleurodont anteriorly and labiolingually compressed and acrodont posteriorly.

At 240 million years old (mya), the Vellberg material predates previous lepidosaur fossil records by over 10 million years and also molecular clock estimates for the origin of lepidosaurs based on haemoglobin amino acid chains (233 mya). However, some age estimates based on mitochondrial DNA and nuclear genes are substantially older suggesting there remains an unrecorded ghost lineage.

This new material helps bridge a notable gap in the record of Lepidosauromorpha. Moreover, very few Middle Triassic localities yield well preserved remains of small vertebrates. Therefore, the source locality of Vellberg has global importance in its potential to help bridge other conspicuous gaps in the fossil record such as those of frogs and salamanders.

Poster Session II (Thursday, November 3)

WHO IS EATING MY TEETH? BIOEROSIONAL TUNNELING IN FOSSIL MAMMAL DENTITIONS

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The early Eocene genus *Tubulodon* (Epoicotheriidae) from Wyoming is one of a few primitive genera of the Palaeanodonta that retained tooth enamel. The enamel of *Tubulodon* is relatively thin and therefore often transparent. Thus, unusual tubes in the orthodentine are often visible. These tubes were initially interpreted as primary dental structures, being prestages to the hexagonal dentinal prisms in aardvarks, and they inspired the name *Tubulodon*. Our detailed scanning electron microscopic study showed that individual tubes are surrounded by a hypermineralized rim and enclose a cluster of much smaller elongated structures, or filaments, each residing in a small tunnel. The tubes and filaments do not belong to the natural orthodentine structure and are here interpreted as early post-mortem bioerosional phenomena. Size and morphology of the filaments affiliates them with actinomycetal bacteria which commonly colonize mucous membranes of warm-blooded vertebrates. Bioerosional destruction is not unique to *Tubulodon*. Additional evidence that this is a widespread taphonomical phenomenon comes from numerous specimens of other early Eocene teeth from the Willwood Formation of the Bighorn Basin, Wyoming, as well as diverse mammalian taxa from different stratigraphic levels and geographic locations where we observed varying degrees of tunneling, and even substantial tube development in the dentary itself. In contrast to the orthodentine, the enamel is not altered.

Poster Session I (Wednesday, November 2)

MODELING THEROPOD JOINT STABILITY

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The hip, knee, and ankle of birds and other theropods primarily flex and extend, but rotations and loads about other axes cannot be ignored. When standing or moving on one leg, the medially-placed foot and the laterally-located hip and knee result in limb segments out of line with the ground reaction force. The major joints must stabilize the substantial mediolateral and long-axis torques this posture creates.

We developed a simple 2-D model of single leg support to investigate the effects of proportions on transverse loading. In extant birds, the relatively horizontal femur is under torsion from a couple between the knee (resisting tibiotarsal adduction) and the hip (resisting external femoral rotation). Knee and hip torques, and thus femoral torsion, were most affected by increased body width and body mass. Surprisingly, these joint moments were predicted to be independent of limb length.

A second model was constructed to explore the role of collateral ligaments in bicondylar joint stabilization. As expected, collaterals are ideally situated to strain longitudinally, thereby preventing dislocation and resisting abduction/adduction. In contrast, torsional loads lengthen the collaterals obliquely and more gradually, allowing at least 10X more degrees of long-axis rotation for the same strain. Wider condyles and shorter ligaments provide greater stability than narrower condyles and longer ligaments.

Although soft tissues are lost during fossilization, we expect changes in geometry (mass, body width, condyle width, femoral cross-section, ligament insertion sites) to change in a coordinated fashion as theropods change body size and transition to more avian posture. Now that 3-D motion and loading data are becoming available, relatively simple limb models may help identify unifying principles in vertebrate joint design.

Technical Session XV (Saturday, November 5, 9:30 am)

THE ORIGIN AND EARLY EVOLUTION OF THE GORGONOPSIA

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Gorgonopsia is a clade of morphologically conservative, carnivorous therapsids characterized by the possession of large, sabre-like maxillary fangs. Gorgonopsians were the dominant terrestrial vertebrate predators of the Late Permian and reached large size (up to ~4 m body length). However, the Middle Permian record of this group is very poor: Middle Permian gorgonopsians are extremely rare and were apparently restricted to small size. This is unusual, as the other major Middle Permian therapsid groups (Biarmosuchia, Dinocephalia, Anomodontia, and Therocephalia) are represented by comparatively abundant material across a range of body sizes in the same deposits. Despite the paucity of specimens, there exists a high degree of nominal diversity in Middle Permian gorgonopsians, with nine genera described from the *Tapinocephalus* Assemblage Zone (AZ) of the Karoo Basin in South Africa and another taxon (*Kamagorgon ulanovi*) known from Russia. Here I review the Middle Permian record of gorgonopsians based on new material and new imaging of the holotypes. The first named Middle Permian gorgonopsian, *Eriphostoma microdon*, has generally been considered a nomen dubium and most workers have expressed doubts as to its identification as a gorgonopsian. Based on new, high resolution CT scans, I demonstrate that *Eriphostoma* is a valid, diagnosable gorgonopsian taxon with elongate delta-shaped palatine bosses similar to the condition in *Gorgonops*. The majority of other nominal Middle Permian gorgonopsians from the Karoo are very similar to *Eriphostoma* and probably synonymous with it. *Eriphostoma*-like early gorgonopsians are also known from the latest Middle Permian *Pristerognathus* AZ, and the diversification of gorgonopsians as major predators did not occur until the Late Permian, after the extinction of large, predatory basal therocephalians. The Russian *Kamagorgon* is a diagnosable taxon but exhibits no gorgonopsian synapomorphies and should provisionally be considered basal Therapsida incertae sedis.

Technical Session XVII (Saturday, November 5, 3:45 pm)

FUNCTIONAL MORPHOLOGY AND EVOLUTION OF LOCKING MECHANISM IN THE SHOULDER OF RHINOCEROTID PERISSODACTYLS

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We observed the presence of a prominent intermediate tubercle (INT) on the proximal humerus of some extinct rhinos, suggesting a shoulder locking mechanism similar to horses. In living horses a large INT serves to trap the ossified proximal tendon of the biceps brachii, preventing shoulder flexion, allowing prolonged standing with minimal muscular effort. We recorded 3D landmark data on the proximal humeri of living and extinct rhinocerotoids and other perissodactyls and compared them to horses. We observed an INT in some amynodontids and some rhinocerotids, but this structure was absent in hyracodontids, tapiroids, chalicotheriids, and brontotheriids. However, principal components analysis indicates that in most species in which the INT is found, this structure is shallower and broader than the INT of *Equus*, and most lacked a prominent anterodistal transverse ridge that serves to trap the biceps tendon. Only in a few extinct Miocene rhinos, including *Paraceras*, *Aphelops*, *Chilotherium*, and *Teleoceras*, was a well-developed INT consistent with that of *Equus* observed. Dissection of the shoulder of an extant rhino, *Dicerorhinus*, confirms that the bone-soft tissue relationships in the shoulder of rhinos are consistent with horses, indicating that the enlarged INT in these extinct rhinos could have served a similar role in locking the shoulder.

Optimization of the INT character onto a rhino cladogram suggests that this trait evolved multiple times, however the extent of homoplasy is contingent upon which published phylogeny is used. Although an osteological shoulder lock is not present in living rhinos, *Diceros* and *Ceratotherium* retain a small, broad INT like that of earlier rhinos. This condition appears to be insufficiently developed to function as a lock; however, it serves to displace the proximal biceps tendon anteriorly, giving the muscle greater mechanical advantage in extending the shoulder joint and preventing flexion during standing. We suggest that increased mechanical advantage of the biceps is the initial functional role of the INT, and the structure was later co-opted as part of a locking mechanism complex in smaller subsets of rhinos and horses.

Poster Session I (Wednesday, November 2)

GISWEAR: 3D AND GIS DIET ANALYSIS METHOD FOR BUNODONT OMNIVORE GROUPS SUINA AND HOMINIDAE

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The method presented here, GISWear, uses automated three-dimensional surface scanning and GIS (Geographic Information Systems) methods for occlusal surface analyses in order to perform quantitative and objective diet analysis. GISWear uses characters similar to traditional mesowear but in three dimensions by looking at the sharpness and relief of the whole occlusal surface, resulting from both attrition and abrasion. GISWear is introduced to extract dietary information from animals with bunodont tooth form. Suoids (pigs and peccaries) and hominids (great apes) were the main groups analysed. Dietary categories were classified within the omnivore group to distinguish the tendency to favour certain foods.

The material examined consists of extant and extinct species. Recent species were used to generate a method and palaeo-species were then classified to diet categories using the generated method. The factors used were mean slope and surface sharpness (proportion of steep parts on the tooth surface). A decision tree was selected as the analytical tool. It divides large groups into smaller subgroups with absolute values. These groups are defined by their diet classification. Decision trees were made both manually and automatically.

The manual decision tree divided specimens into four groups using mean slope. This is the same number of groups that mesowear has, even though the diet categories are not the same. The automated decision tree divided specimens into eight groups using mean slope and surface sharpness. GISWear is ready to use for independently acquired 3D dental data by simple conditional sentences with two clear factors: relief and sharpness.

Technical Session VIII (Thursday, November 3, 2:15 pm)

JOINT PATTERNING AND THE EVOLUTION OF SIZE PROPORTIONS IN FINGERS AND TOES

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Phalanges (finger and toe bones) originate from a single condensation that grows and segments sequentially along each digit, repeatedly deploying the same activator-inhibitor gene networks as each element is formed and each joint is initiated in sequence. In our model of this patterning, the size of each phalanx depends on the size of the proximal adjacent phalanges. Experimental evidence from chick embryos supports the model of dependence and further suggests that variation in timing is an important mechanism producing variation in initial condensation size for a given phalanx. Comparative analyses show that, across many vertebrate lineages, there is a predictable suite of variations in phalanx size proportions that have arisen multiple independent times in evolution. Our studies support the idea that non-ungual pedal phalanges are integrated and act as a developmental module whose variations are biased toward certain patterns; these biases are reflected in evolutionary patterns in all vertebrate groups across both shallow and deep evolutionary time.

Poster Session III (Friday, November 4)

ALLOMETRIC MORPHOLOGICAL CHANGES IN THE AVIAN BRAIN

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Many allometric relationships have been found in the bodies of vertebrates. No allometric work concerning brain morphology, however, has been done. As the brain is a part of a vertebrate's body, the allometric relationship between brain morphology and brain size should be investigated. In this study, avian brain endocasts, which were reconstructed from CT images, were analyzed using three dimensional geometric morphometrics and the morphological changes relative to brain size were detected by two-block partial least squares method. In the principal component analysis, the first component of brain morphological change correlated with the degree of extension of the cerebrum, and the second correlated with the degree of brain flexure. The results of two-block partial least square showed that the larger the brain size, the greater the brain posture in relation to the lateral semicircular canal becomes, and

brain flexure angle decreases. This feature was verified by the linear measuring method. It was found that the brain of *Archaeopteryx* had a relatively extended and anteverted posture in relation to its brain size, measured by the linear measuring method. A residual of any particular animal from the regression line of allometric morphological size change presumably reflects its relative eye size in relation to brain size. Therefore, it is considered that *Archaeopteryx* had small eyes relative to its brain size. It is known that there are various associations between eye size compared to brain size and the behavior of Aves. The small eyes of *Archaeopteryx* might relate to its behavioral patterns, such as its technique for capturing prey, or the degree to which it was nocturnal.

Technical Session X (Friday, November 4, 11:15 am)

DIETARY RECONSTRUCTION OF *ANTILLOTHRIX BERNENSIS*, A HOLOCENE MONKEY FROM THE DOMINICAN REPUBLIC

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In 2009, a team from Indiana University recovered a cranium of the extinct primate *Antillothrix bernensis* in southeastern Hispaniola from the Padre Nuestro cavern. A mandible was recovered in 2010. Here we analyze the dentition and skull to reconstruct its dietary adaptations. Padre Nuestro is a 'drowned' cavern now at water depths of ~10 meters, but the floor was dry when fossils were emplaced, as indicated by the presence of flowstones that formed in dry conditions. We recovered >1600 bones from the floor, including endemic Antillean solenodontid insectivorans, cavioid rodents and ground sloths, and a variety of lower vertebrates. Bone collagen is not preserved, preventing direct radiometric age determination of the vertebrates. The co-occurrence of a pre-ceramic 'Casimiroid' stone tool assemblage intermixed with the bones suggests a mid-Holocene age.

Antillothrix was about the size of a female *Cebus* monkey (~2.5 kg). The cranium is robust, with strongly sculpted temporalis origins (although not a sagittal crest) and an exceptionally broad zygomatic arch with rugose markings for the masseter. The postglenoid process is extremely large. The mandibular corpus is broad in the molar region; it is shallow anteriorly but deepens posteriorly.

Root sockets suggest that the upper incisor crowns were broad, a morphology that resembles extant soft-fruit and hard-object feeders that emphasize incisal processing. Weakly developed shearing crests on the upper molars of the Padre Nuestro specimen, other aspects of molar structure, large incisors and overall robusticity of the masticatory apparatus, suggest a diet of palm nuts or other hard objects, or, less likely, soft fruit. Significant consumption of leaves or other high fiber foods is unlikely. Lower molar wear evinces low anisotropy of a Phase II wear facet; wear inconsistent with a diet of leaves. Low surface complexity suggests little brittle food crushing. MIcrowear suggests a diet of soft fruit in the days before death, perhaps similar to that of *Cebus apella*, a seasonal hard object feeder.

Poster Session II (Thursday, November 3)

FLESHING OUT A FOSSIL FIND

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Using *Eodromaeus murphi* as an example, the careful planning and use of a variety of disparate materials and techniques necessary to sculpt a life reconstruction are demonstrated. Establishing a pose for the armature, and then a plan for how to mold the completed sculpture, should proceed hand in hand before modelling begins. To avoid silicone mold inhibition, the model should be sculpted with sulpher-free plasticene clay. A stock or custom glass eye can be ordered after establishing a proper diameter, based upon the orbital opening of the skull. Photographic reference of varied extant taxa should be used to authentically detail the form, and inspire the coloration. Intrinsic tinting of resin pre-paints the cast model with a scratch-proof base coat. In this example of a basal theropod, a flocking gun can be used to apply simple hair-like protofeathers. Cast dental acrylic teeth effectively mimic enamel. A moist appearance for the mouth can be achieved with a glossy acrylic spray, while the skin might be dulled with a matte clear coat, especially to avoid hot-spots during photography.

Poster Session I (Wednesday, November 2)

HOLOCENE LOSS OF LAGOMORPH SPECIES RICHNESS IN THE GREAT BASIN OF NORTH AMERICA

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We are only beginning to understand what impact modern rates of climate change will have on the biodiversity and ranges of extant biota. Nevertheless, analyses of faunal responses to previous climatic events can inform how species will react to future environmental alterations. The Great Basin of western North America plays host to one of the world's most important Neogene small mammal deposits, rendering it an optimal system in which to study how species richness is affected by climate change. The geographic range and diversity of these small mammals were impacted as the Great Basin became drier and warmer since the Late Pleistocene. Here, we use a fossil assemblage to evaluate species richness from the Late Pleistocene to the Late Holocene. We focus on seven species in the order Lagomorpha that are still found in the Great Basin today. Our analyses of multiple paleontological sites within the Great Basin shows a general decrease in species richness throughout the Holocene, with more rare species in the assemblages of Late Holocene communities than in earlier ones. This notion of range contraction is concordant with modern geographic data for Great Basin lagomorphs, two of which are a conservation concern. The pertinence of this result is underscored by the expectation that the western United States will continue to increase in temperature at an even greater rate than the global mean temperature will increase.

Poster Session IV (Saturday, November 5)

AN ANALYSIS OF THE HERPETOFAUNA FROM THE PINDAÏ CAVES OF NEW CALEDONIA: AN EXAMPLE OF HUMAN-INDUCED EXTINCTION IN THE LATE QUATERNARY SOUTH PACIFIC?

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Excavations in the Pindaï Caves of New Caledonia, a large island in the South Pacific, have yielded a fossil assemblage rich in squamate remains. The fossiliferous deposits at Pindaï Caves are restricted to six caves along the northwest coast of the Grand Terre. The fossils examined in this study are from four of the caves and are derived from degraded Barn Owl (*Tyto alba*) pellets. Radiocarbon dating suggests dates of 1370 to 5590 YBP spanning the deposits. As humans are thought to have reached New Caledonia about 2800 YBP, this assemblage provides a unique opportunity to examine the effect human arrival had on the herpetofauna of New Caledonia. Approximately 25,000 squamate fossils, comprising chiefly maxillae, premaxillae, prefrontals, frontals, parietals, quadrates, dentaries, surangulars, and vertebrae have been recovered from Pindaï to date. All are attributable to Gekkota and Scincidae, with the diplodactylid gecko species *Bavayia* cf. *cyclura* and *Rhacodactylus trachyrhynchus* most common. Similar to the New Caledonian avifauna, which experienced elevated extinction rates upon the arrival of humans, the Pindaï fossil herpetofauna includes at least one extinct species. Additionally, *R. trachyrhynchus* is rare in the region today, being known from only a single recent specimen, and gekkonid geckos, which are widespread in coastal New Caledonia today, are lacking in our samples. Gekkonids may have been introduced as recently as 235 years ago with the arrival of Europeans, but the arrival of Melanesians nearly 3000 years ago may have precipitated ecological changes that changed patterns of lizard abundance if not species composition.

Technical Session XVI (Saturday, November 5, 10:30 am)

INFERRING AGE AND BIOGEOGRAPHIC RELATIONSHIPS FROM A VERTEBRATE FOSSIL ASSEMBLAGE: NEW METHODOLOGIES FOR JBEL TSELFAT (UPPER CRETACEOUS, MOROCCO)

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Marine fossil vertebrate faunas are usually unsuitable to date a locality. The age of Jbel Tselfat, a North-Moroccan marine locality, is debated between Early and Late Cenomanian by numerous authors. The fossiliferous layers appear as isolated outcrops on a thrust sheet, precluding the description of a stratigraphic sequence. Analyses of rock samples collected in 2008 did not permit to identify microfossils or other stratigraphic markers. The biogeographic relationships of this locality with other Upper Cretaceous sites have never been tested with a phylogenetic approach.

Here, two analyses are attempted. The first one is designed to date Jbel Tselfat, with a comparative approach including several Upper Creataceous ichthyofaunas. Species-level is used to maximise taxonomic and stratigraphic precision. Thus, if two localities share the same species, they are considered to belong to the same area of endemism or to closely related, vicariated areas. In both cases, their age is identical or very similar. The absence of shared taxa is considered uninformative.

The fauna of 18 localities is listed and only the Italian localities of Cinto Euganeo and Floresta, and in a less degree the Mexican locality of Vallecillo, share species with Jbel Tselfat. The age of these localities is close to the Cenomanian-Turonian boundary. Geochemical analyses and thin section observation confirm this age for the Jbel Tselfat, by correlation with the Anoxic Oceanic Event 2.

The second analysis consists on a biogeographic cladistic analysis. Data issued from phylogenetic relationships and geographic distributions are cross-combined: relationships among areas of endemism are inferred from phylogenetic relationships of taxa. The analysis is based on LisBeth, a new program using three-item analysis. Results indicate close relationships between Lebanese localities (Hakel, Hajoula, Namoura) and Moroccan and Italian localities (Floresta, Cinto Euganeo, Jbel Tselfat). These two assemblages are close to the Croatian site of Hvar. This result emphasizes the influence of paleoenvironements in biogeographic reconstructions, reminding the issue of diachronism.

Poster Session I (Wednesday, November 2)

ECOLOGY AND EVOLUTION OF COSMOPOLITODUS HASTALIS AND CARCHARODON CARCHARIAS

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The ability of the modern white shark, *Carcharodon carcharias*, to regulate its body temperature allows it to exploit a wide range of habitats and food sources that are not available to most other chondrichthyans. Fossils from the Pisco Formation (Fm.) of Peru record a

transition from *Cosmopolitodus hastalis* and an unnamed *Carcharodon* species to the modern *C. carcharias* during the mid-Miocene to early Pliocene. Tooth morphology suggests these two earlier species were piscivorous, whereas fossil teeth from *C. carcharias* exhibit attributes consistent with the ability to hunt marine mammals. To better understand potential ecological differences that may have influenced this dietary and evolutionary shift, fossils from these three species were selected for biogeochemical analysis. Oxygen isotopes from enamel phosphate were analyzed from the three shark species throughout the 5 vertebrate fossil containing layers in the Pisco Fm. Previous studies have found that oxygen isotopes in bioapatite form in equilibrium with body water at body temperature, which is similar to ambient water temperature in invertebrates and ectothermic vertebrates. Comparison between the mean values and standard deviations of the *C. hastalis* and *C. n. sp.* teeth illustrated a small shift in mean oxygen isotope values, but a large reduction in standard deviation suggesting that habitat preferences or environmental conditions did not dramatically change during this transition. Finally, *C. carcharias* teeth had higher oxygen isotope values, which indicate colder water temperatures and potentially a habitat expansion with the evolution of partial endothermy.

Poster Session II (Thursday, November 3)

EFFECT OF THE GENETIC BOTTLENECK ON THE SEXUAL DIMORPHISM OF THE BLACK FOOTED FERRET (MUSTELA NIGRIPES)

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Sexual dimorphism is common in mammals, particularly within the Mustelidae. However, few studies have focused on the exact details of those differences. Therefore, we sought to characterize sexual dimorphism in the crania of *Mustela nigripes* (the black-footed ferret) through the use of geometric morphometrics. Similar analyses conducted on mammals and reptiles have proven to be useful in understanding shape change within and between species. Since *M. nigripes* underwent a genetic bottle neck throughout the 20th century, culminating in its near extinction in the 1980s, we further sought to characterize what effect this genetic reduction has had on the dimorphism of the species. Landmarks were placed on the skull in dorsal, ventral, and lateral views, and were selected based on ease of replication or their known association with dimorphism. For example, some landmarks captured the shape of the canine, carnassial, and sagittal crest. Landmarks were then analyzed statistically, as well as through thin plate splines. Principal component analysis revealed a clustering of individuals bred after the bottleneck, while those born before spanned the entire plot. A stepwise discriminant analysis was also used to determine which landmarks best represented the changes occurring between sexes, as well as those before and after the bottleneck. In lateral view no landmarks best explained the change in either sex or from the bottleneck. Those landmarks with the greatest differences in dorsal view represented changes in the rostrum and zygomatic arch length. Ventral view indicated similar changes. The majority of differences between the sexes were observed in the lateral spline with dorsal rotation of the rostrum and lengthening of the sagittal crest in males. The dorsal and ventral splines of post-bottleneck males revealed shortening of the sagittal crest, postorbital widening of the skull, and shortening of the P4. Post-bottleneck females underwent a shortening of the sagittal crest, shifting of the P4, and lengthening of the braincase in dorsal and ventral views. Overall, it is apparent that the genetic bottleneck had profound effects on the sexual dimorphism of *M. nigripes*.

Poster Session II (Thursday, November 3)

SHARK COPROLITES AS PALEOENVIRONMENTAL AND PALEOECOLOGICAL INDICATORS AT THE ARLINGTON ARCHOSAUR SITE, WOODBINE FORMATION (CENOMANIAN), NORTH CENTRAL TEXAS

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The Arlington Archosaur Site (AAS) is a North Texas fossil locality that preserves fossil elements of a Mid–Cretaceous ecosystem from a low lying coastal plain. The site lies within the Cenomanian (~95 Ma) rocks of the Lewisville Member of the Woodbine Formation of North Texas, Tarrant County. The depositional environment is a coastal delta plain; fine grained sediments, some of which are rich with organic material; wood and coal transitioning into coastal shelf environment, possibly a brackish tidal flat. This project reports the unique occurrence of an abundance of coprolites found in the Woodbine Formation and uses them as ecological indicators of transitional environments from a coastal peninsula that jutted out into the southeastern interior seaway. The coprolites here are being used to denote environmental fluctuation and possible ecological interactions. A collection of (140+) coprolites have been recovered from the AAS. The shark coprolites demonstrate variable morphologies suggestive of multiple taxa. The morphologies of the specimens are cylindrical, spiral and scroll. The cylindrical coprolites are interpreted as crocodilian intestinal tract material, based on size, morphology and content. The spiral specimens have a pronounced external spiral that coils to the end: isopolar and amphipolar. Both the scroll and spiral coprolites are indicative of sharks. Many researchers refer to two basic types of valves: spiral and scroll. However, there are some that split the more primitive valve into the ring valve and the spiral valve and for this research were grouped together as spiral. The spiral valve shape is found primarily in the Lamnidae. The scroll valve resembles a loose roll of paper and is considered more advanced. It is found primarily in the Carcharhinidae, but there are some carcharhinids that have a spiral valve. The specimens recovered to date are preserved intact, not flattened, or deformed and retain the original shape. This is indicative of rapid burial in a low energy environment, immediately after defecation and close to the bottom of the depositional environment. This will be the most decisive analysis of Woodbine coprolites to date.

Poster Session I (Wednesday, November 2)

ISOTOPIC EVIDENCE OF PALEOENVIRONMENTS AND NICHE PARTITIONING OF EARLY MIOCENE FOSSIL FAUNA FROM NAPAK AND MOROTO, UGANDA

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Early Miocene fossil fauna from sites along the flanks of the extinct Moroto (>20.6 Ma) and Napak (~20 Ma) volcanoes in Uganda document the early stages of a transition to modern East African faunal communities, including the evolution and diversification of catarrhines. Ongoing research at these sites includes characterizing the environmental context of taxonomic shifts. Isotopic analyses of bulk C and O isotopes of herbivore enamel from 130 specimens of variable taxa from multiple sites were used to constrain dietary patterns and by inference paleovegetation physiognomy. The general goal was to target taxa well represented in assemblages from most sites (including suiformes, pecorans, rhinoceros, proboscideans, and anthracotheres) to examine dietary changes spatially and temporally in the sequences. Despite the fact that the paleohabitats were dominated by C3 vegetation, isotopic signatures of fossil taxa reveal highly variable and complex foraging patterns suggesting habitat heterogeneity. The data provide an opportunity to explore potential ecological differences associated with the developing volcanic edifices, and the basis for differential faunal representation at various sites. Overall, the C isotopic dietary signatures of enamel range from -6permil to -14permil, indicating relatively open forest ecosystems at some sites, especially those associated with early stages of volcanism, and are unlike dietary values documented in modern closed canopy habitats. Although O isotopic profiles overlap those of other Miocene/Pliocene fossil sites and modern values, the enamel signatures at Napak and Moroto tend to be more depleted, perhaps indicating different regional climatic regimes with varying moisture sources/isotopic values or reduced local evapotranspiration. Ultimately, characterizing isotopic variability in fossil herbivore enamel, reflecting environmental factors such as canopy effect, relative evapotranspiration, and water stress (as well as varied foraging behavior of taxa), will provide a means of correlating ecological variability and change with taxonomic variability and change over time and space.

Poster Session IV (Saturday, November 5)

***MESCALEROLEMUR HORNERI*: A NEW ADAPIFORM PRIMATE FROM THE MIDDLE EOCENE OF WEST TEXAS**

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In 1973, the adapiform primate *Mahgarita stevensi* was discovered at the Duchesnean (latest middle Eocene) Teepee Canyon locality in the Devil's Graveyard Formation of West Texas. Subsequent phylogenetic analyses revealed that *Mahgarita* is more closely related to Eurasian and African adapiforms than to other North American adapiforms. Since 2005, renewed collecting of vertebrate fossils in the Devil's Graveyard Formation has yielded additional primate fossils from the late Uintan (late middle Eocene) Purple Bench locality. The Purple Bench primate community includes two omomyiforms, *Diablomomys* and *Mytonius*, and a new adapiform: *Mescalerolemur horneri*. *Mescalerolemur* is currently known from a partial palate, several partial mandibles, and several isolated teeth. Regressions of mandibular first molar area on body mass for living primates suggest that *Mescalerolemur* was a relatively small adapiform with a body mass of about 370 g. This estimate is smaller than the body masses reconstructed for *Diablomomys* (440 g), *Mytonius* (870 g), and *Mahgarita* (700 g). Comparisons of dental anatomy demonstrate that *Mescalerolemur* and *Mahgarita* share a number of derived features, including loss of the first premolars, extreme reduction of the second premolars, and crowding of the antemolar dentition. Both genera also share a unique configuration of the mandibular and maxillary fourth premolar crowns that distinguish them from all other known adapiform taxa. A parsimony analysis of 360 dental characters demonstrates that *Mescalerolemur* and *Mahgarita* are closely related sister taxa that are more closely related to Eurasian and African adapiforms than to North American notharctines. The presence of both genera in the Big Bend region of Texas after notharctines had become locally extinct provides further evidence of faunal interchange between North America and East Asia during the middle Eocene. The fact that *Mescalerolemur* and *Mahgarita* are both unknown outside of Texas also supports prior hypotheses that low-latitude faunal assemblages in North America demonstrate increased endemism by the late middle Eocene.

Poster Session I (Wednesday, November 2)

NEW THEROPOD CRANIAL MATERIAL FROM THE YELLOW CAT MEMBER, CEDAR MOUNTAIN FORMATION (BARREMIAN-BASAL APTIAN, CRETACEOUS), STIKES QUARRY, NORTH OF ARCHES NATIONAL PARK, EAST-CENTRAL UTAH

KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA; LOEWEN, Mark, Utah Museum of Natural History, Salt Lake City, UT, USA; DEBLIEUX, Donald, Utah Geological Survey, Salt Lake City, UT, USA; MADSEN, Scott, Utah Geological Survey, Salt Lake City, UT, USA; CHOINIERE, Jonah, American Museum of Natural History, New York, NY, USA

The Stikes Quarry is a dense and intertwining accumulation of well-preserved bones in a 1-m-thick lenticular bonebed that is at least 10 m wide. At least two associated iguanadont skeletons at the top of the bonebed overlie a small theropod, first identified during initial excavation in 2004. Salvage of disrupted blocks following a massive rock fall revealed portions of a larger theropod with significant skull material. Comparison of overlapping material (surangular, premaxillary tooth, and astragalus) suggests this specimen may represent the coeval *Utahraptor*.

The small and large dentaries preserve procumbent anterior teeth and a ventrally positioned lingual groove. The small jaw's teeth, lack serrations and only the first of the large jaw's teeth preserve weak serrations. The thickened and inclined symphasis of the large left dentary is flattened anterioventrally with six well-developed foramina that extend back below the third alveolus. The surangular is much like *Dromaeosaurus,* though much larger. Both serrated carina of an isolated premaxillary tooth twist counter clockwise toward its apex as in *Utahraptor* and *Dromaeosaurus*.

The autapomorphic braincase is nearly complete from basal tubera forward to the frontals. The occipital region is dorsally directed, with a kidney-shaped occipital condyle, and pendant, dorsoventrally deep basitubera and paroccipital processes. The dorsal part of the occipital region is dominated by a hypertrophied nuchal crest and a large dorsal process of the supraoccipital. Anterior to the nuchal crest the tall sagittal crest is formed of a narrow skull table that becomes blade-like at a distinct pyramidal peak at the midline of the frontoparietal suture. The frontals overlie a large olfactory bulb.

Further excavation will confirm the affinity of this cranial material. If the larger theropod bones belong to *Utahraptor*, they will add many important characters to better resolve the phylogenetic relationships of this poorly known genus.

Poster Session I (Wednesday, November 2)

THE LATE CARBONIFEROUS TETRAPOD *GEPHYROSTEGUS BOHEMICUS*: THE ANATOMY OF THE SKULL AND RELATIONSHIPS

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Gephyrostegus bohemicus is a small terrestrial tetrapod known from the Late Carboniferous coal deposits of the Nyány Basin in the Czech Republic. *Gephyrostegus bohemicus*, together with *Bruktererpeton fiebigi* from the Late Carboniferous deposits of Germany, compose the family Gephyrostegidae. *Gephyrostegus bohemicus* is known from several skulls representing various growth stages. The length of the smallest skull is about 25 mm. The length of the largest, holotypic skull is about 56 mm. The skull is narrow, elongate and about twice as long as wide. The orbits lie at about mid-length of the skull, are of oval shape and face dorsolaterally. The sensory grooves are absent. The steep cheeks form an angle of about 60° with the skull table. The jaw joint lies slightly posterior to the posterolateral corner of the skull table. The quadrate and articular are ossified. The braincase is not well ossified. There are 2 tusks on the vomer, 2 tusks on the palatine and 2 tusks on the ectopterygoid. The medial surface of the lower jaw bears two Meckelian fenestrae. The marginal teeth are conical, pointed and slightly curved posteriorly; their bases do not bear distinct dorsoventral grooves indicating the infolding of the dentine. *Gephyrostegus bohemicus* exhibits two autapomorphic features: 1) presence of the pustular ornamentation on skull table bones; and 2) presence of the plate-like tabular process bearing small pits on its dorsal surface. *Gephyrostegus bohemicus* shares with *B. fiebigi* a series of low and sharp ridges coursing in anteromedial-posterolateral direction on the posteroventral surface of the vomer. *Gephyrostegus bohemicus* shares with seymouriamorphs the transverse process of the pterygoid and the densely arranged rows of small denticles radiating on the ventral surface of the palate. The phylogenetic analysis shows that *Gephyrostegus* plus *Bruktererpeton* are sister taxa and lie immediately basal to Seymouriamorpha. The bootstrap analysis shows that the node uniting *Gephyrostegus* plus *Bruktererpeton* and all seymouriamorphs is slightly less supported than the bootstrap value uniting all seymouriamorphs.

Poster Session II (Thursday, November 3)

NODE AGE ESTIMATIONS AND THE ORIGIN OF ANGEL SHARKS, SQUATINIFORMES (NEOSELACHII, SQUALOMORPHII)

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Extant angel sharks represent a peculiar group of moderately body-sized sharks with enlarged pectoral fins resembling superficially rays. They are characterized by a combination of plesiomorphic and derived features, which are supposedly related to their highly adapted bottom-dwelling mode of life. Extant angel sharks are placed in a single genus, *Squatina*, including 22 species, which are distributed worldwide in temperate to tropical seas. So far, 34 fossil species mostly based on isolated teeth have been described. Nevertheless, their evolutionary history remains incompletely known despite all progress accomplished in the last years. This mainly is related to the nature of their fossil record, where holomorphic specimens or identifiable skeletal remains are rare or have not been considered in detail up to now. However, the squatiniform fossil record does not consist entirely of isolated teeth, but includes several holomorphic and skeletal remains from different stratigraphic ages throughout their evolutionary history. With this knowledge it is possible to provide origin and diversification estimates for different clades and to reduce gaps in the fossil record. Using reliable skeletal remains and a modified approach we establish the origin and divergence of Squatiniformes and Squatinidae. While the Late Jurassic *Pseudorhina* is member of the stem of Squatiniformes, the Squatinidae represents the crown with a fossil record extending back at least into the Aptian. Isolated teeth were omitted from this study because they are considered to be unreliable according to the poor knowledge of squatiniform dental character traits and their evolution. We estimate a "hard" minimum age constraint of 156.2 Ma and a "soft" maximum age constraint of 181.74 Ma for the origin of Squatiniformes. For the crown represented by Squatinidae, we estimate a "hard" minimum age constraint of 114 Ma and a "soft" maximum age constraint of 157.59 Ma. These age constraints most likely designate the timing of the origin of identifiable squatiniform and squatinid characters as currently understood rather than the origin of Squatiniformes or the divergence between the stem and the crown.

Romer Prize/Technical Session 5 (Thursday, November 3, 8:15 am)

THE BIOSTRATINOMY OF FOSSIL FRESHWATER TURTLE SHELLS IN FLUVIAL DEPOSITS INTEGRATING ACTUALISTIC EXPERIMENTATION

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Biostratinomy, the transport, deposition, and burial of an organism's remains, is an essential component of vertebrate paleontology as it determines which skeletal elements have an opportunity to fossilize. Of all vertebrate fossils, freshwater turtles are particularly common in terrestrial deposits of fluvial origin. Frequently, these turtle specimens are found complete, or the entire turtle shell is recovered intact with little or no additional skeletal material, such as those commonly found in the Kaiparowits Formation (Campanian) of southern Utah. However, some varieties of turtles are frequently found with better preservation than other varieties. It is hypothesized that this difference in preservation is due to differences in the morphology of the turtle shell. To test this hypothesis, actualistic experiments were conducted to compare the shell morphology and biostratinomy of various extant turtles to identify patterns that would lead to preferential preservation. Several extant turtle shells of different sizes and shapes were each placed within a laboratory flume to observe the transport and deposition of the shell at a chosen water depth and flow velocity to simulate fluvial processes. Differences in the mode and distance of movement were observed between the different shell morphologies during numerous recorded trials. The resulting data demonstrates a clear link between shell profile, shell transportability, and speed of burial. Lower shell profiles are prone to rapid burial with little transport while higher shell profiles are transported more easily and prone to breakage due to longer burial times. These experiments suggest that intact turtle shells with lower profiles should be buried more easily, and therefore, be more common in fluvial deposits. Turtle shells with higher profiles should be preserved more frequently as fragments in fluvial deposits due to increased damage caused by transport and long exposure prior to burial. In support of these results, nearly all of the intact fossil turtle shells collected from the Kaiparowits Formation have a low profile, while turtles with higher profiles are commonly represented by fragments.

Poster Session II (Thursday, November 3)

THE BRAINCASE OF THE BASAL SAUROPOD DINOSAUR *SPINOPHOROSAURUS* AND A CT-BASED ANALYSIS OF THE BRAIN AND OTIC REGIONS

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In 2006, a well-preserved sauropod skeleton was found in Middle Jurassic deposits ("Argiles de l'Irhazer") in Niger (Agadez region). The specimen clearly proved to represent a new species, which was named *Spinophorosaurus nigerensis*. The holotype braincase, although incomplete, is otherwise well preserved. It differs significantly from the braincases of the Late Jurassic sauropods from the Tendaguru Formation (Tanzania), which are all neosauropods, either diplocodoids or macronarians. Among the other few braincases of African Jurassic sauropods found to date, the only one to share noteworthy character-states with the braincase of *Spinophorosaurus* is *Atlasaurus imelakei*, which may be phylogenetically close to another

Nigerian basal sauropod, *Jobaria tiguidensis*. For example, the basisphenoid of *Spinophorosaurus* and *Atlasaurus* bears basipterygoid processes that are elongate and strongly swept caudally. The *Spinophorosaurus* braincase was CT scanned, and 3D renderings of the brain endocast and inner ear were generated. The endocast resembles that of most other sauropods in having well-marked pontine and cerebral flexures (about 45°) and a large and oblong pituitary fossa. It is primitive in having the brain structure obscured by the former existence of relatively thick meninges. Caudodorsal to the brain region is a mushroom-shaped dural expansion that opens dorsally at the postparietal fontanel. This latter attribute is sometimes regarded as a feature of diplodocoids, but is also found in some basal sauropodomorphs. The configuration of the labyrinth is also primitive in having, in particular, the semicircular canals long and proportionally slender rather than being short and thick as in most neosauropods. This condition is strikingly different from that in *Camarasaurus*, for instance, and is more reminiscent of that of the basal sauropodomorph *Massospondylus*. Therefore, the paleoneuroanatomy of *Spinophorosaurus* provides an important transitional morphology between that of basal sauropodomorphs and more advanced sauropods, which is concordant with previous assessments based largely on the postcranial skeleton.

Poster Session IV (Saturday, November 5)

PARENTAL CARE IN A CRETACEOUS CHORISTODERAN DIAPSID

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Parental care has evolved numerous times in vertebrates. Among extant amniotes, it is present in some squamates, crocodilians, birds, and mammals. However, evidence of this behavior is extremely rare in the fossil record, especially in pre-Cretaceous ornithischian dinosaurs (*Psittacosaurus*, *Oryctodromeus*, and *Maiasaura*) and a varanopid pelycosaur. Intensive parental care is known in modern archosaurs (crocodiles and birds), and it has been argued that parental care is a homologous character of this group. Here we report new evidence of maternal care in an Early Cretaceous diapsid, the monjurosuchid choristoderan *Monjurosuchus*, from the Yixian Formation of China. This taxon belongs to the Jehol Biota, known for its highly diversified fossil record including the major clades of Lower Cretaceous terrestrial and freshwater vertebrates. The sample contains seven individuals of *Monjurosuchus* (one adult and six juveniles). All juveniles are in contact, or near contact, with the adult and are of essentially identical size (one-fourth of the adult in length), indicating that they belong to one family unit and that the juveniles remained in the vicinity of the adult to receive care. The sacral ribs of the adult are not fused to the sacral proximally or to the ilia distally, so that the pelvis is mobile as in the female *Keichousaurus hui*, implying that the adult of *Monjurosuchus* is also female. This is the oldest record in non-dinosaurian/crocodilian diapsids with evidence of parental care and supports maternal care as an ancestral condition in archosaurs. The viviparity of the choristoderan *Hyphalosaurus*, closely related to *Monjurosuchus* from the same rock unit, and the parental care of *Monjurosuchus* suggest that the choristderes, at least in the Jehol Biota, may have had both viviparity and parental care to maximize their survival rates, which is probably because the young were exposed to great stress by predators such as other aquatic animals, dinosaurs, and birds in and out of the water.

Technical Session VII (Thursday, November 3, 4:00 pm)

STABLE ISOTOPE RECORD OF MIDDLE EOCENE TO EARLY MIOCENE CLIMATE, GRAN BARRANCA, SOUTHERN ARGENTINA

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Gran Barranca, in southern Argentina, exposes one of the most complete and paleontologically important sections of middle Eocene (41 Ma; Barrancan) to early Miocene (19 Ma; Colhuehuapian) terrestrial strata in South America. Fossil tooth enamel and bone were collected from approximately 75 horizons through the section and analyzed for C- and O-isotope ratios of the carbonate component. Oxygen isotope compositions are consistent with previous isotopic studies of the phosphate component and show amplified parallel changes to the benthic marine record: a ~1‰ increase during middle Eocene to earliest Oligocene global cooling, a ~2‰ decrease during late Oligocene warming, and a ~1‰ increase during early Miocene cooling. Carbon isotope compositions show a consistent gradual decrease of ~1‰ through the section. The oxgen isotope record is inconsistent with expected temperature-induced shifts to precipitation compositions, and instead could reflect either changes to aridity or water sources, e.g. variations in the intensity of an Andean rainshadow. The carbon isotope record, however, suggests a long-term increase in mean annual precipitation from c. 700±350 mm/yr to c. 1100±550 mm/yr between the middle Eocene and early Miocene. An early Miocene increase in open habitat grasses does not appear to reflect decreased mean annual precipitation, and may instead reflect increased precipitation seasonality. Similarly, increases in hypsodonty in the late Eocene and late Oligocene do not obviously correlate with isotopic indicators of aridity. Thus, changes to floral ecosystems and tooth morphology may reflect drivers other than mean annual temperature or precipitation.

Symposium 3 (Thursday, November 3, 9:30 am)

TWO NEW SPECIMENS OF AN ENIGMATIC MOSASAUR (SQUAMATA) *PROGNATHODON OVERTONI* FROM THE UPPER CAMPANIAN OF SOUTHERN ALBERTA, CANADA WITH GUT CONTENTS

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Currently known from the early Campanian to late Maastrichtian (Late Cretaceous), *Prognathodon* constitutes a group of mosasaurine mosasaurs that typically possessed massively-built jaws with robust teeth. Despite their robust nature, only a few articulated skulls are known to date and the information concerning their postcrania is minimal. Moreover, Campanian specimens of *Prognathodon* are extremely rare and generally incomplete. Two new specimens of *Prognathodon overtoni* from the early late Campanian (ca. 74.5 Ma) Bearpaw Formation exposed near Welling, southern Alberta, Canada, provide the first fully articulated skeletons of the genus and provide new insights into the evolutionary history and paleoecology of the genus. Detailed morphological assessment of these and referred materials indicates that many cranial characters are shared between *P. overtoni* and the generic type *P. solvayi* from the early Maastrichtian of Belgium, including: (1) premaxillary-maxillary suture short; (2) frontal table short and triangular, lacking narial embayment; (3) frontal posteromedian flanges short and widely separated; (4) coronoid process deep with long, shallowly inclined posterior border; and (5) blind-ended median opening on medullary floor of basioccipital present. These are interpreted as generically diagnostic characters and the first one in particular distinguishes *Prognathodon* from *Liodon* and other long-snouted mosasaurines. In marked contrast to the robust skull architecture unique to the genus, the postcranium of *P. overtoni* is lightly built, and differs little from that of *Clidastes*, a basal mosasaurine with a gracile cranial anatomy. Marginal teeth are carinate with fine crenulations, indicating their proposed opportunistic predatory behavior. In addition, most of the fully erupted teeth exhibit a similar degree of apical wear, which indicates that the taxon may have regularly handled prey items that involved crunching. To augment these dietary inferences, gut contents from one of the new specimens included fragments of two different sized fish, a sea turtle, and possibly a cephalopod.

Poster Session II (Thursday, November 3)

EFFECTS OF THE LATE PERMIAN EXTINCTION ON THE PERMIAN-TRIASSIC SHARK FAUNA

KOOT, Martha, University of Plymouth, Plymouth, United Kingdom; TWITCHETT, Richard, University of Plymouth, Plymouth, United Kingdom; CUNY, Gilles, Natural History Museum of Denmark, Copenhagen, Denmark; HART, Malcolm, University of Plymouth, Plymouth, United Kingdom

Sharks are predominantly marine top predators that are believed by some to have been relatively unaffected by the Late Permian mass extinction: a view supported by an apparent radiation of fish families across the boundary. In contrast, others have stated that chondrichthyan diversity closely follows diversity fluctuations in other aquatic organisms, including a drastic decline during the Late Permian and a subsequent Early Triassic recovery. To ascertain which view is correct, detailed local elasmobranch records from Permian-Triassic (P-Tr) oceanic basins need to be correlated and compared in terms of preservation and biodiversity. Anomalies in the quality of the fossil record, as well as changes in the global shark community can then be identified, and ultimately significant evolutionary developments as a result of the end-Guadalupian crisis and the late Changhsingian extinction event. Data on local elasmobranch faunas were obtained from a comprehensive literature survey, with additional field data collected from the previously unstudied P-Tr of Oman (western Neothethys), from Japan (Panthalassa), and East Greenland (Boreal). These data show that the Middle Permian fauna of Oman consists of *Glikmanius* sp. cf. *G. occidentalis* (ctenacanthiform), three new hybodontiforms (including one *Lissodus*-like genus) and four unidentified taxa (one hybodontiform, two euselachian and one ?eugeneodontiform). The Early Triassic fauna from the same region has no common genera, includes hybodontiforms, but is dominated by synechodontiform taxa. The Permian and Triassic records from Japan also share no genera. However, the Middle Permian faunas of Oman and Japan are similar, with at least *Glikmanius* in common. The East Greenland Middle Permian-Lower Triassic record is distinct again, being predominantly eugeneodontiform dominated, only having *Hybodus* and *Janassa* in common with Japan and currently no genera with Oman. This new analysis of P-Tr elasmobranchs expands our knowledge on distribution patterns and diversity, and also shows a clear divide between local Permian and Triassic shark communities, suggesting at least some influence of the extinction on evolutionary patterns.

Poster Session II (Thursday, November 3)

DESCRIPTION OF THE DIRE WOLF FORELIMB *CANIS DIRUS GUILDAYI* FROM RANCHO LA BREA

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The extinct Western Dire wolf, *Canis dirus guildayi*, was the most common predator at Rancho La Brea during the Pleistocene. The species *Canis dirus* was originally described as being similar to the timber wolf, although somewhat heavier and more robust, based upon the features emphasized in the cranium and dentition of this species. As the phylogeny of this canid has been described consistently from the skull and teeth; this study will focus on the postcrania. In this descriptive analysis, the bones of the upper forelimb, specifically

the external features of the scapula, humerus and ulna of *C. dirus* showed increased robustness when compared to *Canis lupus*. The caudal border of the dire wolf scapula was more pronounced than that of the grey wolf, specifically at the origin of the teres major and minor muscles. The deltoid tuberosity of the dire wolf humerus was more robust, and the proximal end of the humerus had a greater articular surface than in the grey wolf and coyote. On average the grey wolf ulna was of greater length than that of the dire wolf, but significantly more gracile. Dissections of the forelimbs of *C. lupus* and the extant coyote *Canis latrans* provided comparative muscular information for construction of species-specific muscle maps. Examination of ridges, rugosities and other features reflecting alteration of bone surfaces by muscle attachment were shown to correlate with the osteological patterns on forelimb bones. These results allow for the interpretation of the significance of muscle scars on the fossils as a means of identifying locomotor and other behaviors. Comparisons with extant species allow not only an understanding of the muscular soft tissue anatomy in closely related extinct species, but also permit extrapolation of function to the extinct predator.

Poster Session III (Friday, November 4)

***CAMELOPS* FROM THE MIDDLE PLEISTOCENE (MIDDLE IRVINGTONIAN) FAIRMEAD LANDFILL LOCALITY, MADERA COUNTY, CALIFORNIA**

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As the largest middle Pleistocene (middle Irvingtonian) biota in the San Joaquin Valley of California, the Fairmead Landfill locality in Madera County has produced thousands of fossils representing 57 taxa since its discovery in 1993. Fossils are preserved in the upper unit of the Turlock Lake Formation, which is 0.78 Ma to 0.55 Ma in age. Camelids are the second most common taxon at the site, representing about 20% of identified specimens. In an attempt to identify the species from Fairmead Landfill, this study evaluates several *Camelops* elements from the site including the cranium, mandible, scapula, radius/ulna, metatarsals, tibia, and calcaneum. Pleistocene species of *Camelops* in North America include *C. sulcatus*, *C. traviswhitei*, *C. huerfanensis*, *C. minidokae*, and *C. hesternus*. Three of these taxa can be excluded as the species present at Fairmead Landfill. Measurements of Fairmead *Camelops* mandible and postcranial elements are greater than those of *C. sulcatus* and teeth lack the flat inner faces and deep, rounded grooves in the occlusal pattern found with *C. sulcatus*. Fairmead *Camelops* dentition lacks the V-shaped lakes on upper and lower molars characteristic of *C. traviswhitei* and instead has the U-shaped lakes of other *Camelops* species. Furthermore, the anterior palatine foramen is opposite the dP3/dP4 in the Fairmead *Camelops* maxilla, consistent with its position opposite the dP3/dP4 or P3/P4 in *C. hesternus*, whereas the foramen is opposite M1 in *C. huerfanensis*. Fairmead Landfill skull and postcrania were compared with *C. minidokae* from Irvington (>0.78 Ma in age) and *C. hesternus* from Rancho La Brea (20-30 kya in age). With all elements, it is observed that measurements of Fairmead specimens fall between the smaller species *C. minidokae* and the larger species *C. hesternus*, with the Fairmead *Camelops* being closer to *C. minidokae* in size. While our results do not permit species assignment of the Fairmead Landfill *Camelops* at this time, the intermediate size of the specimens is consistent with the hypothesis that *C. minidokae* may have given rise to *C. hesternus*, with the Fairmead specimens perhaps representing a transitional population.

Technical Session XVI (Saturday, November 5, 10:45 am)

ORIGIN AND DIVERSIFICATION OF CODS AND ALLIES (TELEOSTEI, GADIFORMES)

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Gadiform fishes are very diverse and abundant in modern temperate and polar waters. Although the monophyly of Gadiformes is beyond discussion and well-supported by morphological and molecular data, different concepts of gadiform intrarelationships exist. Most current analyses recognize three suborders, Muraenolepidoidei, Macrouroidei, and Gadoidei within Gadiformes with muraenolepidoids being the most plesiomorphic member. The sister group of Gadiformes is Zeiformes based on molecular data. So far, the fossil record and early evolution of Gadiformes have been considered only sporadically. Tracing the origin and diversification of this group is rendered difficult by the fact that their fossil record is rather patchy and predominantly consists of isolated otoliths. Moreover, muraenolepidoids have an extremely incomplete fossil record and cannot contribute to reconstructing the origin of gadiforms. The oldest reliable gadiform fossils belong to gadoids and are from the Paleocene. Questionable gadiform records were reported from the Cretaceous. Based on a combined approach using fossil occurrences, diversity patterns expressed by the number of fossil taxa throughout the Cenozoic, aspects of stratigraphic bounding, and phylogenetic methods, gadiform fishes seemingly originated in shallow shelf environments of the Northern Hemisphere during the Late Cretaceous. At least two different diversification centers can be distinguished in their early evolutionary history. While gadoids experienced a first major radiation event in the eastern North Atlantic and/or North Sea Basin in the earliest Paleogene, the first major radiation event of macrouroids occurred in the Middle to Late Paleogene ca. 20 million years later in the Southern Hemisphere. Macrouroid diversification is related to their migration into the South Atlantic before the opening of the Drake Passage and subsequent establishment of the circum-Antarctic current. The adaptive radiation events in gadoids and macrouroids with their adaptation to deep-water environments in the Early Cenozoic most likely were the foundation and regulation parameters for their evolutionary success.

Technical Session XII (Friday, November 4, 3:15 pm)

EVIDENCE FOR MULTIPLE CENOZOIC INVASIONS OF AFRICA BY PENGUINS (AVES, SPHENISCIFORMES)

KSEPKA, Daniel, North Carolina State University, Raleigh, NC, USA; THOMAS, Daniel, University of Cape Town, Cape Town, South Africa

Africa was the last major Southern Hemisphere landmass to be colonized by penguins. Although the continent hosts only a single breeding species today, the fossil record reveals that at least four extinct penguin species co-existed along the South African coast during the early Pliocene. We present a new study of these species based on over 200 specimens, including new material, collected from the Pliocene Muishond Fontein Phosphatic Sand Member of the Varswater Formation. Multiple specimens show extremely poor ossification and lack of fusion in the carpometacarpus and tarsometatarsus. Stages of ossification observed in these fossils match those seen in unfledged chicks of extant penguins, suggesting these individuals were washed out to sea from nesting colonies in the vicinity.

A total evidence (morphology + molecular sequence data) phylogenetic analysis reveals that contrary to previous hypotheses, the Pliocene species do not represent an endemic radiation or direct ancestors of the living *Spheniscus demersus* (Blackfooted Penguin). Biogeographic reconstructions using parsimony and Bayesian approaches implemented in RASP support the inference of at least three separate dispersal events to Africa during the Neogene. Ancestral area reconstructions suggest the now-extinct Pliocene lineages arrived from either South America or Austro-New Zealand, and were likely assisted by the eastward flowing Antarctic Circumpolar and South Atlantic currents. Divergence dates inferred from both a time-calibrated cladogram minimizing ghost lineages and from previous molecular sequence-based divergence dating studies indicate that the extant African species *Spheniscus demersus* arrived after the time of deposition of the Muishond Fontein Phosphatic Sand Member and so may not have overlapped with any of the extinct species. As has been proposed for the South African marine avifauna in general, pronounced regional sea level fall (~90m) may be implicated in the steep decline in penguin diversity.

Poster Session IV (Saturday, November 5)

TAUNG ... A RIVER RAN THROUGH IT

KUHN, Brian, Institute for Human Evolution, Johannesburg, South Africa; HOPLEY, Philip, Birkbeck College, London, United Kingdom; HERRIES, Andrew, La Trobe University, Melbourne, Australia; MENTER, Colin, University of Johannesburg, Johannesburg, South Africa; BOUNTALIS, Alexandra, Institute for Human Evolution, Johannesburg, South Africa

In 1924, The Taung Child fossil was recovered from the Buxton Limeworks in South Africa. This fossil was designated as the type specimen of *Australopithecus africanus* in 1925, which spurred 85 years of fossil discoveries that would indicate that Africa was the cradle of humankind. Renewed scientific endeavours at the Taung palaeoanthropology site, Northwest Province, South Africa, took place in 2010 and have yielded new results that will allow us to more precisely reconstruct the age, provenience and context of the Taung Child. Initial sedimentological analysis has identified riverine tufa deposits overlying the pink calcretes and palustrine deposits of the Dart and Hrdlicka Pinnacles. Palaeomagnetic analyses indicate that the older pink deposit has a normal magnetic polarity and the younger orange deposit has a reversed magnetic polarity and may suggest deposition around 2.6 Ma. Here we discuss the latest results in relation to previous hypotheses and how these new discoveries can be used to reinterpret the depositional and environmental influences on the Dart and Hrdlicka Pinnacles at Taung and potentially the age of the *Au. africanus* type specimen.

Poster Session I (Wednesday, November 2)

DISTINGUISHING FORAGING RANGE AND DIVING HABITS AMONG MARINE VERTEBRATES USING CARBON ISOTOPES AND WT. % CARBONATE

KUYKENDALL, Samantha, Texas A&M University, College Station, TX, USA; ROBBINS, John, Texas A&M University, College Station, TX, USA

Calculated weight percent carbonate values extracted from marine vertebrate tooth enamel potentially provide an independent proxy for deep-diving behavior. The increased storage of oxygen in the blood and tissues relative to the lungs in diving vertebrates leads to a greater amount of respired CO2 in the blood compared to that of non-divers. If this leads to higher wt.% carbonate values in teeth, then diving taxa may be expected to have higher wt.% carbonate values. This scenario is identified when comparing the wt.% carbonate values of a diving sea snake (*Pelamis platurus*; 6.8%) to a non-diving marine iguana (*Amblyrhynchus cristatus*; 3.3%).

Low δ13C values in marine vertebrate teeth reflect both the decrease in primary producer δ13C (δ13CPOM) with increasing distance from shore and the increased respired CO2 in the blood related to diving behavior. There is currently no acceptable proxy for determining which behavior is explained by the low δ13C of an individual. Current research combines low δ13C values with the presence of avascular necrosis (considered evidence of deep/frequent diving) to describe diving behavior. Inclusion of wt.% carbonate values may provide further evidence for separating diving behavior from offshore foraging in marine vertebrates.

Based on paleo-pathology, morphology, and isotope data, some genera of mosasaurs were likely deep/frequent divers. It is expected that the wt.% carbonate values of the tooth enamel of diving individuals will be higher in divers compared to non-divers. Individuals from southern Sweden exhibit significant differences between taxa, where the non-diver *Clidastes* has the lowest value (4.4%), while the suspected divers *Tylosaurus* (5.5%), *Prognathodon*

(7.8%) and *Platecarpus* (8.1%) have higher values. The wt.% carbonate values of specimens from North Texas suspected to be non-divers (*Dallasaurus*, *Clidastes*, and *Russellosaurus*) are similar (average of 4.7%) to those of alleged divers (*Globidens*, *Mosasaurus*, *Platecarpus*, and *Tylosaurus*; average of 4.8%). The disparity between North Texas and southern Sweden individuals may suggest that regional differences in bathymetry permit diving adaptations in marine vertebrates.

Poster Session IV (Saturday, November 5)

VIRTUAL ENDOCAST OF *PLESIADAPIS TRICUSPIDENS*, TYPE-SPECIES OF THE 'PLESIADAPIFORMS'

LADEVÈZE, Sandrine, RBINS, Brussels, Belgium; SMITH, Thierry, RBINS, Brussels, Belgium

The brain evolution of early primates and their stem relatives is a major question when compiling the main characteristics of primates. The paraphyletic 'plesiadapiforms' are crucial for addressing this question as the stem group to primates and because different families are represented by almost complete skulls.

We describe here a virtual endocast produced from ultra high-resolution X-ray computed tomography (µCT) data for the plesiadapid type-species, *Plesiadapis tricuspidens* (Upper Paleocene, Cernay-lès-Reims, France). Plesiadapids have been regarded as the sister group to primates and the virtual endocast of *P. tricuspidens* therefore allows for the approximation of the ancestral condition for primate brain structures. It represents the most complete endocast known for plesiadapids and brings new data to what was previously known based on the incomplete endocast of *P. cookei*. The reconstruction of the endocranial volume (about 4.5 cm3) indicates that *P. tricuspidens* had a relative small brain size as compared with more primitive 'plesiadapiforms' (i.e., *Ignacius graybullianus*, *Microsyops annectens*). Relative to fossil and extant primates and similar to *I. graybullianus*, *P. tricuspidens* had more developed olfactory structures, relative to the less developed visual system. This is consistent with the idea that the specializations for visual acuity in primates most probably evolved convergently (in tree shrews but also in microsyopsids) and were not present in the ancestral morphotype of primates. Furthermore, our results suggest a close relationship between plesiadapids and paromomyids (*I. graybullianus*), and question the phylogenetic origin of primates, as *M. annectens* could be closer to primates than previously expected in regard to its endocranial morphology (derived visual features) and its more complete dentition.

Technical Session XIV (Saturday, November 5, 11:45 am)

A NEW CAENAGNATHID OVIRAPTOROSAUR (THEROPODA: MANIRAPTORA) FROM THE UPPER CRETACEOUS (MAASTRICHTIAN) HELL CREEK FORMATION OF THE WESTERN UNITED STATES

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The oviraptorosaurian theropod clade Caenagnathidae has long been enigmatic due to the incomplete nature of nearly all described fossils. Here we report on a new, large-bodied caenagnathid taxon represented by three well-preserved partial skeletons and several isolated bones. The specimens were recovered from the uppermost Cretaceous (Maastrichtian) Hell Creek Formation of Montana and the Dakotas, and are therefore among the stratigraphically youngest oviraptorosaurian remains yet known. Collectively, the fossils include elements from most regions of the skeleton, providing a wealth of information on the osteology and phylogenetic affinities of Caenagnathidae. The new taxon confirms the referral of the mandibular material previously named *Caenagnathus* to the genus *Chirostenotes*. The skull of the Hell Creek caenagnathid is characterized by a very tall, crescentic median crest comprised by the elongate posterodorsal processes of the premaxillae. The maxilla has a prominent dorsal process. The mandible closely resembles that of "*Caenagnathus collinsi*" but differs in the presence of a lateral flange on the dentary. The pterygoids are fused medially to form an X-shaped structure. The extensively pneumatized caudal series terminates in a pygostyle-like conformation consisting of three greatly modified but unfused vertebrae. Manual unguals exhibit a conspicuous proximodorsal "lip." The distal surface of the pubic "boot" is deeply concave, comprising a "cup-like" morphology. The shaft of the ischium is strongly curved posterodistally, and the triangular obturator process is positioned at its approximate proximodistal midpoint. A well-developed "accessory trochanteric crest" rises from the lateral edge of the proximal end of the femur. The astragalus is coossified with the calcaneum and bears a rugose, ovoid tuberosity on the anterior surface of the base of the ascending process. The Hell Creek caenagnathid provides insight into the paleobiology of these unusual dinosaurs. For example, the two partial skeletons from South Dakota differ from one another in the robustness of certain appendicular bones, and selected elements of all three skeletons show pathological changes.

Poster Session IV (Saturday, November 5)

A NEW SHOVEL-TUSKED GOMPHOTHERE (PROBOSCIDEA) FROM THE CLARENDONIAN OF OREGON

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Unusual shovel-tusked gomphothere material from the late Clarendonian Black Butte local fauna in Oregon, including a lower tusk, partial upper tusk, and mandible preserving a third molar, has been described and referred to *Platybelodon*. *Platybelodon* has the following diagnostic characteristics: molars strongly double-trefoiled; third molar with 5 lophs; lower tusks short with broad and very flat profiles lacking significant dorso-ventral concavities; and lower tusk internal structures lacking obvious lamination but instead filled with small, short dentinal rods. However, despite being referred to *Platybelodon* the Black Butte shovel-tusked gomphothere (BBSG) has the following features: molars with weakly developed single trefoiling; third molar with only 4 lophs (the fourth little more than a talonid); broad, moderately flattened, relatively elongated lower tusk with a prominent dorsal concavity; and lower tusk internal structure showing lamination rather than dentinal rods. In addition, the lower tusk of the BBSG has prominent corrugations over its entire surface, a feature unknown in any other gomphothere. Thus, given the lack of a single diagnostic feature shared between the BBSG and *Platybelodon*, and the large number of differences between these taxa, the identification of the BBSG as *Platybelodon* must be refuted.

Refutation of the *Platybelodon* identification requires a new identification to be made for the BBSG. No known shovel-tusker genus possesses the combination of features observed in this animal. For example, conservative *Amebelodon* species (e.g. *A. floridanus*) have narrow, modestly flattened lower tusks with conservative cheek teeth (e.g. single trefoiling, third molars with four lophs), while advanced *Amebelodon* species (e.g. *A. fricki*), though having broad, moderately flattened lower tusks with dorso-ventral concavities, possess advanced cheek teeth (e.g. double trefoiling, third molars with five plus lophs). *Serbelodon* resembles conservative *Amebelodon* beyond having very short lower tusks, and *Torynobelodon* differs from the Black Butte shovel-tusker in having narrow lower tusks with dentinal rods much like those found in *Platybelodon*. Given the character incongruence between the BBSG and all known shovel-tusker genera, the only reasonable conclusion is that the BBSG represents a currently unnamed new genus and species.

Technical Session XIII (Friday, November 4, 2:45 pm)

THREE-DIMENSONAL QUANTIFICATION OF OCCLUSAL PATTERN IN EXTANT EQUIDS

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Extant members of the genus *Equus* (zebra, horses and asses) are the most numerous and widely-distributed group of modern perissodactyls living in some of the harshest climates and terrains in the world (many of them in desert ecosystems). All of these extant equids show high-crowned (hypsodont) teeth, complex enamel ridge patterns and prominent cementum.

In herbivorous mammals, tooth wear is a combined result of attrition (tooth-tooth contact) and abrasion (tooth-food contact), which is determined by the biomechanical properties of food items, the availability of food plants as well as the prevalent environmental condition in a given habitat. This study focuses on quantifying occlusal patterns of the extant Equidae and links them with dietary traits as well as environmental conditions like rainfall and climatic water balance. Therefore, we generate 3D digital models of upper post-canine tooth rows using a topometric digitization system (smart*SCAN*3D, Breuckmann). Geographic Information System (SAGA) and an industrial metrology software (PolyWorks v11) are employed to characterize the occlusal topography and the dental patterns of the following *Equus* species: *E. africanus* (n=6), *E. grevyi* (n=10), *E. zebra hartmannae* (n=6), *E. quagga boehmi* (n=6), *E. zebra zebra* (n=6), *E. ferus przewalski* (n=6), *E. hemionus* (n=6), *E. kiang* (n=5), *E. khur* (n=6) and the domestic form *E. africanus* f. *asinus* (n=6).

Despite of evident similarity in dental morphology in the investigated species, we detect characteristic signatures in occlusal parameters like ratio of enamel and dentin as well as relative length of enamel ridges. We subsequently relate these dental topographic features to environmental conditions, which helps to infer adaptive traits related to the habitats of extinct and extant species.

Technical Session XIV (Saturday, November 5, 8:00 am)

A NEW EUSAURISCHIAN FROM THE SANTA MARIA FORMATION, LATE TRIASSIC OF BRAZIL, HIGHLIGHTS MOSAIC PATTERN OF CHARACTER EVOLUTION DURING THE RISE OF DINOSAURS

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Derived theropod, sauropodomorph, and ornithischian dinosaurs are promptly recognized based on the set of traits that typically characterize each of the groups. On the contrary, most basal members of these lineages lack such diagnostic traits, but share generalized features also frequently seen in more basal dinosauromorphs. This is the case of a new early dinosaur from the Santa Maria Formation (Late Triassic *Hyperodapedon* biozone) of south Brazil. The specimen (ULBRA-PVT016) corresponds to the disarticulated partial skeleton of a single individual, including most skull bones. The new taxon differs from all relatively well-known Triassic dinosauromorphs by a unique set of characters that include dinosaur plesiomorphies such as palatal teeth, a deep acetabular medial wall with straight ventral margin, and narrow sacral transverse processes that do not roof the intercostal space, as well as typical theropod traits as a concave ventral margin of the premaxilla-maxilla articulation and unserrated tooth crowns in the rostral tip of the jaws. Yet, multiple phylogenetic analyses consistently place the new form along the sauropodomorph stem, although this is not supported by strong tree

statistics or many robust synapomorphies. Apart from highly homoplastic characters, such as lanceolate and coarsely serrated tooth crowns that overlap one another, these include: strap-shaped ventral ramus of the squamosal, humerus with broad distal margin, and ilium with subtringular preacetabular ala. In addition, the new dinosaur lacks typical sauropodomorph traits such as a small head and mesialmost teeth with elongated crowns inset from the rostral end of the jaws. Such an ambiguous combination of features is not rare for basal dinosaurs, the early radiation of which is characterized by high levels of homoplasy, revealing a mosaic pattern of character transformation. This may severely affect taxonomic/phylogenetic inferences, and the origin of the main dinosaur groups may represent a segment of evolutionary history that is particularly hard to reconstruct. Indeed, the currently poorly constrained phylogenetic position of various basal members of the group is not surprising.

Poster Session IV (Saturday, November 5)

NEW INFORMATION ON THE VERTEBRATE ASSEMBLAGE OF THE SANTONIAN-AGED MILK RIVER FORMATION OF ALBERTA (CANADA) AND THE EMERGENCE OF LATEST CRETACEOUS VERTEBRATE COMMUNITIES IN NORTH AMERICA

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The fossil assemblage from the Deadhorse Coulee Member of the Milk River Formation of Alberta provides important information about Santonian-aged vertebrates from North America, which are poorly documented in the fossil record. A continental deposit between the underlying Upper Colorado Group and the overlying Pakowki Formation marine deposits, the Milk River Formation provides the earliest record of a Late Cretaceous vertebrate assemblage in a series of well-known terrestrial fossiliferous strata in Alberta. The collection of additional material from this formation and an update of work by previous authors has allowed for the recognition of a diverse assemblage with at least 101 vertebrate taxa from the formation, consisting of 18 fish (including 10 teleosts), seven amphibians, 11 turtles, 14 squamates, one champsosaur, three crocodylomorphs, 16 non-avian dinosaurs, one possible bird, and 30 mammals. A new field survey resulted in the recovery of a number of important new specimens of previously unknown dinosaur taxa, including a new *Prenocephale*-grade pachycephalosaurid that represents the oldest known pachycephalosaurid from North America, a possible non-hadrosaurid hadrosauroid, and a new baenid turtle. New taxa have been identified from previously collected but undescribed specimens and include the oldest known leptoceratopsid neoceratopsian and a trionychid turtle. Additions to the fish assemblage include a diverse teleost assemblage, and the oldest North American occurrences of a polyodontid fish and the vidalamiine amiid *Melvius*. Many of these clades are represented later in the Cretaceous by common and well-known taxa, but others (goniopholidid crocodylomorphs, possible non-hadrosaurid hadrosauroids, triconodont mammals) represent the last occurrences of taxa that are not found subsequently in Alberta. This study supports previous work suggesting that the Milk River Formation represents a transitional assemblage crucial to our understanding of the evolution of later Campanian and Maastrichtian North American assemblages.

Symposium 1 (Wednesday, November 2, 10:45 am)

INTEGRATING THE GENOTYPE; PHENOTYPE MAP ACROSS THE ORIGIN OF BIRD WINGS

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Evolution of the genotype – phenotype map is one of the fundamental goals of evolutionary biology because it describes the interface between phenotype and genotype. Macroevolutionary transformations of phenotype are expected to be paralleled by similarly large-scale changes to genotype. In this regard, the fossil record may offer insights into the behavior of the genotype-phenotype map that traditional microevolutionary research cannot. Here we discuss a test case using the non-avian to avian theropod forelimb transformation from an arm to a wing. Phenotypic changes are documented with discrete and continuous skeletal characters to identify phylogenetic and anatomical regions of significant evolutionary change. Peaks of phenotypic change in the forelimb, relative to 'background' rates of skeletal evolution, occur during digit losses in tetanurans and biomechanical changes within derived maniraptorans. Genotypic changes are inferred from sequence data from extant birds, crocodylians, and other reptiles. We use RAG-1 and RAG-2 protein coding sequences to calibrate 'background' rates of genotypic change along the Archosauria - Aves branch. Coding and, where known, regulatory sequences from a selection of genes involved in the limb gene regulatory network were assembled from representative extant taxa. This data is used to explore for significant evolutionary changes to these sequences across the Archosauria – Aves branch and we suggest methods to estimate temporal calibrations to these changes. Some of these temporally calibrated sequence changes appear to be associated with phenotypic changes. This work, although preliminary, presents a novel method to associate large-scale phenotypic and genotypic changes and attempts to infer how evolutionary processes effect the genotype-phenotype map.

Poster Session I (Wednesday, November 2)

THE ENDOCRANIAL ANATOMY OF THE MONGOLIAN THERIZINOSAUROID DINOSAUR *ERLIKOSAURUS ANDREWSI* AS REVEALED BY 3D VISUALIZATION

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Therizinosaurs are one of the most enigmatic and peculiar clades among theropods, exhibiting an unusual suite of characters, such as lanceolate teeth, a rostral rhamphotheca, long manual claws, and a wide, opisthopubic pelvis. Although their fossil record is generally rather poor, numerous discoveries have expanded our knowledge of this group in the last 20 years. However, the holotype skull of *Erlikosaurus andrewsi* from the Late Cretaceous of Mongolia still remains the only complete, articulated and three-dimensionally preserved skull of a therizinosaur.

Here, we present the first results of the endocranial anatomy of *Erlikosaurus* based on computed tomographic scanning. The endocast, the cranial nerves and the endosseous labyrinth are digitally visualized, revealing these structures for the first time for any therizinosaurid.

Generally, the endocast of *Erlikosaurus* is large and complex. It shows a mixture of plesiomorphic and derived ("avian") characters, reflecting the basal position of therizinosaurs among maniraptoran dinosaurs. The individual parts of the brain are clearly reproduced by the endocranial cavity, indicating a close association between the brain and the braincase wall. Respectively, the cerebral hemispheres were found to be enlarged and prominently developed, indicating comparably high cognitive capabilities. This is consistent with an encephalization quotient within the range of other coelurosaurian dinosaurs. The cerebellum is only weakly demarcated, but appears to be high and narrow. Laterally, it is framed by enlarged floccular lobes and the well developed endosseous labyrinths. The semicircular canals of the latter are delicate and elaborate. The olfactory bulbs are of moderate size, and the olfactory tracts are long and extend far from the cerebrum. Yet, the brain lacks ventrolaterally displaced and pronounced optic lobes, found in more derived maniraptoran theropods and birds. This suggests that the senses of olfaction and hearing may have been more advanced and that *Erlikosaurus* relied on its olfactory and acoustic acuity rather than visual orientation.

Poster Session III (Friday, November 4)

TURTLE EGGS AND EMBRYOS IN A CLUTCH FROM THE UPPER CRETACEOUS (CAMPANIAN) JUDITH RIVER FORMATION OF MONTANA

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Turtle eggs are unique among amniotes in that the eggshell consists of aragonite, whereas all other amniotic eggs are comprised of calcite. This mineral composition and distinctive microstructure allow for confident identification of turtle eggs within the fossil record. Interpretations of paleoecology are possible from fossil turtle eggs because of the presence of modern analogs.

The Judith River Formation contains numerous dinosaur eggs and eggshell localities; however, fossil turtle eggs and eggshells are rare from this formation. A clutch of unhatched turtle eggs (MOR 710) consists of at least 13 eggs, some containing embryonic remains. These mostly intact specimens were discovered at the base of the outcrop and therefore provide little taphonomic information about nest construction. The relatively smooth, cream-colored eggs measure 3 x 4 cm and exhibit minor lithostatic compaction. The rigid eggshell consists of a single structural layer comprised of radiating, acicular aragonite crystals that form interlocking shell units, which flare slightly toward the outer shell surface. The shell unit width-to-height ratio is approximately 1:2. At least one egg displays abnormal, double eggshell layers, a condition reported in at least nine species of modern turtles. The embryonic remains are partially articulated and show a late stage of ossification, suggesting that they were close to hatching at time of death. Histological thin sections of the embryonic bone show enlarged vascular spaces, within the cortex, surrounding the marrow cavity. Vascular spaces are orientated longitudinally and are mostly circular in transverse section. Numerous osteocytes are preserved but show little organization. The distinctive shape of the premaxilla suggests that the eggs were laid by a trionychid turtle. Modern trionychid turtles inhabit aquatic environments and the presence of the fossil turtle eggs in fine-grained overbank deposits is consistent with a similar paleoenvironmental interpretation. Finally, based on data from modern trionychid turtle species, the shape and number of eggs suggests they were laid by a mid-sized turtle with a carapace length between 20 and 30 cm.

Poster Session II (Thursday, November 3)

PHYLOGENETIC PATTERNS, HOMOPLASY, AND THE EVOLUTION OF THE ANTORBITAL FENESTRA IN CROCODYLIFORMES

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Crocodyliformes are the only group of Archosauriformes that have enclosed the antorbital fenestra and internalized the associated pneumatic cavity multiple times in their evolutionary history. A large-scale phylogenetic analysis of Crocodyliformes allows evaluating the pattern of character evolution of this fenestra in the history of the group.

The closure of the antorbital fenestra is optimized as a highly homoplastic process, inferred to occur independently up to eight times. Although this closure is observed in few basal crocodyliforms (e.g., *Edentosuchus,* the Fruita Form), most transformations are focused in certain mesoeucrocodylian clades.

In notosuchians, a closed antorbital fenestra is observed in derived notosuchians (including sebecosuchians). However, the presence of an antorbital fenestra in *Notosuchus* creates an ambiguous optimization for this character. Furthermore, the presence of a small fenestra in some Cenozoic sebecosuchians (*Bergisuchus* and *Iberosuchus*) implies a reopening of the fenestra in the evolution of this group. Among neosuchians, two independent events of closure are optimized on the phylogeny, in Pholidosauridae+Dyrosauridae and in Goniopholidae+Eusuchia. This optimization is due to the condition of basal Thalattosuchia and Atoposauridae, as both have small antorbital fenestra. Given that the homology of the antorbital fenestra of Metriorhynchidae has been recently questioned, an internalized antorbital fenestra could represent an ambiguous synapomorphy of the longirostrine clade composed by Thalattosuchia+Goniopholidae+Pholidosauridae.

The evidence at hand indicates the antobital fenestra of Crocodyliformes is one of the most homoplastic analyzed characters of the group, suggesting not only the closure of this opening in multiple groups but also the independent reappearance of a fenestra (that would not be homologous from a phylogenetic point of view) in some notosuchians and, possibly, in basal thalattosuchians.

Technical Session XIV (Saturday, November 5, 9:30 am)

VARIATION IN BONE HISTOLOGY AND GROWTH OF THE NOASAURID THEROPOD *MASIAKASAURUS KNOPFLERI*

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Bone histology and growth patterns among non-avian theropods have been extensively studied in coelurosaurs. In contrast, similar data from non-coelurosaurian theropods are only known from the small-bodied *Coelophysis rhodesiensis* and the large-bodied *Allosaurus fragilis*. Moreover, interspecific comparisons of growth rates and growth durations among theropods necessarily focus on mean values, precluding assessments of intraspecific variation. Here, we present an intraspecific analysis of bone histology and growth in the small-bodied noasaurid *Masiakasaurus knopfleri*. The study sampled a size-diverse range of four femora and three tibiae. By measuring the sequence of growth lines in each bone and applying a mixed-effects nonlinear regression, we found that the femur and tibia had similar mean circumferential growth rates (reaching a maximum of 7 mm per year) and mean growth durations (12–13 years). However, substantial intraspecific variation exists, with individual growth rates ranging between 3–10 mm per year and individual growth durations ranging between 7–24 years. Moreover, fibrolamellar bone, as is frequently reported in other theropods, is not the predominant bone tissue type. Instead, fibrolamellar bone occurs most prominently in faster-growing femora and tibiae whereas a mixture of fibrolamellar and parallel-fibered bone occurs in slower-growing bones. The results reveal that the complex expression of fibrolamellar bone is related to individually variable growth rates and suggest that growth patterns among non-avian theropods exhibit more intraspecific variation than previously thought.

Poster Session I (Wednesday, November 2)

THEROPOD TRACKWAYS ASSOCIATED WITH ORNITHOMIMID SKELETONS FROM THE NEMEGT FORMATION (MAASTRICHIAN) AT BUGIN TSAV, MONGOLIA

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A theropod tracksite was discovered in the Nemegt Formation (Maastrichian) at Bugin Tsav, Mongolia, by the Korea-Mongolia International Dinosaur Project in 2009. Among 67 theropod tracks, 15 trackways are recognized except for eleven isolated tracks, which are the first theropod trackways reported in the Nemegt Formation. Fifteen trackways are divided into a didactyl trackway, a small bird-like trackway, and 13 tridactyl trackways. These different theropod trackways indicate that at least three different theropod dinosaurs lived in Bugin Tsav region in the same period. This tracksite consists of an alternation of grey mudstone and light brown sandy mudstone probably deposited in the floodplain environment. During excavation of the track horizon, an articulated ornithomimid right foot was found in the mudstone beneath the track-bearing sandy mudstone layer. The site was excavated by illegal poachers for several ornithomimids judging from the number of dug pits and scattered bone pieces of ornithomimids. Based on the stratigraphic relationship between the position of the ornithomimid foot and tracks, theropod tracks were made on the sandy mud deposited after ornithomimids were buried in the mud.

Poster Session IV (Saturday, November 5)

THE PLATACANTHOMYINE RODENT *NEOCOMETES* FROM THE MIOCENE OF SOUTH KOREA AND ITS PALEOBIOGEOGRAPHICAL IMPLICATIONS

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A left first lower molar of *Neocometes* from the Bukpyeong Formation, South Korea is more similar to *N. similis* and *N.* cf. *similis* from Europe than to *N. orientalis* from Thailand, and is therefore referred to *Neocometes* aff. *similis*. The new discovery of *Neocometes* is important in that it is the first evidence in Asia to show close faunal affinity to European *Neocometes*. It is also of paleobiogeographic significance for the Subfamily Platacanthomyinae, because it represents the easternmost occurrence of this subfamily in Eurasia, implying there was continuous gene flow between the *Neocometes* populations of eastern Asia and Western Europe. The paleoclimatic interpretation for the Bukpyeong Formation based on the palynomorphs implies that *Neocometes* had wider climatic tolerances than either of the two extant platacanthomyine genera. The evolutionary stage of Korean *Neocometes* is comparable to material from European localities correlated with MN 4 and MN 5, which constrains the age of the Bukpyeong Formation to between 18 and 15.2 Mya.

Technical Session XVI (Saturday, November 5, 11:45 am)

VASCULARIZATION AND DORSOVENTRAL ASYMMETRIES IN THE PECTORAL FIN OF *TIKTAALIK ROSEAE* SHED LIGHT ON THE FIN TO LIMB TRANSITION

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CT imaging and 3D visualization software provides a detailed and non-destructive way to analyze and reconstruct the internal morphologies of well-preserved fossils. The finned elpistostegalian, *Tiktaalik roseae*, from the Frasnian Stage of the Late Devonian of the Canadian Arctic is known from several partially-articulated specimens. This taxon is important for understanding the fin-limb transition because of its phylogenetic position as the sister group to limbed forms, and the well-preserved skeletal anatomy of the pectoral fin. One specimen in particular, NUFV 110, preserves a complete right pectoral fin with dermal and endochondral elements *in situ*. This fin was CT-scanned and segmented from the glenoid facet to distal lepidotrichia. This study shows that the overlap of the lepidotrichia (fin rays) and endochondral skeleton is asymmetrical in *Tiktaalik*. Specifically, the dorsal hemitrichia extend to the boundary of a transverse joint immediately distal to the ulnare and intermedium; whereas the ventral hemitrichia do not overlap the mesomeres or intermedium. This asymmetry is also observed in mechanically-prepared *T. roseae* specimens (NUFV 108 and NUFV 109). Additionally, the lepidotrichia that overlap the radius are robust and functionally distinct from other lepidotrichia. Based on data from extant sarcopterygians, we hypothesize that the proximal extent of the lepidotrichia marks the distal extent of fin musculature. This observation is supported by the presence of grooves for nerves and blood vessels on the ventral surfaces of the endochondral bones where lepidotrichia and scales are absent, as well as an extensive network of vascularization that runs through the ventral ridge of the humerus. The dorsoventral asymmetries of hemitrichia, grooves and vascularization indicate a pectoral fin with relatively large ventral musculature, which has functional implications for an aquatic animal living in contact with the substrate. These features help us address questions about how the fin rays were lost during the fin to limb transition, a key adaptation in the evolution of tetrapods.

Technical Session XVII (Saturday, November 5, 2:15 pm)

DECREASING LIMB INERTIA AMONG NORTH AMERICAN UNGULATES ACROSS THE PALEOGENE NEOGENE BOUNDARY

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The proportions of the limb bones of tetrapods determine the energetic costs of locomotion; consequently, they can be used to classify locomotor type and can inform hypotheses about an animal's primary habitat. We examined mechanical advantage in the limbs of North American Oligocene and Miocene ungulates (Artiodactyla and Perissodactyla), with the expectation that the distribution of values would change with the spread of grass-dominated plant communities; that is, we expected a transition to greater cursoriality with more open habitats. We assess changes in the occupation of locomotor ecomorphospace (LEMS) using measurements of the lengths of proximal and distal limb bones in species of North American ungulate herbivores. Log-transformed distal/proximal (d/p) limb bone ratio is inversely proportional to oscillatory inertia (and hence the energy required to swing the limb): positive d/p ratios are often associated with cursorial animals that can move efficiently over long distances. Analysis of LEMS reveals significant changes in dominant ungulate locomotor morphology between Oligocene and Miocene faunas. Oligocene ungulates show less variation in LEMS than Miocene ungulates, with greater occupation of the cursorial (low

oscillatory inertia) morphospace (hindlimb and forelimb d/p ratios both >0) in the Miocene. Artiodactyls show a significant shift in limb proportions (P< 0.05): only two species occupy the non-cursorial (high oscillatory inertia) zone in the Miocene (hindlimb and forelimb d/p ratios < 0). Perissodactyls maintain similar levels of disparity in limb proportions in the Miocene as in the Oligocene (P> 0.70), but more perissodactyls occupy the cursorial zone in the Miocene than the Oligocene. Our results suggest the floral regime transition at the Oligo-Miocene boundary is associated with a substantial change in the locomotor mechanics of ungulate species. Through this transition, we find that artiodactyls increased in cursoriality to a greater degree than contemporaneous perissodactyls.

Poster Session IV (Saturday, November 5)

BONE HISTOLOGY AND GROWTH OF CHASMOSAURINE CERATOPSID DINOSAURS FROM THE LATE CAMPANIAN KAIPAROWITS FORMATION, SOUTHERN UTAH

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Ceratopsian dinosaurs are one of the most diverse dinosaur groups in the Cretaceous, and an outstanding question is how growth strategies of this group evolved in relation to their shift from small bipedal basal ceratopsians to larger quadrupedal ceratopsids. Bone histology and growth has previously been investigated for several basal ceratopsians, and two centrosaurine ceratopsids (*Centrosaurus* and *Pachyrhinosaurus*), but chasmosaurine ceratopsid dinosaurs have yet to be investigated. New chasmosaurine specimens from the late Campanian Kaiparowits Formation of southern Utah are ideal for such a study because they preserve multiple ontogenetic stages of at least two different taxa.

I conducted histological analysis of humeri, ulnae, femora, tibiae, ribs, and ossified tendons from multiple specimens of two species of chasmosaurine ceratopsian dinosaurs, *Kosmoceratops richardsoni* and *Utahceratops gettyi*, to examine bone microstructure indicators of growth rate and maturity. The cortex of all elements is relatively thick with varying degrees of trabeculae in the medullary cavity. All specimens examined are dominated by fibro-lamellar bone tissue, indicative of sustained fast growth. Limb bones from throughout ontogeny are highly vascular. Observed vascular canals are oriented radially indicative of fast bone growth. Dense osteocytes throughout limb bone cross sections also suggest fast growth. Larger limb bones preserve a small number of annual growth lines. No growth lines are apparent in the ribs and ossified tendons samples, where they have probably been obscured by remodeling in the form of dense secondary osteons ("Haversian canals"). Overall, the bone microstructure of these taxa is similar to those of centrosaurine ceratopsids, indicating similar growth strategies for these two groups of large quadrupedal ceratopsians. The presence of fibro-lamellar tissue and high vascularity is consistent with the hypothesis that these animals had an elevated metabolism.

Poster Session IV (Saturday, November 5)

THE SMALL MAMMAL FAUNA FROM KOANAKA SOUTH AND THE UTILITY OF RODENTS AS PALEOENVIRONMENTAL INDICATORS

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Recent excavations of fossiliferous deposits from Bone Cave have produced a diverse Pleistocene mammalian fauna. The cave is located in the southern most of the Koanaka Hills, northwestern Ngamiland, Botswana, an area underrepresented for the period. A large assemblage of micromammals was excavated consisting primarily of rodents and shrews. Taphonomy of these fossils is consistent with an owl accumulation and *Tyto alba* (Barn Owl) is the most likely accumulating agent. Our research attempted to identify these fossils to their lowest taxonomic level to better inform on the regional paleoenvironment. Specimens attributed to *Mus* sp., *Gerbilliscus* sp., and *Otomys* sp. were identified, although much of the material could not be confidently diagnosed below subfamily based only on dentition. Comparison of the fossil material with recently trapped modern specimens from the Koanaka area and specimens from the Transvaal Museum in Pretoria call into question the reliability of diagnosing rodents based on dentition alone, in particular for many murine taxa. Of further concern is genetic work on the modern Koanaka rodents which finds genetically distinct cryptic taxa of murines that are morphologically indistinguishable. It has been standard practice in the region for several decades to diagnose similar rodent fossils to the level of genus, and frequently to species, using dental characters. A detailed comparison of qualitative characters and quantitative analyses of large sample sizes, however, have failed to produce reliable apomorphies for identifying most taxa below subfamily. Such a result calls into question prior paleoenvironmental reconstructions in the southern Africa Plio-Pleistocene as they rely heavily on species level identifications of rodents. Well-defined ranges for dental characters must be established and clear apomorphies defined for modern South African murine taxa relied upon to guide the interpretation of regional fossil taxa. Until these data are published, available taxonomic lists and their associated paleoenvironmental reconstructions for south African Plio-Pleistocene fossil localities incorporating rodents should be used cautiously.

Poster Session IV (Saturday, November 5)

COMPARATIVE STUDY OF TWO POPULATIONS OF THE SABERTOOTHED FELID *PROMEGANTEREON OGYGIA* (FELIDAE, MACHAIRODONTINAE) FROM BATALLONES-1 AND BATALLONES-3 SITES (LATE MIOCENE, MN 10, TORREJÓN DE VELASCO, MADRID, SPAIN)

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The fossil sites of Batallones-1 and Batallones-3 are located within the Cerro de los Batallones Late Miocene paleontological complex (Madrid, Spain), which has yielded an abundant and exceptionally preserved sample of fossils of the order Carnivora, around 98% of the total sample. Both localities were formed as cavities in sepiolite levels, acting as natural traps for the carnivorans, which were trapped while trying to scavenge on animals trapped previously. Recent studies on the micromammals of Batallones-1 and Batallones-3 suggest a difference in age, with the former being older than the latter. The carnivoran sample from both sites also shows several differences, such as the presence in Batallones-3 of the ursid *Indarctos* sp., and the mustelid *Eomellivora* sp., which are absent in Batallones-1. In order to better understand these differences, we studied one of the most abundant carnivorans in both assemblages, the primitive saber-toothed felid *Promegantereon ogygia*. Several significant biometrical and morphological differences were found between the populations. The dentition of *P. ogygia* from Batallones-3 shows a relatively smaller lower canine, a reduced m1 talonid and P4 protocone, and a narrower P3, features that indicate more emphasis on cutting in the dentition. The postcranial skeleton of *P. ogygia* from Batallones-3 is characterized by a straight and narrower calcaneus, a metacarpal II with an elongated attachment area for the muscle flexor carpi radialis (flexor of the hand) and an overall slender postcranial skeleton. Some of these differences can be related to a reduction in the weight of the hind limb, which points towards an increase in the cursorial abilities of the Batallones-3 form, whereas others indicate the presence of stronger flexor muscles of the hand, related with the need for prey immobilization during hunting. In summary, the population of *P. ogygia* from Batallones-3 shows several derived characters compared with that from Batallones-1. Only future studies including the whole sample of fossils of *P. ogygia* from Batallones-3 will establish the taxonomic status of this population.

Technical Session VI (Thursday, November 3, 2:30 pm)

A RE-EXAMINATION OF THE CRANIAL MORPHOLOGY OF *CONFUCIUSORNIS SANCTUS*

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As one of the most widely known Mesozoic birds, the Chinese Early Cretaceous confuciusornithid *Confuciusornis sanctus* has been extensively studied from many different perspectives. The structure of the skeleton has been described in more detail in this species than in most birds of equivalent geological age, but the osteology of the cranium in particular remains to be fully studied. Based on original observations of the type series, some previously referred specimens, and 9 new specimens, and using previous work on confuciusornithid anatomy as a starting point, we investigated the cranial morphology of *C. sanctus* in unprecedented detail. The degree of fusion among the bones of the skull appears to be smaller in *C. sanctus* than in most other basal or derived birds. However, the sutural contacts among the rostral bones appear particularly firm, which may indicate that *C. sanctus* was capable of forceful biting and/or pecking. The maxilla is more primitive than in other birds, except *Archaeopteryx*, whereas the nasal is nearly triangular and the lacrimal is approximately C-shaped. A prefrontal is present, perhaps indicating that this bone either disappeared later in avian evolution than previously believed or secondarily re-appeared in *C. sanctus*. We tentatively reconstructed the palate of *C. sanctus* as part of our study. The palate is characterized by absence of the ectopterygoid, reduction of the palatine and presence of a relatively primitive pterygoid. Comparisons with theropod dinosaurs, Mesozoic birds and extant birds suggest that the palate of *C. sanctus* should be interpreted as more primitive than in any other known bird except *Archaeopteryx*. All new findings, but especially the palate, reconfirm the relatively basal phylogenetic position of *C. sanctus*. The specimens included in this study show considerable variation in some skull features, such as the length of the frontal process of the maxilla. Due to the poor preservation of many of the available specimens, many details of the cranium of *C. sanctus* remain enigmatic and will need to be elucidated in the future on the basis of better material.

Poster Session IV (Saturday, November 5)

AN EXCEPTIONAL ORNITHISCHIAN TRACKSITE FROM THE EARLY MESOZOIC OF SHAANXI, CHINA

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A site with eight well-preserved trackways of an Early Mesozoic quadrupedal ornithischian dinosaur is the first report of *Deltapodus*- and *Moyenisauripus*-like trackways from Asia. The tracks occur in the Fuxian Fm, near the Triassic-Jurassic boundary in Shenmu County (Shaanxi Province, China), geographically close to the discovery site of the first dinosaur track (*Sinoichnites*) reported from China. Size and morphology suggest that *Sinoichnites,*

based on a holotype pes which is now lost, also represents an ornithischian. Study of all eight trackways indicates the track maker produced *Deltapodus*-like tracks, with indistinct pes digit traces and sub-circular manus traces when the substrate was soft, and *Moyenosauripus*-like tracks, with clear tridactyl pes and pentadactyl manus traces when the substrate was firmer. The tridactyl *Sinoichnites* pes suggests an intermediate mode of preservation.

These observations have global ichnotaxonomic significance because *Moyenosauripus* is well-known in the Lower Jurassic, and *Deltaopdus*, of presumed stegosaurian affinity, is now increasingly well-known from the Middle and Upper Jurassic. If, as we suspect, these two ichnogenera represent different modes of preservation pertaining to the same or similar track makers, then *Sinoichnites, Moyenosauripus* and *Deltapodus* are merely different expressions of a generalized ornithischian morphology common throughout the Jurassic in Europe, Asia, Africa and North America. *Sinoichnites* and *Deltapodus* are too-poorly preserved to match any diagnostic foot morphology and could have been made by almost any ornithischian. In contrast *Moyenosauripus* has a tetradactyl pes and small pentadactyl manus, whereas the Shaanxi morphotype has a tridactyl pes and large pentadactyl manus, possibly representing ornithopod and stegosaurian trackmakers respectively. The whole tracksite (~8 x 10 m) was excavated and reassembled for display at the Shenmu Museum. This is one of the largest excavation and reassembly efforts in the history of vertebrate ichnology.

Poster Session III (Friday, November 4)

THE OLDEST MORPHOLOGICALLY MODERN SOFT-SHELLED TURTLE (TESTUDINES, PAN-TRIONYCHIDAE) FROM THE JEHOL BIOTA OF CHINA

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A new turtle from Jiufotang Formation of western Liaoning, China, represents the first species of soft-shelled turtle of Jehol Biota and the oldest morphologically modern pan-trionychid. The new taxon is diagnosed by the combination of the following characters: neural bone at least four times wider than long; suprascapular fontanelles open and confluent; preneural absent; reversals of the orientation in the neural series at neurals V; costals VIII reduced; postorbital bar narrow, around one-fourth of orbit diameter; jugal contacting squamosal; foramen jugulare posterius excluded from fenestra postotica by descending process of opisthotic, which reaches pterygoid; neural spine weakly developed on anterior cervicals; phalangeal formula for pes 2-3-3-4-?. The new taxon is furthermore different from all modern soft-shelled turtles by possessing a complete row of neurals that fully hinders any medial contact of the costals and by having parietals that do not contribute to the processus trochlearis oticum. The new taxon can therefore be diagnosed as being situated outside of crown Trionychidae.

Poster Session III (Friday, November 4)

A REEVALUATION OF THE RELATIONSHIPS AMONG BASAL ORNITHURINE BIRDS FROM CHINA AND NEW INFORMATION ON THE ANATOMY OF *HONGSHANORNIS LONGICRESTA*

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The past five years have seen the discovery of an array of new Early Cretaceous ornithurine birds from northern China. However, the relationships among these taxa have been unresolved in many recent analyses. Other analyses have recovered conflicting hypotheses concerning the relative placement of key taxa. Whether or not a clade comprising several ornithurine taxa from the Early Cretaceous of China is supported and could represent a small endemic, Asian radiation is debated. Specimens of *Hongshanornis longicresta* provide valuable information on the relationships and morphological evolution of basal ornithurines. Here, the morphology of *Hongshanornis* is reevaluated through examination of the holotype specimen, in which most bone is preserved as impressions, and newly-available latex peels. *Longicrusavis houi*, which was proposed as the sister taxon of *Hongshanornis longicresta* is also reevaluated. As well as comprising the best-preserved ornithurines from Yixian Formation, the two specimens come from nearby localities, Shifo in eastern Inner Mongolia (*Hongshanornis*) and Lingyuan in western Liaoning Province (*Longicrusavis*). Phylogenetic analysis utilizing a new dataset for Mesozoic avialans evaluates the placement of these taxa as well as other early Cretaceous ornithurines (e.g., *Archaeorhynchus*, *Jianchangornis* and *Gansus*). A change in hind limb proportions related to an ecological shift toward a "wading", or more generally terrestrial, habitus has been proposed in *Hongshanornis* and other investigated taxa. In addition, a functional transition has been identified across this part of bird evolution after the origin of flight. Evidence bearing on avialan hind limb evolution, both meristic data and discrete quantitative characters, is considered for basal Ornithurae in light of the phylogenetic results. A shift is identified, but the relationship between this shift and a particular ecology for early ornithurines is questioned.

Poster Session II (Thursday, November 3)

MORPHOLOGICAL RESPONSES OF THE DIRE WOLVES (CANIS DIRUS) OF RANCHO LA BREA OVER TIME DUE TO CLIMATIC CHANGES

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This study demonstrates the lack of morphological response of *Canis dirus*, the dire wolf, to climatic shifts during the late Pleistocene, a period of extreme climatic variability, ranging from glaciations to temperatures approaching modern maximums. To test if climate change caused morphological change in *Canis dirus* many variables were measured on hundreds of fossils from the Rancho La Brea collections, including femora, tibiae, humeri, and astragali. These measurements were then grouped based on mean radiocarbon age from each of five differently dated bone-producing pits. The correlation of pit ages to paleoclimate allowed the temporal and climatic aspects of the hypothesis to be tested. The resulting data was not normally distributed so a non-parametric test for significance of differences was used, the Kruskal-Wallis test. Individual tests were performed on each of the data sets. The results of the tests (with the exception of the aberrant results from the population dated at 16,000 years ago) indicate that over nearly 25,000 years, there has been morphological stasis over time in dire wolves, despite significant climatic shifts.

Poster Session II (Thursday, November 3)

A SLOTH-DOMINATED LATE-QUATERNARY ASPHALT SEEP FROM SANTA ELENA, ECUADOR

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Asphalt seeps, or "tar pits," represent important repositories of paleoecological information, especially in areas such as the tropics where fossil preservation potential is generally poor. Fossil deposits in the petroleum-rich sediments of the Santa Elena Peninsula (SEP) in southern Ecuador contain some of the largest and best-preserved assemblages of Pleistocene megafaunal remains known from the neotropics, and thus represent an opportunity to greatly expand our knowledge of conditions surrounding the Late Quaternary Extinction event in this region. Excavations in the early to mid 20th century recovered substantial Pleistocene megafaunal material from several sites on the SEP, but these excavations were not stratigraphically controlled and microvertebrate material was often not collected. Here I report data from recent excavations at Sitio Tanque Loma, a late-Pleistocene locality on the SEP that preserves a dense assemblage of megafaunal remains in hydrocarbon-saturated soils. Over 1,000 megafaunal bones have been identified from this site, more than 85% of which pertain to a single species, the giant ground sloth *Eremotherium laurellardi*. Only five other megafaunal taxa have been identified from this site, including *Glossotherium*, *Holmesina*, cf. *Stegomastodon*, *Equus*, and cf. *Odocoileus*. The absence of carnivores and rarity of microvertebrate remains in the Pleistocene strata at Tanque Loma stand in stark contrast to patterns observed at other well-known asphalt seeps, including Rancho La Brea in California, U.S.A. and La Brea-Talara in Talara, Peru, where carnivores and small vertebrates – especially water birds – tend to be the most common taxa present. Taxonomic, taphonomic and geological data suggest that Tanque Loma represents a fluvial deposit with secondary infiltration of tar, rather than a "tar pit" trap. The overwhelming abundance of a single species (*E. laurellardi*) at this site may have important implications for the biology of this species, and for our understanding of the ecology of terminal-Pleistocene coastal neotropical ecosystems.

Poster Session II (Thursday, November 3)

THE EFFECTIVE USES OF POLYESTER QUILT BATTING FOR CONSTRUCTING PLASTER JACKETS

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Polyester quilt batting has been tested for advantages over other jacketing media particularly burlap, plaster-infused gauze bandages and fiberglass air filter. Polyester has proven itself in industry as being stronger and more durable than natural fibers. Burlap and gauze jackets require additional layers and weight to decrease flexibility; while fiberglass and polyester air filters can be used to construct lightweight, rigid jackets. Fiberglass has restricted use to laboratory and collections settings due to the preventative measures that must be taken to prevent adverse health effects, such as irritation to skin, eyes, digestive system, and respiratory system. Polyester quilt batting is composed of a similar mesh as is fiberglass air filter, and is similarly effective in crafting lightweight, inflexible jackets. There are no known adverse health effects with polyester. Polyester quilt batting is also more affordable than alternative materials, reducing the need to buy multiple materials for varied jacketing techniques.

Comparison of the jacketing material included egg drops with eggs contained in burlap and quilt batting jackets. Jackets were constructed with conventional means for common field and lab settings, using toilet paper as a cushion and separator. Drops were performed at a uniform height of 80 centimeters, resulting in slightly less egg breakage in quilt batting jackets. This is likely due to the reduced mass and force of impact. Some human error included eggs breaking while opening jackets and imperfections in the interior surface of jackets leading to cracks in eggshells. The overall benefits of using polyester quilt batting, to cost as well as material integrity and versatility makes it preferable to most other materials, especially fiberglass air filters.

Poster Session IV (Saturday, November 5)

CONSTRAINTS ON THE FORMATION OF MARINE BONE CONCENTRATIONS
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Marine bone concentrations can occur as distinct widespread stratigraphic intervals approximately .2m -1m thick, for example the Shark Tooth Hill bonebed, CA (Miocene), Zone 12 in the Calvert Fm (Miocene), and the PaleoAngola bonebed in Africa (Cretaceous). Fossil specimens from these intervals are abundant and diverse. However, before reliable paleoecologic information can be interpreted from them, we need a firm understanding of bonebed genesis to account for temporal and ecologic mixing and other taphonomic biases. To date, two hypotheses are generally proposed for non-catastrophic bonebed origin: (1) an offshore concentration where bone input > sediment input; or (2) a winnowed and/or transported lag caused by eustatic sea-level change or storm events. Here, we scrutinize conditions necessary to generate an offshore bone concentration caused by sediment starvation through the use of a quantitative model to evaluate the feasibility of this hypothesis. We constructed a theoretical model using published parameters of bone decay, sedimentation rates, and skeletal input rates for a variety of offshore environments to evaluate the time necessary to generate a 50 cm bonebed (bone fraction >30%). In the absence of bone decay, we found that sedimentation rates must be lower than 1cm/1000years and the equivalent of one large whale or more must die every 1000 km2 per year. Under these conditions, a bone bed .5cm thick will take a maximum of 110,000 years to a minimum of 30, 000 years to form. However, when bone decay rates observed on recent whale fall skeletons and shipwrecks (10% - .01% loss of bone mass per year) are introduced to the model, even large skulls will degrade faster than the maximum possible sedimentation rates can bury them, making it impossible to generate a bonebed under the given assumptions. Our results indicate that marine bone concentrations are unlikely to develop in sediment -starved environments without the aid of other unidentified processes (bioturbation, differential decay?). Thus, we tentatively propose that sediment winnowing and/or bone transport processes are necessary in order to generate an attritional marine bone concentration.

Technical Session XVI (Saturday, November 5, 12:00 pm)

THE EARLY DIVERSITY OF NON-CYPRINID CYPRINIFORMS (OSTARIOPHYSI, CYPRINIFORMES) IN THE EOCENE OF EAST ASIA AND NORTH AMERICA
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Cypriniform fossils are very rare prior to the Eocene. Only fragmentary bones and teeth of a putative 'cyprinid' from the Cretaceous of South America and a catostomid from the Paleocene of Canada are known. Cypriniforms diversified globally during the Eocene, though their Eocene occurrences were without exception assigned to either Cyprinidae or Catostomidae. Furthermore, whereas Eocene cyprinids were reported from Europe and Asia, the non-cyprinids were only found in East Asia and North America. Three Eocene catostomid genera are known: *Amyzon, Plesiomyxocyprinus,* and *Vasnetzovia. Amyzon,* with at least four species, was distributed widely in western North America. One species of *Amyzon* was also reported from Hunan, southern China. The monospecific *Plesiomyxocyprinus* was reported from Jilin, northeastern China. The Siberian *Vasnetzovia*, if valid, would be the third genus in East Asia. Adding to the known diversity, *Jianghanichthys*, a problematic cypriniform from Hubei, southern China, probably represents a new family of Cypriniformes. It had earlier been assigned to a modern genus of Cyprinidae, and later named as a new genus of uncertain family status. Later, we suggested it belonged to Catostomidae based on synapomorphies such as maxilla forming mouth gape, opercular arm developed, and sphenoid prominently exposed. However, our new phylogenetic analysis lacks strong support for this familial assignment. Using cyprinid and cobitoid species as part of the ingroup, and using *Chanos* (Gonorynchiformes) and Citharinidae (Characiformes) as outgroups, *Jianghanichthys* is resolved as basal to the entire ingroup and should be given its own family. Autapomorphies of *Jianghanichthys* include: first principal anal fin ray branched, sensory canal partially enclosed in frontal, and dentary with broad and triangular 'occlusal' surface. A new form from the Eocene of Guangdong, southeastern China, might also belong to this new family. This finding increases the higher-level taxonomic diversity in East Asia, a geographic region that is expected to play a vital role in our understanding of cypriniform evolution, and that is an important area for continued field-based discoveries.

Poster Session I (Wednesday, November 2)

OSTEOLOGY AND PHYLOGENETIC POSITION OF *SINOPHEONEUS YUMENENSIS* (THERAPSIDA, DINOCEPHALIA) FROM THE DASHANKOU FAUNA (MIDDLE PERMIAN)
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Sinopheoneus yumenensis and *Stenocybus acidentatus* are both known dinocephalian taxa from China. *Stenocybus* was proposed as a basal-most dinocephalian or basal-most anteosaurian dinocephalian. Some new specimens from the same locality, which clearly can be referred to *Stenocybus*, are described in detail. Based on available specimens, *Sinopheoneus yumenensis* only differs from *Stenocybus acidentatus* by a larger size and a more pachyostosed orbit region. The latter taxon is regarded as a junior synonym of the former. Phylogenetic analysis shows that *Sinopheoneus* is an anteosaurian dinocephalian.

Poster Session I (Wednesday, November 2)

BIODIVERSITY OF MARINE REPTILES FROM THE MIDDLE TRIASSIC LUOPING BIOTA, YUNNAN, CHINA
LIU, Jun, The University of Hong Kong, Hong Kong, China

The pattern of diversification history of Mesozoic marine reptiles, apex predators of Mesozoic oceans, has received increased attention recently. Fossil Lagerstätten that preserve nearly complete ecosystems provide us almost unbiased snapshots of the diversification history of life. Significant absence from current research of Mesozoic marine reptiles is the compilation of a database of biodiversity from intensively sampled fossil Lagerstätten and a quantitative comparison. Here I present a preliminary review of the diversity of marine reptiles from the Luoping biota and compare the ecological guilds of this Lagerstätte with other well studied Mesozoic marine communities. The Luoping biota is a recently discovered marine Lagerstätte from the Middle Triassic Guanling Formation in eastern Yunnan Province, China and has received intensive collection by the China Geological Survey. Detailed conodont analyses and SHRIMP zircon U-Pb age from interbedded tuff suggest a late Anisian age for this Lagerstätte. All of the main lineages of marine reptiles have already been recorded in the Luoping biota. Ichthyosaurs are exclusively mixosaurids, which are the most abundant reptiles in this fauna. Three morphotypes have been recognized. These are *Mixosaurus* cf. *panxianensis*, *Phalarodon atavus*, and another phylogenetically indeterminate taxon. Sauropterygians include one placodont and several pachypleurosaurs and nothosauroids. The only placodont is identified as *Placodus* sp.. One of the pachypleurosaurs has been named as *Dianopachysaurus dingi*. The other is currently under study by colleagues from other institutions. Nothosauroids include *Lariosaurus* sp., *Nothosaurus* sp. and *Nothosaurus* cf. *giganteus*. Protorosaurs comprise two morphotypes. One of them is identified as *Dinocephalosaurus orientalis*. The other has much thinner cervical vertebrae and is tentatively identified as cf. *Dinocephalosaurus*. Other reptiles include *Sinosaurosphargis yunguiensis*, one phylogenetically undetermined thalattosaur, and several archosaur teeth. Six or seven ecological guilds, as defined by Judy Massare on tooth morphology and swimming ability, have already been present in Luoping biota based on my investigation. Comparison with other Mesozoic marine faunas suggests that complex marine ecosystems have already been re-established at least by the end of Anisian.

Poster Session II (Thursday, November 3)

NEW BAENID TURTLES FROM THE KAIPAROWITS FORMATION OF SOUTHERN UTAH: IMPLICATIONS FOR LARAMIDIAN BIOGEOGRAPHY
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New discoveries demonstrate that the late Campanian dinosaur assemblages of each basin in western North America (Laramidia) were distinct from each other. However, the paleobiogeographic patterns of other vertebrate groups are less well known. Our study examines members of the turtle clade Baenidae, one of the most abundant and diverse clades of freshwater turtles during the Late Cretaceous, from the Upper Cretaceous Kaiparowits Formation of southern Utah. Previously reported taxa from the Kaiparowits Formation include *Neurankylus*, *Boremys*, *Denazinemys*, and *Plesiobaena*. *Neurankylus*, one of the basal members of the clade, exhibits a cosmopolitan distribution, ranging from Alberta to Mexico. *Boremys*, a member of the derived baenid clade Baenodda, contains two species, one from northern Laramidia and the other from southern basins. *Denazinemys* has only been recorded in southern Laramidia, from the Kaiparowits Basin, the San Juan Basin in New Mexico, and the Aguja Basin of Texas. A fourth baenid from the Kaiparowits is highlighted by a newly discovered specimen that includes a nearly complete skull, shell, vertebral column, girdles, and limb elements. This new taxon is assignable to the subclade Baenodda based on a wedge-shaped skull, short frontals, and exposure of the suprapygal on the posterior carapace margin. Preliminary analysis indicates that this species is closely related to *Plesiobaena antiqua* from the Campanian of Alberta and Montana. However, some plesiomorphic characters – particularly large nasals – suggest that it may be basal within the clade containing the northern Laramidian *Plesiobaena* and *Palatobaena*. The shell of this specimen is indistinguishable from other Kaiparowits specimens previously referred to *Plesiobanea*. This species is known only from the Kaiparowits Formation, and thus is distinct from related northern taxa. Individual taxa of the Kaiparowits baenid assemblage do not exhibit a uniform biogeographic distribution, but appear to support a division between northern and southern late Campanian biogeographic provinces of Laramidia.

Symposium 4 (Friday, November 4, 8:00 am)

400-MILLION YEARS OF 'FISHES': A SURVEY OF SAMPLING BIASES BASED ON THE UK RECORD
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Fishes comprise a majority of living vertebrate species, with an extensive fossil record spanning most of the Phanerozoic. Surprisingly few analyses have explored patterns of taxonomic diversity in fossil fishes since these were first investigated by Agassiz more than a century and a half ago. Paleobiodiversity trajectories in fossil fishes are thought to be disproportionately driven by exceptional deposits ("Lagerstätten effects"), but the degree to which these

patterns are influenced by the rock record more generally remains unquantified. Today, as in Agassiz's time, perspectives on fish evolution are strongly influenced by the well-studied UK record, which yields a series of important faunas ranging from Silurian (Llandovery) to latest Eocene (Priabonian) in age. We assembled a database spanning this interval, comprising 1678 species occurrences from 100 localities spanning 70 geologic formations and representing 443 genus-level lineages encompassing a diverse taxonomic assemblage spanning 'agnathans' to fin-bearing members of the tetrapod stem lineage.

Some patterns revealed by our UK survey match features in fish data derived from Sepkoski's genus-level and Benton's (Fossil Record 2) family-level global compendia, most strikingly an increase in taxonomic diversity approaching the Recent. Unlike those analyses, we sampled our data in-bin and excluded extant taxa, suggesting the observed rise is not attributable to a "Pull of the Recent". Furthermore, we show that when accounting for potential sampling bias - through rarefaction, shareholder quorum subsampling or a modelling approach using either the number of fish-bearing formations or localities as a rock record proxy - this signal remains, with a prominent Paleogene peak.

Breaking out the two largest extant clades - Chondrichthyes and Osteichthyes - shows that these groups have similar post-Devonian patterns, both to each other and to the cumulative 'fish' curve. However, we do show the bony fishes make more statistically significant excursions from a model that assumes true diversity is constant and observed diversity is driven purely by sampling. Overall, although correlations between taxonomic diversity and our rock record proxies are significant, fish diversity appears to be less biased by sampling than many terrestrial vertebrate groups, such as dinosaurs.

Poster Session II (Thursday, November 3)

CROCS NOT THEROPODS WERE LIKELY TOP PREDATORS ON THE CRETACEOUS DINOSAUR FREEWAY: IMPLICATIONS OF A LARGE TRACK CENSUS

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The track-rich, Cretaceous Dakota Group has yielded few vertebrate body fossils. However, more than 70 tracksites have been documented in Colorado, New Mexico, Kansas and Oklahoma, providing a census estimate of at least 1380 individual vertebrate track makers, for the region known as the Dinosaur Freeway, representing the coastal plain of the Cretaceous Western Interior Seaway. Ornithopod tracks (*Caririchnium* of the eponymous *Caririchnium* ichnofacies/ichnocoenosis) dominate (at 71% of sites) but large theropod tracks are conspicuously absent, and small theropod tracks (*Magnoavipes*) of likely ornithomimid affinity represent predators too small to have preyed upon large ornithopods. However, crocodylian walking and swim tracks occur at ~28% of the localities and include representatives of large animals (~4 m long). The walking crocodilian trackway *Mehliella* was the first crocodylian track reported from the Cretaceous, and the first, of presumed crown group affinity, given a formal ichnotaxonomic name, both in the early 1930s. The lost, historically-important holotype track was recently relocated in the University of Colorado Museum of Natural History collections. Crocodyle swim tracks (ichnogenus *Hatcherichnus*) are also abundant and represent the *Hatcherichnus* ichnofacies. This suggests that crocodylians were very likely the top ambush predators on the Dinosaur Freeway where croc-infested waterways interpenetrated the ornithopod foraging grounds in a coastal plain ecosystem bordering the Cretaceous Western Interior Seaway.

Symposium 3 (Thursday, November 3, 10:45 am)

CAMPANIAN THEROPOD EVOLUTION AND INTRACONTINENTAL ENDEMISM ON LARAMIDIA

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Laramidia (western North America) was isolated from Asia and Appalachia from ~95-70 Ma. The Campanian vertebrate record of this island continent is richly diverse. Until recently, much of our understanding of this diversity came from the north. However, recent discoveries in the south, together with improved geochronologic control, suggest that many groups of vertebrates exhibited latitudinally arrayed, restricted geographic ranges during this time. A lack of any identifiable, persistent physiographic barrier to dispersal between northern and southern faunas on Laramidia has led to hypotheses invoking differences in climate and flora to explain the apparent endemism in many groups of ornithischian dinosaurs, crocodilians, and turtles.

Theropod dinosaurs present a unique test of the endemism hypothesis because the sensitivity of several subclades to climatic and floral changes was mitigated by a carnivorous diet (e.g. tyrannosaurids, dromaeosaurids). Overall, the same major subclades of theropods are present in the north and south of Laramidia during the Campanian including tyrannosaurids, ornithomimids, dromaeosaurids, oviraptorosaurians and troodontids. However, species-level biodiversity indicates a high degree of interformational endemism. For example, despite their large-body sizes and predatory role, recent finds indicate that tyrannosaurids were divided into distinct clades of northern and southern tyrannosaurids from 80 to 72 Ma. The record among smaller-bodied theropods is equally persuasive with at least oviraptorosaurians and troodontids exhibiting species-level endemism between north and south at 76 Ma. Moreover, all Campanian theropod groups on Laramidia show diversity and distribution patterns consistent with having evolved in isolation on Laramidia between ~95-80 Ma. In summary, theropod ranges in the upper Campanian of Laramidia were more restricted than previously thought, mimicking the record of ornithischians and other non-marine tetrapods. Although the nature of the barrier to north-south mixing remains uncertain, the presence of distinct, latitudinally arrayed tyrannosaurid clades suggests the possibility of a physical barrier to dispersal.

Poster Session IV (Saturday, November 5)

PROBOSCIDEANS FROM THE MIDDLE MIOCENE BARSTOW FORMATION OF CALIFORNIA

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Proboscidean remains were first reported from the Barstow Formation in 1919 based on tooth fragments. In 1933, *Trilophodon bartonis* was described based on a dp3 and p4 designated as co-types; since referred to *Zygolophodon.* Based on field work from the 1960's to the present, the Raymond Alf Museum of Paleontology (RAM) currently houses the largest collection of proboscidean remains from the Barstow Formation. The first RAM specimens collected were the most complete; a dentary with tusk and m3 and a partial skull of *Zygolophodon*, the only known skull of the genus from North America. Neither specimen has precise locality data, but it is probable that the skull and dentary are from the upper member because all documented Barstow Formation proboscidean remains are from that stratigraphic interval. In 1969, a track way consisting of four proboscidean tracks was collected from low in the upper member, approximately 120 feet above the Skyline Tuff. This track way was likely made by *Zygolophodon* because *Gomphotherium* only occurs higher in the formation. Teeth collected over the past two decades include an m2 of *Gomphotherium* and two P3's, two P4's, a DP4, and two dp4's of *Zygolophodon*. Most notable is the m2 as it comes from a site ninety feet below the tuff that underlies the *Hemicyon* Quarry. *Hemicyon* Quarry is the site of the previously oldest known Barstow Formation specimen of *Gomphotherium.* This RAM site has also yielded the holotype of *Megahippus mckennai*, a complete shell with postcranials of *Xerobates mohavense*, and hundreds of isolated elements of small birds and mammals. All proboscidean body fossils from the Barstow Formation are late Barstovian (Ba2) in age. Early Barstovian (Ba1) records of *Zygolophodon* and *Gomphotherium* are reported from northwest North America (including central California and Oregon) and Mexico, areas that geographically bracket the Bartow Formation sites. Why proboscidean skeletal elements are not known from early Barstovian strata of the Barstow Formation after nearly a 100 years of prospecting is unclear, but it is likely not a factor of inadequate sampling.

Poster Session I (Wednesday, November 2)

A NEW SPECIES OF *PARAPLACODUS* (SAUROPTERYGIA: PLACODONTOIDEA) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

LONG, Cheng, Wuhan Institute of Geology and Mineral Resources, Wuhan, China; XIAOHONG, Chen, Wuhan Insititute of Geology and Mineral Resources, Wuhan, China; JUN, Liu, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; XIONGWEI, Zeng, Wuhan Institute of Geology and Mineral Resources, Wuhan, China

Many placodont fossils have been collected from the Triassic of Guizhou and Yunnan provinces, southwestern China, but only one unarmored placodontoid was reported. Recently, a placodontoid specimen was collected from the Middle Triassic Anisian in Luoping County, Yunnan Province and was identified as a new species of *Paraplacodus*. It was the first record of *Paraplacodus* from outside the western Tethys. This specimen shared many synapomorphies with *Paraplacodus broilii*: skull relatively high and narrow; each premaxilla carrying three elongated, slightly curved, strongly procumbent teeth; the retroarticular process massive and short; neural spine much high and narrow; posterior chevrons divaricating anteroposteriorly; and clavicle slender and strongly curved. It differs from *Paraplacodus broilii* by slender dorsal ribs, and each gastral rib composed of single curved element. In our phylogenetic analysis, *Paraplacodus* had a basal position within Placodontia.

Poster Session IV (Saturday, November 5)

NEW INSIGHTS INTO THE VERTEBRATE FAUNA FROM THE MIOCENE OF CHIOS (GREECE)

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In July 2010, we prospected in Chios Island for vertebrate remains, both in Mesozoic and Cenozoic strata. No vertebrates were found in the Mesozoic outcrops inspected. However, after intensive sampling of various levels in the 'Michalos pit' zone, we were able to uncover two layers with Miocene vertebrates. The 'Michalos pit' is a quarry situated SSE of Thymiana, about 8 km from Chios city. All of the vertebrate specimens known so far from the Miocene of Chios come from the exposure of the Kerameía Formation in or close to this quarry.

The upper fossiliferous horizon yielded only a cranial fragment of a large indeterminate mammal. Nevertheless, the lower one, which presents a completely different lithology (clayey versus sandy), produced a diverse vertebrate fauna after screen-washing and sort-

ing. The assemblage is largely dominated by mammals. Rodents and, to a lesser extent, lagomorphs are best represented. Rodents are largely represented by cricetids, in particular species probably belonging to the genera *Cricetodon*, *Megacricetodon*, and *Democricetodon*. Additional potential rodent taxa include a sciurid and a pedetid. Preliminary identification of the specimens of lagomorph suggests the presence of *Prolagus*. The insectivore record consists of *Galerix*-like teeth and an incomplete mandible. Remains of larger mammals were also found. They include a phalanx of an indeterminate ruminant, a possible tooth fragment of *Cainotherium* and another of *Sanitherium*.

This assemblage is consistent with a Middle Miocene age. The excavation site does not correspond to any of the localities previously sampled, though the fauna collected is reminiscent. The stratigraphy suggests that it is not coeval with any of the previously recognized horizons called 'Thymiana A', 'Thymiana B', and 'Thymiana C', all of which may be more recent.

Technical Session XVII (Saturday, November 5, 3:00 pm)

DIVERGENT TOES: EVOLUTION OF AFRICAN ANTELOPE PROXIMAL PHALANGES AND IMPLICATIONS FOR DIVERGENCE OF SHAPE AND SIZE

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Morphological convergence amongst species inhabiting similar environments but having different evolutionary histories is a concept central to evolutionary biology. Cases of divergent evolution, that is, the morphological divergence of closely related species when these species begin to exploit different environments are less well studied. Here we show divergent evolution in the morphology of the proximal phalanges of several closely related species of African antelope inhabiting different environments. This pattern was consistently observed in both an unbiased morphospace and an ecologically weighted morphospace. Divergence, but not convergence, was also observed when size, independent of shape, was considered. Both convergence and divergence were observed when shape, independent of size, was considered. Convergent evolution of the morphology of the proximal phalanges was observed, but only in the ecologically weighted morphospace. Size shows less correlation with phylogeny ($r=0.144$, $p=0.0124$) than does shape ($r=0.2975$, $p<0.0001$). Therefore we suggest that divergence in size will occur more readily when a species encounters new environmental conditions than divergence in shape. These findings are compatible with Foster's rule. We further suggest that once a species begins adapting to a different environment, morphological convergence with distantly related species inhabiting that environment would proceed firstly by shape changes, and subsequently by changes in size.

Poster Session II (Thursday, November 3)

VERTEBRATE ICHNOLOGY OF THE EARLY TRIASSIC RED PEAK FORMATION (CHUGWATER GROUP), CENTRAL WYOMING

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The Early Triassic Red Peak Formation of the Chugwater Group has historically been considered to be nearly devoid of life. Recent field trips to outcrops in central Wyoming have yielded a new medium-high diversity vertebrate ichnoassemblage (≥4 ichnogenera) that represents dinosauromorph, archosaur, lepidosaur, and testudinate track makers (cf. *Rotodactlyus*, *Chirotherium barthii*, *Rhynchosauroides* isp., and cf. *Chelonipus*, respectively). Synapsid and amphibian tracks have not yet been observed though they would not be unexpected. *Rhynchosauroides* tracks greatly outnumber all other taxa, with chirotheroid tracks representing the second most common clade. *Rotodactylus* and *Chelonipus* tracks are rare, although *Chelonipus* is well represented at one locality. Chirotheroid traces are the only taxa present in the uppermost sandstone, which is typically within 1-2 m of the overlying Alcova Limestone; these traces exhibit features consistent with a fully saturated substrate. Tracks are preserved in convex hyporelief on the soles of very fine-grained sandstones interpreted to be crevasse splays and small-scale lenticular channel deposits, they are also preserved as concave epirelief on splay and bar tops. Interpretations of sedimentology suggest fluvial and floodplain deposits dominate the upper Red Peak Fm of central WY, the invertebrate and vertebrate ichnology support this interpretation. This is contrary to previous interpretations that considered the entirety of the Red Peak to represent marine and intertidal depositional environments. This ichnoassemblage provides the first opportunity to observe vertebrate diversity and associated paleoenvironments in the Red Peak Fm.

Poster Session III (Friday, November 4)

A NEW GOBIPTERYGID BIRD FROM THE LATE CRETACEOUS CENTRAL CHINA AND ITS BIOGEOGRAPHIC IMPLICATIONS

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Gobipteryx minuta was the first described enantiornithine bird from the Late Cretaceous of Asia. It was discovered from the Barun Goyot Formation in the Gobi Desert Mongolia. Herein reported is a new gobipterygid bird from the Late Cretaceous Qiupa Formation of Tantou Basin, Luanchuan County of Henan Province. The specimen is an almost complete skull and lower jaws with much of the postcranial skeleton preserved. The 60.6 mm long skull is three-dimensionally preserved. It is larger than specimens of *Gobipteryx*. Important osteological characters include: nasals are long and narrow, fused anteriorly, but not fused posteriorly, occupying 47% of the skull length; the subtriangular nasal opening is typically smaller than the antorbital fenestra; length of the frontal equal to its maximum width; frontal shorter than nasals; vaulted parietals are not fused, and are much shorter than the frontals; a distinct transverse nuchal crest is present on the parietal; distinct fossa present on the dorsolateral surface of the parietal; the quadrate is about 1/4 the length of the skull, similar to that of *Archaeopteryx* and *Gobipteryx*. The proximal end of the quadrate is mobile but covered by the squamosal. The articulation with the lower jaw is at the level of the posterior margin of the orbit. In lateral view, the ventral margin of the dentary slopes ventrocaudally at an angle of roughly 35°. The long mandibular symphysis is well fused, but the suture is visible. The dentary bifurcates into dorsolateral and ventrolateral processes with the longitudinal groove (a lateral depression) in between, as in *Gobipteryx*. The scapula is straight, with a well-developed acromion. The acromion is separated from the humeral articular facet by a thick neck. The deltopectoral crest of the humerus is large and flat, lacking any cranial curvature. The length ratio of the deltopectoral crest to humerus is about 0.4. The capital incision is distinct between the humeral head and the ventral tubercle. The ventral tubercle is well projected. The ulna is longer than the humerus. The radius is much more slender than the ulna.

The new specimen represents the first unquestionable gobipterygid bird outside of the Gobi Region. It is closely related to *Gobipteryx* and is the most southerly occurrence of such a clade, which demonstrating southern extension of gobipteryid bird distribution in eastern Asia. It also indicates that the geological age of the Qiupa Formation may be equal to that of the Barun Goyot Formation.

Poster Session II (Thursday, November 3)

THE TRACKMAKER OF THE LATE TRIASSIC TETRAPOD FOOTPRINT ICHNOTAXON *BRACHYCHIROTHERIUM* WAS AN AETOSAUR

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Brachychirotherium is a common ichnogenus of Late Triassic chirothere footprints well known from western Europe, North America, Argentina and South Africa. Historically most workers have agreed that the trackmaker of *Brachychirotherium* was a derived crurotarsan archosaur, but the trackmaker has been identified as either a "rauisuchian" or an aetosaur, though some workers attribute it to a primitive crocodylomorph (sphenosuchian). New knowledge of the osteology of the manus and pes of a large aetosaur, *Typothorax coccinarum*, indicates a close correspondence between the manus and pes structure of aetosaurs and the morphology of *Brachychirotherium*. Furthermore, functional analysis of complete skeletons indicates aetosaurs were capable of placing their feet in the narrow gauge, nearly overstepped walk characteristic of *Brachychirotherium*. *Brachychirotherium* and aetosaurs have matched geographic and stratigraphic distributions in that both were Pangea-wide during the Late Triassic but restricted to Upper Triassic strata as well. The manus and pes morphology of rauisuchians and early crocodylomorphs (sphenosuchians) deviate from *Brachychirotherium* footprint morphology in key features, thus excluding their identification as trackmakers. Thus, morphological, functional morphological, geographic, and stratigraphic distributional data support identifying aetosaurs as the trackmaker of the footprints of the common Late Triassic chirotherian ichnogenus *Brachychirotherium*. Other suggested trackmakers---rauisuchians and sphenosuchians---can be excluded because their manus and pes morphology, as well as their inferred gait, does not match that of *Brachychirotherium*.

Preparators' Session (Thursday, November 3, 9:30 am)

BEST PRACTICES IN CLEANING, DRYING, AND STABILIZATION WET PLEISTOCENE MEGAFAUNA MATERIAL FROM SNOWMASS, COLORADO

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In 2010, the Denver Museum of Nature and Science collected ca. 600 Pleistocene bones from Ziegler Reservoir in Snowmass Village, Colorado. The first fossils were discovered by construction workers enlarging the reservoir. Working with a combination of heavy equipment and basic manual excavation techniques, museum staff and volunteers recovered the remains of multiple Columbian mammoths, American mastodons, giant bison, deer, and a Jefferson's ground sloth. Bones, teeth, and tusks were extremely well preserved with much of the original organic material intact and no permineralization.

Freshly excavated bones were sediment-covered and saturated with water, presenting conservators and preparators with challenges in cleaning, drying and stabilizing specimens. Minimally invasive techniques (e.g., only water or ethanol as cleaning agents) were used to permit subsequent sampling for testing of DNA, histology, isotopes, and other aspects of composition. Different protocols were develpoed for bones, teeth, and tusks, but most involved retardation of drying by enclosing specimens in plastic bags, plastic containers, or plastic tents. With careful monitoring, specimens dried slowly enough to reduce warping and cracking but had enough air circulation to prevent mold growth. Minimizing moisture gradi-

ents was critical for maintaining integrity as specimens equilibrated to Denver's low ambient humidity. To minimize differential drying of bones in plaster field jackets, small holes were cut in the bottom of the jackets.

Stabilizing the tusk material is vital to preserving the record of the lives of proboscideans. Age, sex, and season of death can be determined by studying the growth layers and composition of tusks. Zip ties were used to help prevent warping and expansion of cracks during the drying process, and in some cases, to close cracks. Once specimens were dry, methyl methacrylate was used as a consolidant and adhesive. For heavier items, epoxy was the preferred adhesive. Ultimately, almost every specimen required unique consideration to determine the best practices for its care and conservation.

Poster Session III (Friday, November 4)

CRANIAL REMAINS OF *CHEIROGASTER* (TESTUDINES: TESTUDINIDAE) FROM THE LATE MIOCENE OF ECOPARC DE CAN MATA (VALLÈS-PENEDÈS BASIN, NE IBERIAN PENINSULA): TAXONOMIC AND PHYLOGENETIC IMPLICATIONS

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Cheirogaster includes medium to large-sized extinct terrestrial tortoises from Europe. Here we report two skulls from the Vallesian (MN9, Late Miocene) of Ecoparc de Can Mata (ECM; els Hostalets de Pierola, Catalonia, Spain), attributed to *Cheirogaster richardi*, whose cranial anatomy was previously unknown. This taxon was considered a subjective junior synonym of *Cheirogaster bolivari* on the basis of a previous neotype designation for *C. richardi*. Such designation, although justified because the holotype of *C. richardi* had been destroyed, must be considered invalid because it was based on material from a different basin—even though remains from the area of the original type locality were available. A new neotype designation based on the material from ECM (from the same age and area than the destroyed holotype) would be desirable in the future, in order to provide an emended diagnosis of *C. richardi* (incorporating cranial features), and further clarifying its taxonomic status as a distinct species from *C. bolivari*.

In order to infer the phylogenetic relationships of *Cheirogaster*, we incorporated the cranial features revealed by the two ECM skulls, together with previously-published data on other Miocene *Cheirogaster* species, into a pre-existing matrix of cranial characters for extant testudinid genera. A cladistic analysis based on maximum parsimony yielded two most-parsimonious trees that support a sister-taxon relationship between *Cheirogaster* and the African large-bodied testudinid *Centrochelys*. Such relationship is supported by bootstrap analysis, with the *Centrochelys+Cheirogaster* clade being defined by several synapomorphies. Our results therefore contrast with those of a previous cladistic analysis, based on molecular and morphologic data (different matrix), indicating a much more basal position of *Cheirogaster* amongst testudinids. Furthermore, the nesting of *Cheirogaster* within a clade otherwise composed by African, Madagascan and Indo-oceanic taxa suggests that, from a paleobiogeographic viewpoint, *Cheirogaster* might be of African origin, although a taxonomic revision of Paleogene *?Cheirogaster* from Europe would be required to test this hypothesis.

Technical Session XV (Saturday, November 5, 10:30 am)

NEGATIVE ALLOMETRY IN ONTOGENY AND EVOLUTION OF MAMMALIAN MIDDLE EAR IN MESOZOIC MAMMALS

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The definitive mammalian middle ear (DMME) is defined by the disconnection of the middle ear from the mandible, and also characterized by the smaller size of the ear, relative to the skull, than those of premammalian synapsids, especially cynodonts. In living therians and monotremes, the ectotympanic and the malleus of the middle ear, which are connected to the mandible in embryos and fetuses, become separated from the mandible in adults. This is accompanied by prominent negative allometry of the middle ear bones that are relatively large in early ontogeny, but precipitously decrease in size in late ontogeny, relative to the growth of cranium and mandible. This negative allometry is crucial for the normal development of the middle ear. Newly discovered Mesozoic mammals show homoplastic evolution of the middle ear of eutriconodont and spalacotherioid mammals that are nested in crown Mammalia. The ear bones of eutriconodonts are massive, large relative to the skull, and connected to the mandible via an equally massive Meckel's element, suggesting that the negative allometry required for full development of the middle ear in living mammals did not occur in eutriconodonts. The absence of negative allometry in eutriconodonts is attributable to developmental paedomorphosis. Alternatively, the middle ear bones are so much smaller relative to the skull size in monotremes and extant therians that their ontogenies can be hypothesized as to show a much greater degree (or peramorphosis) in allometry, relative to the ancestral mammaliaform condition, and to eutriconodonts. Allometry is a fundamental pattern of changes in timing and rate during development, which is now known to be patterned by genes and signaling pathways in embryogenesis. The homoplastic evolution of the middle ear in the early history of mammals is profoundly influenced by labile development.

Poster Session II (Thursday, November 3)

IN THE TREES OR ON THE GROUND?: READRESSING THE LOCOMOTOR CLASSIFICATION OF EXTINCT AND EXTANT MUSTELOIDS USING PRINCIPLE COMPONENTS ANALYSIS

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Previous work indicates the reliability of principle components and discriminant function analyses to infer the behavior of extinct animals. Such analyses use skeletal morphology, quantified by size-independent variables, to statistically differentiate between locomotor groups (e.g., arboreal, aquatic). By entering a fossil species as an unknown, its morphological similarity to extant species with known, observable behaviors can be determined. While this method has been employed with apparent success using datasets at higher taxonomic levels (e.g., multiple orders within Mammalia), these studies are inherently dependent on the accuracy of the locomotor assignment for each species. To date, this has been dictated by the substrate (e.g., tree branches) on which the species typically forages, sleeps, or escapes from predators. However, if focused on the lower taxonomic group, Musteloidea, in which the majority of species are capable of some degree of arboreal, terrestrial, fossorial, and aquatic locomotion, specific locomotor assignment becomes dangerously arbitrary. We address this problem in the context of the Mio-Pliocene ailurine (red pandas), *Pristinailurus bristoli*, from the Gray Fossil Site, Washington County, Tennessee, USA. Despite its close phylogenetic affinity to the extant, highly arboreal red panda, *Ailurus fulgens*, the skeletal morphology of *P. bristoli* bears some similarity to the scansorial raccoon, *Procyon lotor*. Thus, its exact locomotor behavior and associated feeding ecology remain poorly understood. We use multivariate statistics to address the locomotor behavior of *Pristinailurus bristoli* using angular measurements and linear ratios that characterize the shape of the major fore- and hindlimb bones. Rather than basing locomotor assignment on earlier literature, we use principle components analysis to classify each species. Thus, our locomotor groups are defined entirely by forelimb/hindlimb skeletal shape similarity. Ultimately, we infer the locomotion of the extinct red panda and its implications on feeding ecology and present a reduced set of variables that can statistically differentiate between locomotor groups within the Musteloidea.

Poster Session III (Friday, November 4)

DINOSAUR EXTINCTION: CLOSING THE "THREE METER GAP"

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The debate surrounding the extinction of non-avian dinosaurs ignited by publication of the Cretaceous-Tertiary (K-T) meteorite impact theory has seen 30 years of dispute over the position of the stratigraphically highest *in situ* dinosaur. A zone roughly three meters below the K-T boundary devoid of dinosaur fossils, coined the "three meter gap," has helped drive controversy regarding the extinction of dinosaurs. Here we report the discovery of the stratigraphically youngest *in situ* dinosaur specimen: a ceratopsian brow horn found in a poorly rooted, silty mudstone floodplain deposit located no more than 13 centimeters below the palynologically defined boundary. The K-T event is identified using three criteria: 1) the point of a major decrease in Cretaceous palynomorphs without subsequent recovery, 2) the existence of a "fern spike" event also present in several K-T boundary sections worldwide, and 3) correlation to a nearby stratigraphic section where primary extraterrestrial impact markers are present (e.g. iridium anomaly, spherules, shocked quartz, etc.). The *in situ* specimen demonstrates that the gap devoid of non-avian dinosaur fossils does not exist and is inconsistent with the hypothesis that non-avian dinosaurs were extinct prior to the K-T boundary meteorite impact event.

Poster Session IV (Saturday, November 5)

A NEW PARAREPTILE FROM THE LOWER PERMIAN RICHARDS SPUR FISSURE FILL DEPOSITS OF OKLAHOMA

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The fissure fill deposits at the Richards Spur locality (popularly known as Fort Sill) of Oklahoma are unique in that they have yielded one of the most diverse and well preserved Paleozoic tetrapod faunas in the world. This rich fauna of over 30 Early Permian amniotes includes several parareptile species, which is unusual for a Permian locality. Previously described parareptiles from the locality include *Bolosaurus grandis, Delorhynchus priscus, Colobomycter pholeter*, and *Microleter mckinzieorum*. We describe here a new parareptile recovered from Richards Spur. The specimen consists of a small, exquisitely preserved skull (total skull length ca. 25mm), which preserves almost all cranial elements. This new parareptile is characterized by its small triangular shaped skull, large postorbitals, but small squamosals. The specimen also possesses very large teeth on the anterior end of its maxilla; the two anterior-most teeth appear to be at least twice as large as any of the succeeding maxillary teeth, allowing us to designate them as caniniform teeth. CT data have shown that the dentary also carries a pair of very large teeth. The teeth are recurved with a single cusp, indicating that this tiny parareptile was likely a predator. A phylogenetic analysis of 31 taxa and 136 characters was conducted to investigate the relationships of the new parareptile within Parareptilia. A heuristic search produced 55 optimal trees, and the strict consensus of these trees has a topology in which the new Richards Spur parareptile was found to cluster

with *Acleistorhinus pteroticus* and *Lanthanosuchus watsoni*. These results indicate that this new small predator is a lanthanosuchoid, a clade of Early Permian Laurasian parareptiles.

E&O Poster Session

INNOVATION IN GRADUATE EDUCATION: THE NON-TRADITIONAL MASTERS AND E-PH.D. DEGREES IN STEM DISCIPLINES SUCH AS VERTEBRATE PALEONTOLOGY

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Graduate degrees (M.S., Ph.D.) in STEM (Science, Technology, Engineering, and Mathematics) disciplines traditionally focus on research, and less on teaching, service, and outreach. With this model of graduate education, the Masters is oftentimes considered an intermediate degree on the way to the Ph.D. Studies have shown, however, that ~50% of students graduating with the Ph.D. do not end up in the career track for which they were trained and the availability of academic jobs in many STEM disciplines oftentimes exceeds the demand. Two new programs are being piloted at the University of Florida (UF), i.e., the "non-traditional Masters" and "e-Ph.D." degree with students in vertebrate paleontology.

In the non-traditional Masters degree model, students accomplish the requirements of a traditional Masters, including conducting research, but in addition, they: (1) take courses and satisfy a minor in a "plus" field (such as science education); (2) have a member of the plus field on their committee; (3) take a Broader Impacts graduate seminar; and (4) do a Broader Impact deliverable as a formal part of their thesis. Specific examples of the first cohort of non-traditional vertebrate paleontology Masters students will be presented in the poster. The intention of the non-traditional Masters is to produce a more broadly trained student who might opt to pursue a career different from the standard research track.

In the e-Ph.D. degree model, students enroll in standard courses being offered at the UF, but they participate in the courses remotely in real time using video-teleconferencing, or on the web. This program is designed so that Ph.D. students could engage in active research in the field while they also are taking courses. For example, as part of our Panama PIRE project, the junior author lives in Panama while enrolled in a full series of courses at UF. The intent of this program is to break down geographic barriers to graduate education.

The long-term goal of these degree programs is to provide graduate students more flexibility and additional real-world experience that will make their education more relevant in the 21st century of global STEM.

Poster Session I (Wednesday, November 2)

A NEW ABELISAURID TIBIA FROM THE LATE CRETACEOUS OF BRAZIL

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Overall, theropod remains from the Cretaceous deposits of the Bauru Group are very rare and restricted to the incomplete skeleton of the abelisaurid *Pycnonemosaurus nevesi*, several isolated teeth (sometimes difficult to be distinguished from those of the crocodyliform baurusuchids), and a few isolated bones from different sites. Here we report a right tibia (MCT 1783-R; Earth Science Museum, DNPM, Rio de Janeiro) collected in Peirópolis (Marilia Formation). The new specimen clearly represents an abelisauroid by having the cnemial crest elevated above the proximal articular surface, with the main axis forming an angle of about 300 in respect to the horizontal plane. It can be attributed more specifically to abelisaurids due to the location of lateral condyle being at the same level as the medial one. The cnemial crest curves laterally, giving the crest a hook shape in proximal view. The lateral condyle is square-shaped in posterior view, while the medial is more elongated. The fibular crest is abraded, but it is possible to notice that this structure is broad, starting near the cnemial crest and ending near the beginning of the fibular facet. The extension of the fibular facet, occupying about half the total length of this bone, indicates an almost total lack of mobility between the tibia and fibula. The distal portion of the shaft is expanded mediolaterally, forming two asymmetrically malleoli, being the lateral (fibular) broader and projecting farther distally than the medial. The deep triangular depression formed on the anterior view of the distal tibia along with small muscle scars indicates that the shape of the ascending process of the astragalus was of moderate height. MCT 1783-R is a robust but short specimen, pertaining to a medium size animal, approximately the same size as *Berberosaurus*. It differs notably from *Pycnonemosaurus* that is much larger and robust. MCT 1783-R further lacks the hatched shaped condition of the cnemial crest, found in the latter. This new specimen clearly demonstrates two morphotypes of abelisaurid tibia in the Creataceous deposits of the Bauru Basin in Brazil, increasing the theropod diversity from that deposit.

Romer Prize/Technical Session 5 (Thursday, November 3, 11:00 am)

THE COMPLETE MITOGENOME OF THE COLUMBIAN MAMMOTH, WITH EVIDENCE FOR COLUMBIAN/WOOLLY MAMMOTH INTERBREEDING IN NORTH AMERICA

MACPHEE, Ross, American Museum of Natural History, New York, NY, USA; ENK, Jacob, McMaster University, Hamilton, ON, Canada; DEBRUYNE, Regis, Muséum national d'Histoire naturelle, Paris, France; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; POINAR, Hendrik, McMaster University, Hamilton, ON, Canada

It is widely accepted among Quaternary paleontologists that there were two distinct species of mammoth in North America during the Late Pleistocene: *Mammuthus primigenius*, or the woolly mammoth, and *M. columbi*, the Columbian mammoth. These species are normally envisaged as having (1) distinctive morphologies, especially in regard to taxon-specific features of the molars; (2) different apparent precursors (*M. trogontherii* and *M. meridionalis*, respectively), descendants of which entered North America at quite different times; and (3) non- or only slightly-overlapping instantaneous ranges, with *M. primigenius* being adapted to colder conditions than *M. columbi*. The obvious expectation from these considerations is that these elephants would also have been distinct genetically. To evaluate this hypothesis, as part of our ongoing studies of mammoth evolution, we sequenced the first complete mitochondrial genomes of both a Columbian mammoth and a North American woolly mammoth, and compared them to each other and to several previously published genomes of Eurasian woolly mammoths. Surprisingly, the *M. columbi* mitogenome we obtained falls unequivocally within a previously-characterized subclade of endemic North American *M. primigenius*. The conclusion that these two nominal species interbred at some point in their evolutionary histories seems inescapable. One potential explanation is that woolly mammoth haplotypes entered Columbian mammoth populations via introgression along subglacial ecotones, a scenario with compelling parallels among extant elephants and consistent with certain other indications (such as the morph "*M. jeffersonii*", sometimes regarded as an actual hybrid between *columbi* and *primigenius*). Globally, these and other recently published results demonstrate that next-generation sequencing technologies hold much promise for utilizing specimens from contexts (non-cold zone, non-cave) previously regarded as marginal for aDNA investigations, as well as for rigorously testing phylogenetic hypotheses at heretofore unachievable levels of genomic resolution.

Poster Session II (Thursday, November 3)

SIZE AND SHAPE STASIS IN RANCHO LA BREA FELIDS DURING THE LATE PLEISTOCENE: UNIVARIATE AND MULTIVARIATE STATISTICAL APPROACHES

MADAN, Meena, University of California, Irvine, Irvine, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA; SUTYAGINA, Anastasiya, Occidental College, Los Angeles, CA, USA

Several authors have claimed that the large felids of North America changed in size and shape through the late Pleistocene. We re-examined the two common felids, the sabertoothed cat *Smilodon fatalis*, and the American lion, *Panthera atrox*, from the Rancho La Brea tar pits in the Page Museum in Los Angeles. We measured large samples (typically 30 to 100 specimens of each element) of several dimensions of the most common bones (typically leg or foot bones) from all the pits with good radiocarbon dates. We analyzed the univariate data for significance of differences using ANOVA, and used Principal Components Analysis (PCA) to see if shape changes could be recognized by multivariate analysis of humeri and femora. Even though pollen, plants, snails, and isotopic studies provide evidence of dramatic climatic and vegetational change from the previous interglacial to the Holocene, none of the felids show any statistically significant differences in size or shape of their bones from one level to the next. This was true not only of the univariate data, but also the PCA, since the first PC/ first factor (usually a proxy of size) showed no significant differences from one pit to the next. The first PC/first factor typically accounted for 75% or more of the variation, with the second and third factor only accounting for less than 10% each. These factors showed no consistent loadings on any particular variable, so they gave no significant indication of shape change from 34 ka to 11 ka.

Technical Session I (Wednesday, November 2, 10:45 am)

3D COMPUTATIONAL MODELLING OF LOCOMOTOR MUSCLE MOMENT ARMS IN *LESOTHOSAURUS DIAGNOSTICUS*: IMPLICATIONS FOR BASAL DINOSAUR LOCOMOTION

MAIDMENT, Susannah, Natural History Museum, London, United Kingdom; BATES, Karl, University of Liverpool, Liverpool, United Kingdom; ALLEN, Vivian, Royal Veterinary College, London, United Kingdom; BARRETT, Paul, Natural History Museum, London, United Kingdom

Basal ornithischians, like primitive dinosaurs, were small and bipedal, but they possessed several derived pelvic structures: the pubis is retroverted and the preacetabular iliac process is elongated. Hip muscle moments and activation patterns were likely altered by pelvic reorganization: pubic retroversion and preacetabular elongation were developed independently in birds, and are key adaptations underpinning their flexed femoral posture and rotation-based mode of lateral limb support. To examine how pelvic reorganization affected hip muscle function, we modelled the pelvic osteology and myology of the basal ornithischian *Lesothosaurus* and recorded 3D moment arms for 14 muscles at a range of hip joint angles. The results were compared to those from several theropods, including an extant bird. Moment arm polarities in *Lesothosaurus* are similar to other taxa modelled, probably because of shared homologous features related to their common ancestry and obligate bipedality. However, differences were present. Although the osteological correlate of the caudofemoralis brevis (the brevis shelf) is present in all dinosaurs studied, our models indicate this muscle exerted an abduction moment at the hip in *Lesothosaurus* in contrast to an adduction moment in theropods. The iliofemoralis externus (IFE) is a lateral rotator in dinosaurs, but a medial rotator in birds, because of its more cranial origin on the preacetabular process. Although basal ornithischians also developed an elongate preacetabular process, IFE retained its primitive position on the lateral ilium. The puboischiofemoralis externus (PIFE) is a flexor and medial

rotator in theropods, but is a lateral rotator and extensor in birds and *Lesothosaurus*, because of pubic retroversion. Despite the convergent hip morphology of *Lesothosaurus* and birds, muscle moments were rather different, with *Lesothosaurus* exhibiting the condition probably present in basal dinosaurs. Computational modelling of 3D moment arms quantifies muscle leverage, allowing comparisons between muscles and across taxa, and provides a framework for understanding locomotion in extinct animals.

Poster Session I (Wednesday, November 2)

NEW THEROPOD MATERIAL FROM THE CRETACEOUS (CENOMANIAN) WOODBINE FORMATION OF NORTH CENTRAL TEXAS: PALEOBIOGEOGRAPHIC AND PALEOECOLOGICAL IMPLICATIONS

MAIN, Derek, University of Texas, Arlington, TX, USA; NOTO, Christopher, University of Wisconsin, Kenosha, WI, USA; SCOTESE, Christopher, PaleoMap Project, Arlington, TX, USA

Vertebrate fossil material from the mid- Cretaceous is rare. When available, it provides a critical glimpse of a transitional period that resulted in major faunal changes in many areas. The timing and nature of these faunal changes is poorly understood, but have important biogeographic and evolutionary implications. In north Texas there is a unique, urban fossil locality called the Arlington Archosaur Site (AAS), which preserves a diverse coastal delta plain ecosystem. The AAS lies within the Lewisville Member of the Woodbine Formation, dating to the Cenomanian (95 Mya). Until now, theropod material from the Woodbine was rare. Here we describe the first significant theropod material from the AAS, consisting of teeth, limb fragments, a pedal ungual, and manual ungual. The material suggests a relatively diverse theropod community of large, medium, and small taxa. This new material helps demonstrate the transitional nature of Cenomanian terrestrial ecosystems, which shows a mixture of Early and Late Cretaceous groups (basal tetanurans and dromaeosaurids, respectively). The theropod community represented at the AAS therefore shows important biogeographic connections with earlier Gondwanan faunas and suggests that large basal tetanurans continued to play an important ecological role through the mid-Cretaceous.

Paleogeographic and paleoclimatic models demonstrate a semi-arid climate belt extending from Texas to Morocco and Niger during the Cenomanian, linking the ecosystems of these regions within a single climate envelope. It appears that during the Cretaceous large basal tetanurans had an ecological and climatic preference for semi-arid equatorial biomes, which may also help explain their persistence through this time of transition. Equally of interest, this new material implies that Early Cretaceous dinosaur faunas could have dispersed across the Berentsian land bridge and established an Appalachian presence sooner than previously thought. Further research into the fauna of the AAS is expected to shed more light upon the ecology and biogeography of Cenomanian dinosaur communities.

Technical Session X (Friday, November 4, 9:45 am)

SEMI-ARTICULATED FOOT OF EOCENE NOTHARCTUS: NEW EVIDENCE FOR A GROOMING CLAW IN AN ADAPIFORM PRIMATE FROM NORTH AMERICA

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Extant strepsirrhines and the non-anthropoid haplorhine, *Tarsius*, are distinguished from most anthropoid primates in having a grooming claw (instead of nails) on pedal digit II. Based on articulated skeletons from the Eocene of Europe, the adapiform *Europolemur kelleri* has been interpreted to have a grooming claw while *Darwinius* was said to have a nail-like structure on all digits. North American notharctids have also been described as having a grooming claw, but this interpretation has been tentative due to lack of articulated specimens and complete distal phalanges representing this anatomy. Here we describe a dentally-associated, partial foot of *Notharctus tenebrosus* (AMNH 143612) from the Bridger Basin, Wyoming, that preserves metatarsals (MT) I-IV, all phalanges of digits II-III, proximal and distal phalanges of digit IV, and other foot bones in semi-articulation. Results from a principal components analysis (PCA) of nine measurements made on extant primates show clear separation between distal phalanges bearing grooming claws, which have dorsally projecting shafts and proximally restricted volar bony processes for the apical pad, and those bearing nails. Distal phalanx II of AMNH 143614 is clearly distinguished from III-IV in possessing grooming claw morphology. While the non-grooming claws of extant primates generally have relatively wider apical tufts, this feature does not reliably distinguish them from grooming claws. Even so, it is perhaps surprising that the tuft of distal phalanx II in AMNH 143612 is relatively broader than those of III and IV. PCA of size-standardized lengths of MTs and phalanges shows clear separation between anthropoids vs. strepsirrhines and tarsiers with *Notharctus* most similar to *Daubentonia* and *Tarsius* in its pedal proportions. New morphology and analytical results based on AMNH 143612 support the idea that *Notharctus* was similar to *Europolemur*, but unlike most extant anthropoids and possibly *Darwinius*, in possessing a grooming claw. Our results further suggest that grooming claw morphology is related to a dorsally projecting nail and a proximally restricted apical pad, rather than presence of a narrow claw-like nail.

Technical Session I (Wednesday, November 2, 10:15 am)

FAST MOVING DINOSAURS: WHY OUR BASIC TENET IS WRONG

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Locomotion speeds of dinosaurs are often calculated from ichnofossils, using Alexander's formula that is based on data mainly from mammals and birds. Results indicate that dinosaurs were rather slow compared to mammals. Inaccuracies due to errors in hip height estimates and other factors are expected, but the method is generally accepted to deliver at least "ballpark figures". However, in nearly all dinosaurs except theropods the hind limbs differ significantly from both mammals and birds in the distribution of maximal joint torques possible. Is it biomechanically sound to apply the formula under these circumstances?

A detailed assessment of dinosaur limbs, using musculoskeletal modeling in SIMM and Computer Aided Engineering (CAE) kinetic/dynamic modeling, taking gravity, mass distribution and inertia into account, indicates that a basic tenet of Alexander's formula, the proportional relationship between stride length (SL) and stride frequency (SF) seen in mammals and birds, is unlikely to have existed in non-theropod dinosaurs, and may have had an unusually low slope in theropods. This means that speeds calculated from tracks are the slowest speeds at which the animals have moved, but may be significantly too low. We may therefore not expect to gain information on the top speeds of dinosaurs from tracks at all.

Skeleton-based analyses can suffer from similar uncertainties, because large limb excursion angles as seen in quickly moving mammals create high forces in the limbs. Usually, similar limb kinematics are assumed for dinosaurs. However, if dinosaurs combined high SFs with short SLs, they were able to move far faster for given maximal forces in the joints than previous models suggest. The modeling results from SIMM and CAE suggest that dinosaurs used much higher SF/SL ratios than mammals, achieving absolute speeds in walking gaits that force same-size mammals into running gaits.

Poster Session I (Wednesday, November 2)

BIOSTRATIGRAPHY OF THE MEGAHERBIVOROUS DINOSAURS FROM THE DINOSAUR PARK FORMATION (UPPER CAMPANIAN) OF ALBERTA

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The upper Campanian Dinosaur Park Formation (DPF) of Alberta is ~70 m thick where it is exposed in the area of Dinosaur Provincial Park. Although the DPF is rich in megaherbivorous dinosaur fossils (ankylosaurs, ceratopsids, hadrosaurids), the stratigraphic distribution of any one species within the formation is limited. For this reason, researchers have used these fossils to establish discrete assemblage zones within the DPF, but none of these attempts have been quantified to date. In this study, we test these previous zonation schemes using clustering and ordination methods commonly employed in biostratigraphy. The DPF can be broadly divided into lower and upper assemblage zones: the lower ~30 m is characterized by the presence of the ankylosaur *Panoplosaurus mirus*, the ceratopsids *Centrosaurus apertus*, *Chasmosaurus russelli*, and *Ch. belli*, and the hadrosaurids *Gryposaurus notabilis*, *Corythosaurus casuarius*, *Co. intermedius*, and *Lambeosaurus clavinitialis*; the interval from 30–60 m is characterized by the presence of the ceratopsid *Styracosaurus albertensis* and the hadrosaurids *Prosaurolophus maximus* and *L. lambei*. These zones can be further subdivided into ~15 m intervals that span ~300K years of deposition, based on the distributions of the rarer or shorter-lived species, but biostratigraphic resolution does not permit meaningful clustering beyond this. Interestingly, ankylosaurs are mostly absent from the upper ~25 m of the DPF.

In order to test whether the turnover of the DPF megaherbivorous dinosaurs corresponds to palaeoenvironmental change, we subjected the data to a canonical correspondence analysis. We compared the distributions of the megaherbivorous dinosaurs to those of several palaeoenvironmental proxies, including palynomorphs, mollusks, pedotypes, and lithotypes. Megaherbivorous dinosaur turnover most closely mirrored that of the palynomorphs, followed sequentially by lithotypes, mollusks, and pedotypes. However, none of these palaeoenvironmental proxies explained megaherbivorous dinosaur turnover better than a simple time proxy. This suggests that the evolution of the DPF megaherbivorous dinosaurs was not strongly linked to environmental change.

Symposium 4 (Friday, November 4, 11:00 am)

A TEMPERATE PALEODIVERSITY PEAK IN MESOZOIC DINOSAURS AND EVIDENCE FOR LATE CRETACEOUS GEOGRAPHICAL PARTITIONING

MANNION, Philip, University College London, London, United Kingdom; BENSON, Roger, University of Cambridge, Cambridge, United Kingdom; UPCHURCH, Paul, University College London, London, United Kingdom; BUTLER, Richard, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; CARRANO, Matthew, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA

Modern biodiversity peaks in the tropics and declines poleward, a pattern that is potentially driven by climate. Although this latitudinal biodiversity gradient (LBG) also characterises the marine invertebrate fossil record, distributions of ancient terrestrial faunas are poorly understood. Using a comprehensive dinosaur dataset (738 genera and over 3000 occurrence records, including birds), standardised for the uneven spatiotemporal sampling of the fossil record, we demonstrate that the dominant group of Mesozoic terrestrial vertebrates did not

conform to the modern LBG. Instead, dinosaur diversity was highest at temperate paleolatitudes throughout the 160 million year span of dinosaurian evolutionary history, and may have been driven by the amount of available land area among latitudinal belts. Thus, the ubiquity of the paleotemperate peak indicates that there is no evidence that fluctuations in climate exerted a strong influence, or that the tropics acted as a cradle to dinosaur diversity at any point in their evolutionary history: the earliest known representatives of most clades are from temperate paleolatitudes. Late Cretaceous sauropods and ornithischians exhibit disparate LBGs, providing clear evidence of geographical partitioning among major clades of herbivorous dinosaurs. This partitioning may result from the advanced stages of continental fragmentation and/or differing responses to increasing latitudinal climatic zonation. The apparent conformity of post-Eocene birds to the 'standard' LBG contrasts dramatically with Mesozoic dinosaurs. Our results suggest that the modern day LBG on land was only established 30 million years ago, following a significant post-Eocene recalibration, potentially related to a reduction in extratropical speciation rates as a consequence of increased seasonality across the Eocene/Oligocene boundary.

Technical Session X (Friday, November 4, 8:30 am)

EVIDENCE FOR SCANSORIALITY IN THE FORELIMB OF NORTH AMERICAN PALEOCENE INSECTIVORES (MAMMALIA, EULIPOTYPHLA)

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Eulipotyphla is a monophyletic clade of insectivorous mammals (shrews, moles, hedgehogs, selenodons) that generally exhibit terrestrial or fossorial behaviors, but little is known about positional behaviors of early eulipotyphlans. While their teeth are known back to the early Paleocene, postcrania are only rarely found. Here we describe the forelimb of two taxa with dentally associated skeletons that were recovered from freshwater limestone of the late Paleocene Willwood Formation, Bighorn Basin, Wyoming: *Leptacodon rosei* (Soricomorpha?, Nyctitheriidae) and *Adunator* n. sp. (Erinaceomorpha, incertae sedis). Their morphology is very similar, likely reflecting shared ancestry and similar forelimb capabilities. The proximal humerus has a rounded head, low tuberosities and distinct muscle attachment sites for rotators of the shoulder that suggest considerable mobility at the glenohumeral joint. The elbow joint appears to have been habitually flexed, based on the shallow olecranon and deep radial fossae on the distal humerus, and on the short, cranially curving olecranon process of the ulna. Considerable supination was possible at the elbow joint between the nearly spherical humeral capitulum, the deeply concave, rounded central fossa of the proximal radius, and the flat, craniolaterally facing radial notch on the ulna. These characteristics of the forelimb indicate arboreal capabilities and suggest that early members of Soricomorpha and Erinaceomorpha were scansorial, unlike the terrestrial *Macrocranion* or *Pholidocercus*, Eocene erinaceomorphs for which whole skeletons are known. The distal humeri greatly resemble those of plesiadapiforms in morphology and proportion, particularly in having an entepicondyle that is about half the width of the articular surface and a similar trochlear shape that is wider than long. Both humeri have unique similarities to euarchontans including a robust, medially protruding lesser tuberosity and a nearly spherical capitulum. These similarities may represent convergence on arboreal capabilities or the retention of a primitive morphology that allowed considerable forelimb mobility inherited from a boreoeutherian ancestor.

Poster Session IV (Saturday, November 5)

DIGGING MORPHOLOGY AND THE INTERACTION BETWEEN SOIL AND CLIMATE DETERMINE POCKET GOPHER (*THOMOMYS*) DISTRIBUTION ACROSS TIME AND SPACE

MARCY, Ariel, Stanford University, Stanford, CA, USA; HADLY, Elizabeth, Stanford University, Stanford, CA, USA

The allopatric distribution of northern Californian pocket gophers (*Thomomys* spp.) is hypothesized to be a result of competitive exclusion. Replacement of subgenus *Thomomys* with subgenus *Megascapheus* occurred gradually during the Pleistocene-Holocene transition, suggesting a role for abiotic factors in their niches. A principle component analysis (PCA) of linear and geometric morphometric data from 80 adult female forelimbs and 450 crania show that these groups separate by tooth and/or claw-digging traits. We propose that morphological differences contribute to the competitive dominance of one species over another given the local environmental inputs on soil condition in their range, and suggest that climate has impacted soils through the past 20,000 years, favoring *Megascapheus*. GIS analysis of specimen localities mapped on NRCS physical soil maps and PRISM climate data helps explain boundaries between gopher taxa. Soil clay, bulk density, and shrink-swell capacity separate species with digging strategy differences. While clay and bulk density stay constant over 1000s of years, low precipitation and high temperatures can produce shrink-swell behavior in reactive soils within days. The strong yet underappreciated interaction between soil and moisture on the distribution of this major vertebrate group is rarely considered when projecting species responses to climatic change. Understanding how the environment impacts gopher digging efficacy could pinpoint the key climatic changes most likely to have influenced past populations of gophers as well as predict future distributions in this region.

Poster Session III (Friday, November 4)

OCCURRENCE OF THE MARINE TURTLE *THALASSEMYS* IN THE KIMMERIDGIAN OF OKER, GERMANY

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A partial chelonian was collected from the Langenberg Formation quarry of Oker (near Goslar, Lower Saxony, Germany). The amniotes from this formation include other chelonians (possible Plesiochelyidae), the sauropod *Europasaurus holgeri*, theropods (Velociraptorinae), crocodylomorphs *(*Atoposauridae, *Theriosuchus pusillus, Goniopholis simus, Machimosaurus hugii, Steneosaurus brevirostris)* and pterosaurs (Dsungapteridae, ?Ornithocheiroidea, ?Ctenochasmatidae).

The reported specimen, DFMMh/FV 296, includes a skull part (articulated quadrate, squamosal, basisphenoid, and pterygoid), a disarticulated 40 cm long partial carapace, plastron, and one cervical vertebra.

The carapace bears fontanelles, trapezoidal suprapygal with straight edges, small last neurals (about half the size of previous neurals), scute sulci bear a well-defined step near the neurals, a plicated longitudinal pattern in the proximal end of the costals originating on the posterior side of the scute sulci and dissipating posteriorly, wide central opening in the plastron, xiphiplastra with little or no contact between each other, and both the hyo- and hypoplastron have digit-form buttress projections.

The specimen has a central plastra fontanelle, which is regarded as a feature of the clade including *Solnhofia*, *Santanachelys*, and *Thalassemys*. DFMMh/FV 296 differs from *Solnhofia* by the trapezoidal shape of the first suprapygal. Within this clade, a suprapygal with straight edges and xiphiplastron participation in the central fontanelle is autapomorphic for the *Thalassemys* genus. A large central fontanelle with hyo and hypoplastron polygonal medial margins (i.e., segments with well-defined angles, rather than being gently curved), reduced contact between xiphiplastra and reduced size of the two last neural plates is shared between *T. hugii* and the Oker specimen. DFMMh/FV 296 differs from this species due to the presence of plastral projections. The different shape of the plastron (no polygonal-like margins or hyo- and hypoplastron projections) suggests that *T. moseri* might be reclassified into a different genus. Therefore, we can assign this specimen to *Thalassemys* sp.

Poster Session II (Thursday, November 3)

ONTOGENETIC CHANGES IN THE SKULL ELEMENTS OF THE LATE JURASSIC DWARF SAUROPOD *EUROPASAURUS HOLGERI*

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Juvenile sauropods are very rare in the fossil record. No extensive ontogenetic growth series exists for sauropod skulls, and consequently, the morphological changes in ontogeny are not well understood. This study explores such changes in the most complete collection of disarticulated skull bones of a single sauropod taxon, the dwarf basal macronarian *Europasaurus holgeri* from the Kimmeridgian of northern Germany. The skull material includes different individuals of various ontogenetic stages. Because size alone is not a good indicator to determine ontogenetic stage, we used size-independent characters to stage the bone elements. Since the original description of *Europasaurus*, new skull material has been found and has allowed us to create an updated skull reconstruction of an adult individual. The updated reconstruction features smaller external nares and a larger orbit as compared to the original reconstruction. Important ontogenetic changes are the decreasing ventral exposure of the jugal, which is extensive in the juvenile, and the increasingly erect nasal process of the premaxilla. This, the large orbit, and other skull parts are paedomorphic characters resulting from dwarfing. The ventral exposure of the jugal and the inclined premaxillary nasal process in the juvenile *Europasaurus* represents the retention of plesiomorphic characters seen in basal sauropodomorphs (e.g. *Plateosaurus* and *Massospondylus*) and basal sauropod dinosaurs (e.g. *Shunosaurus*). Apart from three partial braincases, only isolated skull bones have been found. This pattern, the lack of fusion of the skull bones, is regarded as another paedomorphic character. By studying the skull bones in detail, we also found that the material represents two morphs of different size classes that also belong to different ontogenetic stages. One such distinctive feature is the dimorphism of the orbital margin of the frontals.

Poster Session IV (Saturday, November 5)

POPULATIONS, PLASTICITY AND PHENOTYPE: THE PROBLEMS OF CONTINUOUS VARIATION AND MISSING LINKS IN IGUANODONTIAN DINOSAURS

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There has been a resurgence of interest in basal iguanodontian dinosaurs as a consequence of the discovery of an unexpectedly diverse Cedar Mountain Formation fauna. This has led to renewed interest in historical genera such as *Camptosaurus* and *Iguanodon*, and the creation of new taxa from material formerly referred to these genera. There has also been a notable

proliferation of singular apomorphies or unique character-combinations used to define new taxa, which raises the possibility that these new taxa will become obsolete following the discovery of more complete material. As a result, our understanding of 'apomorphic' and 'plesiomorphic' character-states has become blurred and confused.

A clearer understanding of the ranges and styles of anatomical variation within populations of diagnosable Operational Taxonomic Units (OTUs) is becoming increasingly important, because it will inform the selection of features that are likely to be taxonomically informative. To explore this general concern, a comprehensive review of non-hadrosaurid ankylopollexian material, collected from Europe and the United States, has been examined at first hand. Particular emphasis has been placed upon localities that have yielded multiple specimens.

Results demonstrate that many anatomical features are far more labile: between taxa and within populations, than previously supposed. Variation between morphs within populations may also be a source of confusion. Although certain anatomical characters may be used to define 'grades' of iguanodontians, their usefulness can be altered dramatically by the discovery of new 'intermediate' taxa; this results from attempting to code evolutionarily continuous features as discrete characters for the purposes of defining OTUs and promotes variability to taxonomic status. It also appears to be the case that particular anatomical characters, such as the structure of teeth, have continued to be used because they maintain historical associations or reflect an (unstated) expression of anthropologic preference for specific areas of the skeleton, particularly with regards to cranial material.

Technical Session VIII (Thursday, November 3, 3:45 pm)

THE EARLY HISTORY OF TETRAPODS IN THE SOUTHERN HEMISPHERE: THE SPATIAL AND TEMPORAL DISTRIBUTION OF PALEOZOIC BASAL TETRAPODS IN WESTERN GONDWANA

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The history of early tetrapod diversification in Gondwana has remained elusive, particularly in the southern part of the supercontinent. The earliest record of non-amniotes include Pennsylvanian temnospondyl footprints from northern Chile followed by a gap of more than 40 My that separates it from the diversified Middle Permian faunas known from both southern Africa and South America. The only exception is the Early Permian temnospondyl remains reported from western Namibia (Gai-as Formation). Recent work in the area evidenced they are fairly abundant in nearly the whole succession and just above the *Mesosaurus* bearing-levels. They represent the only evidence of non-amniotes in western Gondwana during the early-middle Permian and the earliest body-fossil remains of the group. Comparatively, the Gondwanan early amniote record is better represented. The oldest record of amniotes in Gondwana are the mesosaurids, a group of endemic aquatic parareptiles known only from Artinskian (Early Permian) levels of Namibia, South Africa, Uruguay, and Brazil. It was not until the Guadalupian (Middle Permian) that more diverse amniote faunas comprising only synapsids are represented in southern Africa and Brazil. Nevertheless, several tetrapod footprints and trackways from Permian levels of western Argentina have recently been re-evaluated and the host sequences dated. They reveal diverse amniote faunas, including small-to-medium sized animals, all recorded in interdune deposits, which have been dated as Artinskian, the same age as the mesosaurid-bearing strata. This would imply that amniotes were already widespread in south-western Gondwana by the beginning of the Permian, with both fully terrestrial and specialized aquatic forms. This early diversification was probably related to a climatic shift linked to the withdrawal of Gondwanan glaciations, an event recently dated in western Argentina as late Pennsylvanian, significantly earlier than was previously thought.

Poster Session IV (Saturday, November 5)

PALEOGEOGRAFICAL AND PALEONTOLOGICAL CHARACTERISTICS OF THE LOWER PERMIAN REDBEDS OF NORTH-CENTRAL TEXAS AND THE BROMACKER QUARRY IN THE LOWER PERMIAN TAMBACH FORMATION IN CENTRAL GERMANY

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In the past 20 years of an international reserarch program the Bromacker quarry in middle part of Germany has developed from an important tetrapod footprint site to the most important locality of Lower Permian vertebrate fossils outside of North America. The Bromacker site is part of the Tambach Formation (about 120 m of reddish-brown fluvial sandstone, siltstone, and conglomerate). This formation is part of the Rotliegend sequences in the Thuringian Forest and was deposited in the intramontane Tambach Basin in the large Variscan orogen. Far from the ocean shoreline, the Tambach Formation was deposited at an elevation of 100 m to more than 1000 m above sea level. This interpretation is based dominatized conglomerates and new information about the climate. Together with tetrapod footprints we have found typical frost marks that are characteristic of ice impressions. The ice layers were developed part of the year about 10 to 15° north of the equator in a tropical climate of high altitude. The frost in the Variscian Mountains may have influenced the numbers of species of flora (3-4), invertebrates (about 10) and terrestrial tetrapod fauna (13). The climatic differences between "summer" and "winter" in the upland basin is not well known jet. In the Lower Permian of Northern Texas over 200 vertebrate localities within the Bowie, Wichita and Clear Fork Group exist. Approximately 50 genera (more than150 species) of terrestrial amphibians and amniotes have been described in the last 140 years. The Archer City, Nocona, Petrolia, Waggoner Ranch, Arroyo and Vale formations consist of continental and paralic rocks (reddish-brown to gray clay-, silt-, sandstone, and limestone). The most terrestrial and fluvial sequences are altered southward, becoming more and more in limestone-bounded, and fluvial-deltaic, and finally typical of marine sedimentation under deltaic conditions (Cisco and Albany Group). Most of the tetrapods, invertebrates, and plants were living at sea level near the cost line. The paleogeographic position of the northern Texas, Lower Permian localities was a few degrees north of the equator at sea lever. The climate was tropical and frost did not exist. The Archer City Formation was deposited near the Permo-Carboniferous boundary and possibly permits a correlation with the Bromacker locality of the Tambach Formation in Germany.

Poster Session I (Wednesday, November 2)

A BURROW RUNS THROUGH IT: UNUSUAL CO-OCCURRENCE OF A LARGE MAMMAL BURROW SYSTEM AND DINOSAUR SKELETON IN THE MORRISON FORMATION OF UTAH

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Despite a relatively diverse mammalian fauna in the Morrison Formation, little of their paleobiology is understood. A fossorial lifestyle has been suggested for many Morrison mammal taxa, but examples of preserved burrows are exceedingly rare. Here we describe a large and extensive burrow system in association with a camarasaurid sauropod skeleton, discovered during field operations by the Natural History Museum of Los Angeles County in the summer of 2010. The locality is near Bluff, Utah in the lower Morrison Formation, most likely the Salt Wash Member. The primary bone bed contains most of a single disarticulated skeleton in a fine-grained, gray-green mudstone. This sediment layer thins laterally and is surrounded by mottled red mudstone, suggesting it was once a water body. The bone bed layer is covered by more mottled red mudstone and capped by a meter or more of a well-cemented channel sandstone. The largest burrows are 8-10 cm in diameter, but expand to 12-15 cm wide at burrow junctions. Burrow allometry, which in many burrowing animals correlates with body mass, indicates relatively large tracemakers (400-500 g). Burrows are filled with a very fine sandy mud and cemented with chert. Some internal sedimentary structure is visible, possibly the result of active back-filling. Several branching burrow systems have been found throughout the quarry and include main tunnels, side tunnels, and variously sized chambers. Some of the smaller side tunnels wind around and between sauropod bones, indicating how the bones affected tracemaker behavior. The paleoenvironmental history of the site indicates the burrows were likely made long after the sauropod was buried, when pedogenesis was occurring over the previous water hole. The tracemakers then tunneled into the underlying strata containing the sauropod. The occurrence of these burrows in a paleosol, as well as their complex geometry, point toward mammals as the most likely tracemakers, as opposed to other similarly sized vertebrates or large decapods. These burrows confirm the notion that at least some Morrison mammals utilized a fossorial lifestyle. Furthermore, the estimated mass of the tracemaker would make this the largest mammal known from the Morrison Formation thus far, suggesting a remaining undiscovered mammalian diversity.

Technical Session XIX (Saturday, November 5, 2:45 pm)

INTERPRETING THE FOSSIL RECORD OF MYSTICETI (CETACEA) USING NEW METHODOLOGIES IN DIVERGENCE DATING

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Recent efforts have improved the use of fossil information in divergence dating analyses. However, these new methods are continuously being developed and lack application to real data sets for many organismal groups. This study investigates the usefulness of the fossil record of Cetacea (Mammalia), with specific focus on Mysticeti (baleen whales) for divergence dating, and applies newer methods for the dating of this clade. The cetacean fossil record is complete for certain time intervals, however other intervals contain few fossils or are missing fossil data entirely. The extent and understanding of these gaps in time and the ghost lineages they represent is limited due to the lack of interpretation of the divergences of various clades. The use of internal and external fossil calibrations was tested on Cetacea and divergence dating conducted using both mitochondrial DNA and the nuclear recombination activating gene-1 (RAG-1), as well as fossil dates calibrated to a relaxed molecular clock. The analyses employed the program BEAST and were run for 50 million generations. Fossil calibrations were utilized as lognormal priors, which act as a "soft bound" versus setting a single (hard) age. A new method of interpreting the effectiveness of the fossil calibrations was utilized in this study for the first time in a non-squamate clade. Preliminary results suggest that the two most commonly used fossil calibrations for Cetacea perform well in divergence analysis, which corroborates recent studies. These calibrations represent the divergence of Cetacea (*Himalayacetus subathuensis)* and of crown Cetacea (*Llanocetus denticrenatus)*. Some differences in cetacean divergence dates were found from separate analyses of mitochondrial and nuclear data, as well as from analyses using different numbers

of fossil calibrations. The phylogenetic position of *Caperea* and *Eschrichtius* were different between the two analyses and this alone could be reason for the date differences, as phylogenetic position has a well-recognized influence on divergence dating.

Technical Session XV (Saturday, November 5, 11:00 am)

MIDDLE JURASSIC MAMMALS FROM THE ITAT FORMATION AT BEREZOVSK QUARRY IN WESTERN SIBERIA (RUSSIA)

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The Berezovsk coal mine in the Nazarovo Basin in southern Krasnoyarsk territory of western Siberia has yielded the first Middle Jurassic (Bathonian) mammals of Russia. Limnic clays and marls of the Itat Formation have produced teeth and mandibular fragments of the eleutherodontid haramiyid *Sineleutherus issedonicus*, diverse docodonts (*Itatodon tatarinovi*, *Simpsonodon sibiricus*, and *Hutegotherium yaomingi*), an amphilestid-grade eutriconodontan, as well as the cladotherian amphiteriid *Amphibetulimus krasnolutzkii*. *Amphibetulimus* and an unidentified amphitheriid from the Balabansai Formation of Kyrgyzstan represent the first records of Amphitheriidae outside Britain.

Recent discoveries comprise an edentulous dentary of a haramiyid (probably *Sineleutherus*), the distal part of a ?docodont humerus, ?P5 and p4 of a new multituberculate, and an edentulous mandible and lower molars of a basal dryolestid. The eleutherodontid dentary holds two alveoli for single-rooted incisors of which the anterior is oriented almost horizontally and the posterior at an angle of about 45°. After a wide diastema follow six alveoli which possibly belong to a single-rooted premolariform and three double-rooted (pre-)molariforms; behind the sixth alveolus the jaw is broken. As is evident from µCT study, the alveoli are connected by a large mandibular canal, that labially opens into two mental foramina.

The lower dryolestid molars represent, besides the specimens from Kirtlington in Britain, the geologically oldest evidence for that group and prove that Dryolestidae were present in the Middle Jurassic of Asia. Sistergroup Paurodontidae recently has been reported from the late Middle Jurassic (Callovian) of Kyrgyzstan. Whereas Dryolestidae and Paurodontidae were very successful in Western Europe and North America in the Late Jurassic and Early Cretaceous, they have not been found after the Middle Jurassic in Asia so far.

Currently, the Berezovsk mammal assemblage is similar in diversity to that from the Balabansai Formation in Kyrgyzstan, but has a much greater potential for further discoveries. It will play a major role for the understanding of Jurassic mammalian evolution in Asia.

Poster Session I (Wednesday, November 2)

A NEW HALECOMORPH FISH FROM THE EARLY CRETACEOUS WETLAND OF LAS HOYAS

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At least three different taxa can be recognized among the some 250 specimens preliminarily assessed to the Amiiformes (Actinopterygii, Halecomorphi) from the continental beds of Las Hoyas (upper Barremian, Cuenca, Spain). One of them, only four specimens so far, lacks ossified autocentra in the axial skeleton, unlike the others. On the basis of meristic characters (i.e., number of fin rays, number of ribs and haemal spines) these four specimens probably belong to a single taxon. Amiiformes are divided into Amioidea and Caturoidea. The absence of ossified autocentra is a typical feature of caturoids. However, these four specimens do not show any diagnostic character of Caturidae (i.e., presence of paired, block-like ural neural arch ossifications; four or more ossified ural neural arches) or Caturoidea (e.g., haemal spines broadly spatulate in the transverse plane; 22 or more pairs of branchiostegal rays). Incomplete specimens from Las Hoyas were reported as *Caturus* sp. as they present amioid scales and unossified vertebral autocentra. These four complete, articulated specimens have, nonetheless, shown that they are very different from any caturoid in body and caudal fin morphology. Since they do not present caturoid or caturid diagnostic characters either, this combination of amioid scales and unossified vertebral autocentra does not seem to fit easily into any other neopterygian taxon. These specimens do present diagnostic characters of the Holostei (e.g., tube-like rostral bone with no internasal lamella, all principal caudal fin rays branched, presence of upper and lower fringing fulcra on caudal fin), the Halecomorphi (symplectic forming part of double articulation with lower jaw), and even the unnamed taxon Halecomorphi B (e.g., preopercle crescent-shaped, long and narrow). The state of preservation of the specimens does not allow verification of some diagnostic characters of the Amiiformes (absence of opisthotic and pterotic bones); yet, they seem to show the other diagnostic character of amiiform fishes, two or less ossified ural neural arches. Therefore, with the present evidence, the new genus can be considered as Halecomorphi B indet.

Technical Session X (Friday, November 4, 10:30 am)

CARBON ISOTOPIC RECORD OF THE RELATIVE ROLES OF BIOTIC AND ABIOTIC FACTORS IN THE LATE MIOCENE EXTINCTION OF *OREOPITHECUS BAMBOLII*, BACCINELLO BASIN, TUSCANY

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Oreopithecus bambolii is a Late Miocene hominoid with an extensive fossil record in the Baccinello Basin (Tuscany, Italy), and was the only European hominoid to survive a major extinction event ca. 9.6 Ma ago. *Oreopithecus* lived in the insular Tusco-Sardinian paleobioprovince, where it evolved many unique anatomical specializations that make it important for understanding the mechanisms and history of Late Miocene hominoid evolution. The eventual extinction of *Oreopithecus* and its associated fauna has generally been attributed to interaction with species that arrived from continental Europe following tectonic collision of the Tusco-Sardinian province with mainland Italy, but palynological, paleontological, and sedimentological records indicate an environmental shift toward more arid and variable climates across the extinction event.

To explore the possibility of environmental change as a contributing factor in the extinction of *Oreopithecus*, we developed a stable carbon isotope (δ13C) record from organic matter and authigenic carbonate in paleosols from the Baccinello Basin. These data show very low temporal and spatial variability (indicating plant ecosystem stability through time and space) and provide no evidence for ecologically significant changes in floral composition spanning the extinction event, at least as recorded by δ13C values. These results are consistent with the importance of species interaction as an underlying cause for the extinction of *Oreopithecus* and its associated fauna. The carbon isotope values fall entirely within the range of isotopic variability for modern plants following the C3 photosynthetic pathway (trees, shrubs, cool-season grasses), indicating that C4 vegetation (warm-season grasses) was not an important component of biomass. When corrected for temporal variation in the carbon isotopic composition of atmospheric carbon dioxide, the paleosol carbon isotope values are consistent with predicted values based on modern plants and the Baccinello palynoflora, confirming the reliability of paleosol isotopic records as paleoecological proxies.

Poster Session I (Wednesday, November 2)

FRESHWATER NICHE COMPETITION BETWEEN CHORISTODERES AND CROCODILES IN THE MESOZOIC AND PALEOGENE

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Choristoderes are freshwater diapsid reptiles of uncertain phylogenetic position, distributed across Laurasia. Typically choristoderes occurred in warm temperate areas as part of a mesic assemblage including crocodiles. Over the last three decades many new genera have been recovered, belonging to three main morphotypes: large gavial-like (2–5 m), small lizard-like (0.3–0.5 m), and long-necked sauropterygian like genera (~1 m). The Early Cretaceous of Asia saw a peak in diversity with all three morphotypes represented. Perhaps significantly, the same Asian horizons have yielded no aquatic crocodiles. Small lizard-like choristoderes are known from the Middle Jurassic (Britain, Kyrgyzstan) to the Miocene (Czech Republic). At maturity, these taxa were smaller than any co-occurring crocodiles. The larger (~4 m), more derived, longirostrine neochoristoderes (e.g. *Champsosaurus*) are recorded from the Early Cretaceous through to the earliest Eocene. In Late Cretaceous and Paleogene horizons across Euramerica they shared freshwater ecosystems with a diversity of similar sized crocodiles. However, where neochoristoderes and crocodiles co-occur, the former are typically the only reptiles with strongly longirostrine skulls suggesting a degree of niche partitioning. After the extinction of neochoristoderes, their vacant niche may have been taken over by long-snouted crocodiles, which originally inhabited coastal and estuarine environments, but diversified in freshwater deposits around the Oligocene-Miocene.

Preparators' Session (Thursday, November 3, 8:30 am)

CLOSE-RANGE PHOTOGRAMMETRY OF PARTIAL RE-EXCAVATION OF THE LAETOLI HOMININ FOOTPRINTS, IN NORTHERN TANZANIA

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In 1978 members of Mary Leakey's team working near Olduvai Gorge, Tanzania, discovered fossil hominin footprints preserved in a 3.6 million year old volcanic tuff layer. These footprints provide the earliest known evidence of an upright stance in our human ancestors marking a significant milestone in the vertebrate fossil record. At the time of the discovery, a trail containing approximately 40 steps was excavated and documented by Leakey's team, who reburied the excavation to protect the footprints. In 1995, prompted by concerns of vegetation overgrowing the site, members of the Getty Conservation group removed the vegetation, re-exposed, conserved, and documented the previously excavated surface, and re-buried it using a multilayer strategy. In February of 2011, an international team of scientists under the request of the Ministry of Natural Resources and Tourism in Tanzania re-excavated a 3.5 meter long section of the trackway to evaluate and document the condition of the footprints. This provided an opportunity to conduct new, close-range photogrammetric documentation of the footprints, as well as a first generation cast residing in the National Museum of Tanzania and House of Culture in Dar es Salaam. Stereoscopic imaging was conducted using a remotely triggered digital SLR camera mounted on a monopod to obtain overhead images of the re-excavation stages culminating with the footprint tuff. Imagery acquisition averaged approximately 25 minutes per layer and was of minimal impact to the excavation process. Multi-stage imagery was placed in a common coordinate space and used to generate 3D point clouds, surfaces, and associated "aerial" orthophotographs. These data sets allow for a virtual re-excavation, as over 13 layers of materials can be digitally removed to expose the final footprint surface. Close-range photogrammetry provided an excellent method for

documenting field subjects in remote regions of East Africa, as well as museum specimens in display situations. Rapidly developing innovations and reduction in costs of software make this technique available to a much larger spectrum of users and vital to proper documentation and conservation efforts.

Technical Session XVII (Saturday, November 5, 4:00 pm)

INCLUSION OF FOSSIL SPECIES RANGE DATA IN DISPERSAL-EXTINCTION-CLADOGENESIS (DEC) ANALYSES CORRECTS LOW ESTIMATES OF EXTINCTION RATE AND IMPROVES ESTIMATES OF HISTORICAL BIOGEOGRAPHY

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A new phylogenetic method of inference in historical biogeography, dispersal-extinction-cladogenesis (DEC), currently implemented in Lagrange, is beginning to be employed in studies of extinct taxa. This maximum-likelihood method reconstructs the ancestral range of lineages and estimates rates of dispersal and extinction along time-scaled branches. However, the method was primarily designed for molecular-derived ultrametric trees in which all taxa are extant, and it typically underestimates extinction rate and can overestimate vicariance and ancestral range size. Here we test the utility of DEC in analyses that include fossils. Specifically, we use databases such as MIOMAP to include the geographic range of fossil mammals in the DEC analysis, through a modification of DEC that adds each fossil species extant in each North American Land Mammal Age onto the phylogeny with a short branch. Furthermore, following preliminary studies which showed that DEC does not treat branch endings as extinctions, we modified DEC to recognize branch tips as extinction events. We find that the inclusion of fossils in a DEC analysis improves the biogeographic reconstruction through more realistic estimates of extinction rate, and more precise estimates of biogeographic history. These analyses were conducted on a variety of clades with available high-resolution phylogenies of fossil and extant specIes. These included an extinct clade of equids, extinct and extant clades of canids, and a clade of marmots including extinct and extant species.

Symposium 1 (Wednesday, November 2, 10:30 am)

INTRASPECIFIC VARIATION IN THE LIMB STRUCTURE OF THE LOWER JURASSIC ICHTHYOSAUR *STENOPTERYGIUS*

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Stenopterygius, a derived ichthyosaur from the Early Jurassic of Germany, had highly modified limbs, an adaptation for a secondarily aquatic way of life. These modifications included morphological changes such as hyperphalangy and reduced proximodistal differentiation of elements. In addition to these changes, high levels of variability have been reported in the limbs of *Stenopterygius*, including variation in phalangeal counts, digital bifurcation, interdigital ossicles and fusion of phalanges. The objective of this study was to examine the roles of proximal-distal differentiation and hyperphalangy on intraspecific variation. The paddle variants present in a single species, *S. quadriscissus*, were catalogued based on 65 articulated specimens, and these data were compared to a sample of congeners (*S. triscissus* and *S. uniter*) in order to assess whether patterns were conserved at the generic level. Data from the Triassic ichthyosaur *Mixosaurus* was used to evaluate conservation of variants over longer time scales. *Mixosaurus* differs from *Stenopterygius* in retaining a higher degree of proximal-distal differentiation of elements, but is also characterized by hyperphalangy. Across all ichthyosaurian taxa surveyed, intraspecific differences in phalangeal count were observed. The digits with the highest phalangeal counts were most likely to vary between the right and left sides of an individual, but the longest functional digits were least variable within a species, implying a degree of functional constraint on digit length. The longest digits also showed an ontogenetic component to variation in phalangeal count in *Stenopterygius*. Additional sources of variation (digital bifurcation, phalangeal fusion, interdigital ossicles) were conserved at the generic level in *Stenopterygius*, however differed in *Mixosaurus*. In the latter genus, no digital bifurcation, interdigital ossicles or fusion of phalanges was observed, although phalangeal counts were within the range seen in *Stenopterygius*. These results suggest that loss of proximal-distal differentiation, not hyperphalangy, provided increased opportunities for the generation of morphological diversity in ichthyosaur paddles.

Poster Session II (Thursday, November 3)

EXPANDING THE POST-CRANIAL TAXONOMIC CHARACTERIZATION OF THE LATE PLEISTOCENE GROUND SLOTH *MYLODON DARWINI*

MCAFEE, Robert, University of Missouri-Columbia, Columbia, MO, USA

The ground sloth *Mylodon darwini* (Mammalia: Pilosa: Mylodontidae) is one of the earliest established forms from the Pleistocene of South America. It differs significantly from other mylodontids of that period by its reduced dental formula (4/4), a long and narrow skull, and the retention/ossification of nasal cartilage into a bony arch. Despite the long history of this genus, almost nothing is known about the characters of the post-cranial elements as *Mylodon* was long embroiled in disagreements of nomenclature and then largely forgotten in later years with most studies focusing only upon the crania. For the first time, descriptions are made for post-cranial elements of *Mylodon*, based on specimens with a known skull, and contrasted with its closest Pleistocene South American ally, *Glossotherium*, to establish taxonomic characters for future identifications. The new *Mylodon* material comes from the late Pleistocene of the Buenos Aires Province near the town of Oriente. Post-cranial elements exhibiting distinct characters for taxonomic delimitation are the ulna, radius, MC III, and astragalus. The ulna of *Mylodon* is distinguished by a greater development of the olecranon process, whereas the trochlear articular surface is flatter and less concave compared to *Glossotherium*. The radius is longer and wider, narrower in the proximal third of diaphysis, radial tuberosity is positioned more toward the medial surface than the anterior, and it lacks the distinct pronator flange seen in *Lestodon*. For MC III, the proximal projection for articulation with MC IV is thicker than that for MC II, which is opposite the pattern in *Glossotherium*. The astragalus bears a distinct notch separating the discoid and odontoid facets in the anterior aspect, the discoid facet is elongated compared to *Glossotherium*, and unlike *Lestodon* the articular surface for the calcaneus is one continuous facet. Many post-cranial elements in the mylodontid sloths are similar in appearance but elements assigned here to *M. darwini* demonstrate the morphology is not uniformly constrained and that taxonomic characters are identifiable, paving the way for future identification of *Mylodon* material.

Symposium 2 (Wednesday, November 2, 8:15 am)

TORTOISES AS TEMPERATURE PROXIES: A PHYLOGENETIC REAPPRAISAL

MCCORD, Robert, Arizona Museum of Natural History, Mesa, AZ, USA

The use of tortoises as indicators of minimum temperature proxies has a long tradition in vertebrate paleontology notably since work published in the late 1950s and early 1960s. Generations of paleontologists have cited these works in analysis of temperate faunas with tortoise remains.

Subsequent work has clarified and quantified the relationship of tortoises to temperature. There has been an increased understanding of the limiting factors of reptiles in general and tortoises in particular. Cold month mean temperature (CMM) has become recognized as the aspect of temperature that tortoises best reflect, although likely not the true limiting factor. Size and the ability to burrow have been recognized as modifying the limiting conditions in tortoises.

More recently there have been many attempts at the phylogenetic reconstruction of physiological ancestral traits. These methods infer probable ancestral states using means or maximum likelihood methods from known values for extant taxa. This method is here applied to tortoises. Oxygen isotope ratios of biogenetic phosphate can, in some select cases, give CMM data as well. These are here employed as additional data on extinct taxa in a phylogenetic framework.

Phylogenetically inferred CMM minima for extinct tortoises give us a more realistic appraisal of these tortoises as temperature proxies. Tortoises may have some utility as temperature proxies, but are not as sensitive or reliable as other taxa, like crocodilians. The North American tortoises appear to represent a more temperate clade than extant giant tortoises.

Poster Session IV (Saturday, November 5)

A SUBADULT SPECIMEN OF *RUBEOSAURUS OVATUS* (DINOSAURIA: CERATOPSIDAE) AND ITS IMPLICATIONS FOR CENTROSAURINE PHYLOGENY

MCDONALD, Andrew, University of Pennsylvania, Philadelphia, PA, USA

The Upper Two Medicine Formation (middle Campanian) of northwestern Montana boasts an excellent record of centrosaurine ceratopsids. Four taxa have been named: *Brachyceratops montanensis*, *Rubeosaurus ovatus*, *Einiosaurus procurvicornis*, and *Achelousaurus horneri*. *Rubeosaurus* has been historically the most sparsely known and least understood of those taxa, although the recent referral of a second skull elucidated important aspects of its anatomy. A third specimen, USNM 14765, may now be referred to *Rubeosaurus ovatus* based upon features shared with the holotype of that taxon.

USNM 14765 is the partial skull and postcranium of a subadult centrosaurine from the Upper Two Medicine. It was discovered by an expedition of the National Museum of Natural History and described as an adult individual of *Brachyceratops*. However, the holotype and other specimens from the type quarry of *Brachyceratops* are juvenile individuals and do not bear any features by which to diagnose the taxon; *Brachyceratops* is thus a *nomen dubium*. Furthermore, USNM 14765 does not share any characters exclusively with specimens of *Brachyceratops*. A revised interpretation of the parietal processes of USNM 14765 suggests that it possesses a nascent P5 spike in addition to incipient P4 and P3 spikes. P5 spikes are otherwise known only in *Styracosaurus albertensis* from the Dinosaur Park Formation of Alberta and in *Rubeosaurus ovatus*. USNM 14765 differs from *Styracosaurus* by its lack of a P1 process, but agrees with the holotype of *Rubeosaurus* in this character. USNM 14765 may therefore be referred to *Rubeosaurus ovatus* as the third known specimen and first recognized subadult of the species. USNM 14765 provides additional anatomical information on *Rubeosaurus ovatus*, allowing the taxon to be coded for more characters in a phylogenetic analysis. The analysis places *Rubeosaurus ovatus* as the sister taxon to a clade composed of *Einiosaurus procurvicornis*, *Achelousaurus horneri*, *Pachyrhinosaurus lakustai*, and *Pachyrhinosaurus canadensis*.

Symposium 2 (Wednesday, November 2, 9:00 am)

NOTHROTHERIOPS SHASTENSIS: THE DESERT ADAPTED GROUND SLOTH

MCDONALD, H. Gregory, National Park Service, Fort Collins, CO, USA

The ecology of the living tree sloths which are restricted to tropical rainforest habitat represents only a small subset of the total diversity of ecological adaptations in the different sloth lineages represented by extinct taxa. During the Rancholabrean (Late Pleistocene) the major portion of the distribution of the Shasta Ground Sloth, *Nothrotheriops shastensis*, is in the southwestern United States and northern Mexico and most of the localities where it is found are within the present day Sonoran, Chihuahuan, Mojave and Great Basin Deserts. While the boundaries of these different desert regions expanded and contracted during the Pleistocene in response to climate change, the preservation of dung of *Nothrotheriops* in multiple dry caves in these deserts has provided direct evidence that the Shasta Ground Sloth included a diverse array of xeric adapted plants characteristic of these deserts in its diet. All of the plants identified in the *Nothrotheriops* dung are of extant species, many of which still live within the vicinity of localities where the sloth remains were found. This has lead to the conclusion that the extinction of the Shasta Ground Sloth cannot be attributed to a change in the environment impacting its forage. While the biotic component of the ecology of *Nothrotheriops* has been studied in detail, what has not been as closely examined is the abiotic component of its ecology. Two climatic characteristics of desert environments are low amounts and seasonal availability of water and extremes in temperature, both daily and seasonally. Both of these factors have played a critical role in shaping the evolutionary history of all of the North American Deserts in terms of their flora and fauna. During the Pleistocene many species of plants in the southwest underwent an elevation change in their distribution in response to changes in temperature. Changes in the timing of rainfall can affect the timing of blooming of vegetation and the quality of the forage available to the sloth. Consequently each of these components of climate change during the Pleistocene would have impacted the sloth both directly in terms of its physiology and indirectly in terms of its food supply and may have contributed to its extinction.

Poster Session I (Wednesday, November 2)

REDIAGNOSIS AND PHYLOGENETIC RELATIONSHIPS OF _SIGILMASSASAURUS_, A PROBLEMATIC THEROPOD FROM THE MID-CRETACEOUS OF MOROCCO

MCFEETERS, Bradley, Carleton University, Ottawa, ON, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; SCHRÖDER-ADAMS, Claudia, Carleton University, Ottawa, ON, Canada; HINIC-FRLOG, Sanja, Carleton University, Ottawa, ON, Canada

The holotype of the problematic mid-Cretaceous Moroccan theropod *Sigilmassasaurus brevicollis* is an isolated posterior cervical vertebra. Originally described as a highly aberrant theropod representing a previously unknown lineage (Sigilmassasauridae), subsequent studies have been unable to clarify its systematic position or have questioned its validity as a unique taxon. Unambiguously referred material is restricted to cervical and anteriormost dorsal vertebrae sharing apomorphies with the holotype. Of the five characters originally used to diagnose the taxon, only one, intercentral articulations much wider than high, exceeding length of centrum in width, is confirmed to be present and unique to *Sigilmassasaurus*. Additional new characters that diagnose and differentiate *Sigilmassasaurus* from all other theropods known from comparable material include: (1) prominent median tuberosity on the anterior articular facet; (2) interzygapophyseal laminae absent on cervicals and anteriormost dorsals, such that the anterior margin of the neural spine contacts the anterodorsal margin of the neural canal; and (3) the spinopostzygapophyseal fossa takes the form of a posteroventrally open trench continuous with the posterior margin of the neural spine and the posterodorsal margin of the neural canal. The absence of epipophyses may also be diagnostic of *Sigilmassasaurus*, but it is unknown whether this characterizes all or only part of the cervical series. Other potential apomorphies sensitive to positional interpretation and homologies of the material include the first appearance of true centrodiapophyseal laminae close to the cervico-dorsal transition, and the appearance of the largest hypapophyses in the posterior cervicals. A phylogenetic analysis supports previous hypotheses that *Sigilmassasaurus* is a tetanuran. The previously proposed synonymy of *Sigilmassasaurus* and *Carcharodontosaurus* cannot be verified or rejected as the taxa lack comparable material. Until such comparisons can be made *Sigilmassasaurus* is provisionally retained as a valid taxon.

Poster Session I (Wednesday, November 2)

CRANIAL MORPHOLOGY AND VARIATION IN _PROSAUROLOPHUS MAXIMUS_ WITH IMPLICATIONS FOR HADROSAURID DIVERSITY AND EVOLUTION

MCGARRITY, Christopher, University of Toronto, Toronto, ON, Canada

The hadrosaurine *Prosaurolophus maximus* is known from numerous articulated specimens in Late Campanian deposits of the Dinosaur Park Formation of southern Alberta. Therefore, it is an ideal taxon to reconstruct patterns of growth and variation in hadrosaurids, and improve our understanding of their evolutionary relationships. Though well represented in the fossil record, *P. maximus* has been poorly documented. This study describes the cranial anatomy in *P. maximus*, quantitatively examines its range of variation, and provides the first ontogenetic series for this taxon, with implications for dinosaur diversity and evolution.

Prosaurolophus maximus is characterized by a solid nasal crest located above the rostrodorsal margin of the orbit that is excavated laterally by the circumnarial depression. Regression analyses indicate that growth of the crest is positively allometric, consistent with hypotheses of a sexually selected structure. A second species, *P. blackfeetensis* from the Two Medicine Formation of Montana, was named based on morphological differences in the nasal crest; however, morphometric results in this study fail to quantitatively differentiate *P. blackfeetensis* from *P. maximus*.

A species-level phylogenetic analysis of hadrosaurids, the first to include both species of *Prosaurolophus*, recovers a single most parsimonious tree with *P. maximus* and *P. blackfeetensis* as sister taxa. The analysis supports a monophyletic relationship between *Saurolophus* and *Prosaurolophus* with an *Edmontosaurus*-*Kerberosaurus* clade as their sister taxon. Inclusion of *Hadrosaurus* into the current data matrix supports a monophyletic Hadrosaurinae. Based on both the morphometric and phylogenetic data, this study supports the previous hypothesis that *P. blackfeetensis* is a junior synonym of *P. maximus* thereby increasing its temporal range to 1.6 Ma, and suggests a long period of morphological stasis in this taxon.

Symposium 2 (Wednesday, November 2, 9:15 am)

HOW QUATERNARY CLIMATE CHANGE PATTERNED MORPHOLOGICAL VARIATION IN _MICROTUS CALIFORNICUS_

MCGUIRE, Jenny, National Evolutionary Synthesis Center, Durham, NC, USA

Within a species, variation is an important factor determining the potential to evolve in the face of future climate change. The paleontological record can trace changes in variation, by providing snapshots of functional morphological traits through time. If those traits are correlated with climate variables, we can uses them to trace how changes in climate have patterned variation in the past and determine how adept the species will be to respond to future climate change. This study uses population-level paleo- and neontological data to examine how the morphological variation of an ecologically important species, *Microtus californicus* (the California vole), has changed throughout the Quaternary. I use geometric morphometric methods to test three hypotheses: 1) that *M. californicus* tooth shape is correlated with precipitation; 2) that the overall Quaternary warming and drying trends in California caused certain *M. californicus* morphotypes to shift northwest through time; and 3) that Quaternary climate change led to an overall reduction in morphological variation.

I find that precipitation is a major factor in structuring *M. californicus* first lower molar (m1) variation. As most of California has become dryer throughout the Quaternary, the geographic structure of m1 variation has shifted across the landscape. The majority of fossil variation now is found only in the present-day northern range of the species, while m1s in the southern portion of the state have decreased variation with a predominantly dry-adapted southern lineage. Quaternary climate change, and the subsequent loss of morphotypes, has resulted in an overall reduction in the morphological variation in the m1 of *M. californicus*. This has left the species more vulnerable to future environmental changes. When examined with respect to the overall species range, the projected changes in precipitation may stress all regions of this species' range, as precipitation increases in the north in the face of lost high-precipitation morphotypes and continues to decrease in the south where populations may already be at their morphological limits.

Poster Session III (Friday, November 4)

TAXONOMY, PALEOECOLOGY, AND FUNCTIONAL MORPHOLOGY OF MIOCENE CAMELIDS IN THE JUNTURA FORMATION

MCHORSE, Brianna, University of Oregon Department of Biology and Clark Honors College, Eugene, OR, USA; HOPKINS, Samantha, University of Oregon Department of Geological Sciences and Clark Honors College, Eugene, OR, USA; DAVIS, Edward, University of Oregon Department of Geological Sciences and Museum of Natural and Cultural History, Eugene, OR, USA

Paleoecological research relies largely on the accuracy with which fossil specimens can be identified. Species-level identifications provide the most precise data for measuring communities through time and changing environments. While cranial fossils allow quick identification of specimens to the species level because of the density of characters (teeth, foramina, sutures, etc.), postcranial elements tend to be less diagnostic. However, postcranial material is favorably preserved in the fossil record. Previous studies have suggested that the dimensions of camelid metapodials tend to cluster in a species-specific way, and that the degree of splaying in the distal condyles can point to the presence or absence of the secondarily digitigrade posture associated with pacing. We measured 10 parameters on Miocene camel metapodials from the Black Butte site in the Juntura Formation to identify the specimens, determine likelihood of pacing, and examine whether sexual dimorphism was likely in any of the species present. Cranial elements are relatively rare at this site, so the camels were not previously assigned to definitive taxa. Bivariate analyses suggest that the camels in this fauna represent at least two distinct species based on several size parameters, but the degree of splaying in the distal condyles varies considerably across all size classes. Since this character directly influences foot posture and gait, the range of splaying across size groups in this sample suggests that either the camels had tremendous individual variation in gait within species or that several more species were present in the fauna. A more precise understanding of the paleoecology of camels from Juntura will help to place them in ecological context relative to the other animals with which they lived.

Poster Session I (Wednesday, November 2)

ASSESSING RATE AND SCALE IN TEMNOSPONDYL EVOLUTION

MCHUGH, Julia, University of Iowa, Iowa City, IA, USA

Rate and magnitude of speciations and extinctions can only be properly addressed in a phylogenetic context with respect to either community background levels or within a clade of interest. Here, stage-level rates of speciation and extinction are calculated for the extinct amphibian clade Temnospondyli, spanning the Early Carboniferous (Bashkirian) to the Late Triassic (Norian). Rates are based on specimen occurrence data and minimum divergence of ghost lineages derived from a large-scale species-level phylogenetic analysis, which is based upon a matrix of 87 taxa and 328 morphological characters. Results show two discrete periods of elevated levels of lineage extinctions per million-years: 1) Wuchiapingian-Ladinian, peaking in the Induan; and 2) a bimodal event with peaks in the Sakmarian and Kungurian. Origination levels of lineages per million-years show five discrete events: 1) Changsingian-Anisian, peaking in the Induan; 2) Gzhelian-Sakmarian, peaking in the Asselian; 3) Serpukhovian-Kasimovian, peaking in the Bashkirian; 4) Wordian-Wuchiapingian, peaking in the Capitanian; and 5) Carnian. When ghost lineage data are removed from estimations of lineage originations only events 1, 2 and 5 remain, illustrating the importance of utilizing ghost lineages derived from phylogeny in the estimation of speciation levels. The largest individual origination and extinction events are concurrent with the Permian-Triassic boundary. The speciation peak at the beginning of the Induan greatly exceeds the extinction event at the end of the stage, indicating that despite a dramatic increase in extinction levels, the speciation initiated in the late Changsingian began a large amphibian radiation that continued through the Permian-Triassic boundary and into the Triassic.

Poster Session IV (Saturday, November 5)

PALEOECOLOGY, PALEOENVIRONMENT, PALEONTOLOGY, AND PALEOPEDOLOGY OF HAWK RIM, CENTRAL OREGON, USA

MCLAUGHLIN, Win, University of Oregon, Eugene, OR, USA; HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

The Miocene offers an opportunity to study the effects of changing environments on terrestrial faunas. A dramatic change in ecology gave rise to open habitats as climate cooled and dried. Several remarkable sites exist in the Northwestern United States preserving Miocene faunas, including Mascall, Red Basin, Beatys Butte, and Virgin Valley. Hawk Rim represents a new mid-Miocene site in Eastern Oregon. Located east of Prineville, the site is sedimentologically and stratigraphically consistent with the Mascall Formation of the John Day Basin to the north and east of Hawk Rim. Several members of the fauna are shared with the Mascall attesting to the Barstovian age of the site. The fauna shares taxa with the Mascall including the canid *Tephrocyon rurestris*, the equids *Parahippus* and *Merychippus*, and camelid and dromomerycid artiodactyls. Also present are pond turtles (*Clemmys*). Hawk Rim is also distinct from the Mascall fauna. Hawk Rim preserves remains of the canid *Cynarctoides acridens*, the castorid *Monosaulax*, tortoises (Testudinidae), and the remains of several large birds, none of which are known from the Mascall; *C. acridens* is unknown from the Northwest region prior to this record. The *Monosaulax* species is also unlike any published specimens from Oregon, again suggesting a fauna with different characteristics and components then traditional Mascall assembledges. As individuals these taxa are of interest, but the real story is told by the paleoecology. The lower reaches of the Hawk Rim section have several lacustrine diatomite layers as well as preserved logs and tree stumps, suggesting the presence of a wet, forested ecosystem. These diatomites and trees are absent in the upper part of the section. Climate data from paleosols allow us to relate local habitats in the John Day Basin and sites in Southeast Oregon such as Red Basin and Beatys Butte, making analyses of large-scale ecological trends in mid-Miocene of Oregon possible.

Technical Session III (Wednesday, November 2, 2:15 pm)

CARNIVORE POSTCRANIAL DISPARITY: ADAPTATION TO CLIMATE AND HABITAT

MEACHEN-SAMUELS, Julie, National Evolutionary Synthesis Center, Durham, NC, USA; WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden

Carnivores have a broad impact on the ecosystems in which they reside. Through interspecific interactions with other carnivores and top-down control of prey species they influence everything from prey abundance to vegetation types. This study examines the functional diversity of extant carnivorans to investigate the influences of temperature, precipitation and habitat type on postcranial morphology. Understanding patterns of functional diversity is crucial to paleontological studies, where morphology, rather than observational data, is our main guide to community ecology and evolution.

We amassed a database of 21 postcranial measurements from 121 species of extant mammalian carnivorans from across the globe. We correlated these species' occurrence data to climate, temperature, and habitat information from an NCEAS mammalian paleocommunities working group database of approximately 300 localities world-wide, and examined patterns between carnivore postcranial morphology and climate variables. Results show distinct trends between mean annual temperature, precipitation and several aspects of postcranial morphology. Brachial index (BI) shows a negative correlation with precipitation, with high BI associated with low mean precipitation, and low BI associated with high mean precipitation. Shoulder moment index (SM) shows a similar correlation with temperature, with high SM associated with low mean temperatures and low SM associated with high mean temperatures. Greater trochanter height index (GTH) shows a bimodal distribution, associated with precipitation less than or greater than 1200 mm/year. Low precipitation is associated with low GTH, and cursorial and semi-fossorial locomotor groups. High precipitation is associated with high GTH, and arboreal and semi-aquatic locomotor groups. These results have implications for past climate regimes for fossil species, and for predicting how extant carnivoran communities will change with ongoing global climate change.

Symposium 2 (Wednesday, November 2, 8:45 am)

THE ENVIRONMENTAL RECONSTRUCTION OF EL GOLFO, SONORA, AND THE USE OF *HELODERMA*

MEAD, Jim, East Tennessee State University, Johnson City, TN, USA; SHAW, Christopher, George C. Page Museum, Los Angeles, CA, USA

The El Golfo badlands in northwestern Sonora, Mexico have proven to preserve vast information about the faunal history of the Irvingtonian LMA (middle Pleistocene). Mammalian taxa have received the majority of attention at the local fauna. Only now are the amphibian and reptilian remains being described. Most large (>200 mm SVL), robust lizards in Mexico and Southwestern USA today are within Iguanidae: *Sauromalus*, *Ctenosaura*, *Iguana*. Select species within Anguidae can be large but are not robust. The largest and most robust lizard in the region during the late Neogene is *Heloderma* (Helodermatidae). One large, trunk vertebra from El Golfo lacks a zygosphene and zagantrum; these processes are absent on *Heloderma* yet prominent on large iguanids. The El Golfo occurrence of *Heloderma* is the first record for the Irvingtonian. Species of *Heloderma* today are not active at temperatures much below 24°C (75°F). The lizard inhabits El Golfo today with its hot, desert ecoregion of the Gran Desierto, coastal sand dunes, and shoreline of the Gulf of California. Fossil macrobotanical remains from the sediments indicate that at least some river-side locales had cottonwood (*Populus*), fan palm (*Washingtonia*), and walnut (*Juglans pseudomorpha*) trees. Generalized environmental reconstructions recognized based on recovered fauna include 1) permanent freshwater of stream and/or pond, 2) near-shore and/or upland shrub and brush woodland, and 3) open grassland possibly with scattered trees. *Heloderma suspectum* also thrives in semidesert grasslands to woodlands; *H. horridum* lives further south along the coastal west side of Mexico to Guatemala in tropical dry forests, tropical deciduous forests, pine-oak woodlands, and tropical thornscrubs. The recovery of *Heloderma* at El Golfo may support an arid environmental reconstruction although the species could also be living in a mixed woodland to grassland habitat now not found in the Grand Desierto. *Heloderma* living in the Mio-Pliocene of eastern Tennessee is known to have inhabited an oak-hickory subtropical forest surrounding a lake environment.

Technical Session XII (Friday, November 4, 3:30 pm)

THE LIANG BUA AVIFAUNA: FAUNAL COMPOSITION, DIVERSITY, AND EXTINCTION

MEIJER, Hanneke, Smithsonian Institution National Museum of Natural History, Washington, DC, USA; JAMES, Helen, Smithsonian Institution National Museum of Natural History, Washington, DC, USA; SUTIKNA, Thomas, The National Research and Development Centre for Archaeology, Jakarta, Indonesia; DUE, Rhokus, The National Research and Development Centre for Archaeology, Jakarta, Indonesia; TOCHERI, Matthew, Smithsonian Institution National Museum of Natural History, Washington, DC, USA

Liang Bua, a cave on the Indonesian island of Flores, preserves a rich fossil sequence spanning the past 95,000 years. Recent excavations have recovered a faunal assemblage that comprises well-preserved mammal, bird, reptile, fish and mollusc remains. Bird fossils are numerous throughout the Liang Bua stratigraphic sequence, providing important new insights into the evolutionary and ecological history of a Wallacean bird community. Here, we present the results of the first study of a large sample of avian bone and bone fragments (N = 577) retrieved from the excavation of 9.5 m of sediments from Sector XI, a 2 m by 2 m square along the east wall of the cave. We identified 242 non-passerine bird bones to genus, and where possible, species level. These represent at least 29 taxa in 14 families. Twenty-four taxa were recorded in the Pleistocene sediments, and nine in those of the Holocene. Four taxa are present in both time periods. The Pleistocene assemblage represents a diverse avifauna including several birds of prey (Accipitridae), kingfishers (Halcyonidae), snipes (*Gallinago* sp.), plovers (*Pluvialis fulva*), parrots (*Geoffroyus geoffroyi*), pigeons (Columbidae) and swiftlets (Apodidae) and indicates that the cave's surrounding environment was floristically diverse and included several habitat levels. Four species, the giant marabou *Leptoptilos robustus*, the vulture *Trigonoceps* sp., a possibly flightless crake *Porzana* sp. and a large barn owl *Tyto* sp. are thought to have gone extinct at the end of the Pleistocene. The Holocene documents the arrival of Imperial pigeons *Ducula* sp., Gurney's Eagle *Aquila gurneyi* and Junglefowl *Gallus* sp. However, species diversity is significantly lower in the Holocene sediments, and together with the probable loss of at least four Pleistocene species, this is interpreted as evidence for an avifaunal turnover toward the end of the Pleistocene. The observed changes in avifaunal composition and species diversity may reflect climatic change at the end of the Pleistocene, possibly amplified by the arrival of modern humans in the Holocene.

Poster Session I (Wednesday, November 2)

A DIPNOAN PTERYGOID FROM BERGISCH GLADBACH, GERMANY
MELLBIN, Barbro, Uppsala University, Uppsala, Sweden

The Late Devonian Bergisch Gladbach locality in western Germany has yielded numerous fossil lungfish over the years, including *Rhinodipterus*, *Griphognathus*, and *Dipterus*. Lungfishes are very important to our understanding of Devonian vertebrate evolution, but despite a rich fossil record key parts of their early history are still poorly understood. It is therefore important to try to resolve outstanding issues in Devonian lungfish morphology, phylogeny, ecology and evolution. The locality is no longer accessible, but still provides unique specimens such as an unusually large dipnoan pterygoid that was discovered in the collections of the Swedish Museum of Natural History. Initially, this fossil was interpreted to be a dipnorhynchid pterygoid, as it seems to share several characteristics with *Dipnorynchus*, including having dentine-plated pterygoids. However, upon closer inspection, this particular pterygoid may represent a new lungfish taxon. Like *Dipnorhynchus* this pterygoid has no clearly defined teeth, but it does present three distinct oval elevations along its lateral edge and two elevations along the medial side. The anterior medial elevation is similar in size to the lateral elevations whereas the posterior one is significantly larger, round, and placed slightly posterior to the centre of the specimen. None of these features are characteristic for a *Dipnorhynchus* pterygoid. There appears to be no fusion between the left and right pterygoid, which also differentiates this specimen from *Dipnorhynchus* where the entire palate is fused. The anteromedial edge would have been in contact with the corresponding surface of the left pterygoid and a long, narrow parasphenoid would have been present between the pterygoids. Its unusual size and features, completely unlike that of other Bergisch Gladbach lungfishes, may provide important data from both a phylogenetic and ecological perspective.

Poster Session I (Wednesday, November 2)

***ACROCANTHOSAURUS ATOKENSIS* (DINOSAURIA: THEROPODA) FROM THE CLOVERLY FORMATION OF WYOMING: IMPLICATIONS FOR EARLY CRETACEOUS NORTH AMERICAN ECOSYSTEMS**
MELSTROM, Keegan, University of Michigan, Ann Arbor, MI, USA; DEMIC, Michael, University of Michigan, Ann Arbor, MI, USA

We present the first remains of the allosauroid theropod *Acrocanthosaurus atokensis* from the Albian Cloverly Formation of Wyoming. This partial skeleton contains axial and appendicular material and is referable to *Acrocanthosaurus* based on the presence of a pointed femoral head in proximal view. The absence of neurocentral fusion and bone histology of the femur indicate that the specimen is a juvenile. We use the circumferences of femoral lines of arrested growth visible in thin section to estimate the mass of the specimen over successive years. These estimates suggest that at least early in ontogeny, *Acrocanthosaurus* grew at rates similar to those of scaled-up precocial birds. At these rates, *Acrocanthosaurus* would have reached adult body mass (ca. 6,000 kg) within 20-30 years. Gigantism in *Acrocanthosaurus* evolved via acceleration of basal allosauroid growth rates, similar to the situation in some other clades of giant theropods (e.g., Tyrannosaurids). All large-bodied theropod remains from the Early Cretaceous of North America are consistent with identification as *Acrocanthosaurus atokensis*, but most are too fragmentary to confidently assign to the taxon. Like some other Early Cretaceous North American dinosaur genera, *Acrocanthosaurus*' geographic range spanned over 1500 km of paleolatitude. In North America, end-Early Cretaceous ecosystems were more similar to those of the end-Late Cretaceous than previously thought; both featured a single very large-bodied, fast growing, geographically widespread theropod dinosaur.

Symposium 2 (Wednesday, November 2, 9:30 am)

PALEOECOLOGY OF TWO PLIOCENE VERTEBRATE FOSSIL ASSEMBLAGES IN WESTERN NORTH AMERICA: THE PANACA FAUNA OF LINCOLN COUNTY, NEVADA AND THE HAGERMAN FAUNA OF TWIN FALLS COUNTY, IDAHO
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To characterize the responses of terrestrial vertebrates to Plio-Pleistocene climate change in western North America, it is important to establish baseline characteristics of terrestrial communities and ecosystems early in this interval. To that end, we have conducted a comparative study of two Pliocene (Blancan Land Mammal Age) faunal assemblages-one from the Panaca Formation of Lincoln County, Nevada, and other from the fossil-rich beds of the Glenns Ferry Formation exposed near Hagerman, Idaho. Both the Panaca and Hagerman ecosystems represent mid-latitude, inland basins that were dominated by fluvial, floodplain, and lacustrine habitats in a seasonal climate with wet and dry periods. The Panaca vertebrate faunal assemblage contains forty-three genera in twenty-five families. This diverse fauna reflects a mixture of habitats, including lacustrine, marsh-meadow, riparian, upland, and steppe. Especially revealing is the Panaca avifauna, which includes *Cygnus*, *Anas*, and *Rallus*. More xerophilic inhabitants include *Bassaricus*, *Repomys*, *Prodipodomys* and *Lepoides*. Lagomorphs are especially abundant and diverse. The Panaca fauna includes at least two early Blancan immigrant taxa from Asia: the vole *Mimomys panacaensis* and the caprine *Sinocapra willdownsi*. The Hagerman fauna, with ninety-one vertebrate genera in thirty-five families, has greater diversity than the Panaca fauna. We attribute the greater diversity of the Hagerman fauna primarily to the fact that the Hagerman basin was much larger than the Panaca basin, and it was connected by riparian corridors to other stream systems and to the Pacific Ocean. The Panaca Basin, by contrast, was a much smaller, internally drained basin with an ephemeral pluvial lake. Also, the Hagerman fauna has been studied more intensively than has the Panaca fauna, so it is more completely known. We compared trophic level diversity values within these two faunas to that of the modern Amboseli Basin of East Africa. Relative to the other two faunas, the Panaca fauna seems to be slightly over-rich in small mammal taxa and depauperate in carnivore taxa, however it is too early to determine the significance of these values.

Technical Session XIII (Friday, November 4, 3:15 pm)

EFFECTS OF VARIABLE MAGNIFICATION AND IMAGING RESOLUTION ON PALEODIETARY INTERPRETATIONS DERIVED FROM DENTAL MICROWEAR ANALYSIS
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Light microscope dental microwear analysis (LMDMA) has been increasingly utilized for paleodiet studies. LMDMA involves viewing dental surfaces, either through the objective lenses of a microscope, or on micrographs taken through a microscope. Published LMDMA studies report a highly varied range of magnifications (30x-100x). The magnifications used in most LMDMA studies appear to have been arbitrarily chosen and no studies have been undertaken to examine the effects of differential resolution. To test the effects of resolution, the two authors independently examined 30 randomly ordered digital micrographs (taken when viewed at 100x magnification through the microscope), consisting of equal numbers of dental wear surfaces from a browser (moose), a grazer (zebra) and hard object feeder (peccary). Both observers labeled microwear features in predefined 400µm x 400µm areas with an initial image resolution of 1.33 pixels/µm. The images were reanalyzed with decreasing resolutions: 80%, 40%, 20%, 10%, and 5% of initial resolution. Significant interobserver differences were found at all resolutions; however, correlation coefficients were consistently very high, indicating that both observers recovered similar data at all resolutions, albeit with differing degrees of feature recognition. Both observers recognized significantly fewer features as resolution decreased, but similar proportional differences in the numbers of pits and scratches between the browser and grazer were always recovered. However, at the lowest resolutions (5% and 10%) each observer positioned the hard object feeder very differently with respect to the browser and grazer, suggesting that different dietary categories or particular surface textures may be more sensitive to resolution variation. Paleodietary predictions based on LMDMA seemed insensitive to resolution, as long as a resolution is consistent and equivalent to 20% (0.27 pixels/µm) or higher. Because LMDMA at this lower resolution is rapid, researchers may be able to conduct larger microwear studies than current methods allow, potentially involving thousands of specimens used to analyze paleodiet trends through long intervals of time.

Poster Session III (Friday, November 4)

EFFECTS OF GEOGRAPHIC AREA AND SAMPLE SIZE ON TAPHONOMIC OVERPRINTING
MILIDEO, Lauren, Penn State University Department of Geosciences, University Park, PA, USA; GRAHAM, Russell, Penn State University Department of Geosciences, University Park, PA, USA; FALK, Carl, PaleoCultural Research Group, Fairfield, PA, USA; SEMKEN, JR., Holmes, University of Iowa, Dept. Geoscience, Iowa City, IA, USA

We analyzed late Holocene (4-0 Ka) paleontologically- and archaeologically-derived mammal samples along a multistate geographic transect for environmental signals. Previous work suggests that both natural and, in the case of archaeological sites, human-induced (cultural filter) taphonomic factors had a substantial influence on the faunal compositions of sites within an area of an individual state, Iowa. These taphonomic factors included food gathering strategies that depend on culture, season, and resource availability, site types (cave-deposited versus floodplain open areas) and site accessibility (e.g., size of cave opening). Finally, excavation and screening procedures, including screen size, may alter the assemblage. Therefore, in order to analyze this sample for an environmental signal, sites of like taphonomic pathways had to be compared, which was difficult because of the limited sample size.

Thus, in order to assess the effects of sample size and geographic area on taphonomic overprinting, we performed Nonmetric Multidimensional Scaling (NMDS) analyses of sites within individual states (North Dakota, South Dakota, Iowa and Illinois, USA) which today lie along a strong environmental gradient, the prairie-forest ecotone. In addition, a subsequent NMDS analysis for a sample that included all sites along the transect was performed. NMDS analysis of the sites from each state revealed no specific pattern or gradient, even when such a gradient was known to exist. However, the known ecological gradient does emerge through NMDS analysis of the full dataset and we conclude that the taphonomic bias may be overcome. The signal that can be extracted is a product of the relative strengths of the environmental gradient versus taphonomic factors. With a large enough dataset and extensive geographic area, the true underlying structure (an ecological gradient here) will shine through in ordinations of even taphonomically diverse datasets.

Poster Session III (Friday, November 4)

NEW ANTHRACOTHERES (ARTIODACTYLA) FROM WADI MOGHRA, EGYPT, AND THEIR BEARING ON HIPPOPOTAMUS PHYLOGENY

MILLER, Ellen, Wake Forest University, Winston Salem, NC, USA; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; ABDEL GAWAD, Mohamed, Cairo University, Giza, Egypt; HAMDAN, Mohamed, Cairo University, Giza, Egypt

Wadi Moghra, Egypt, is one of the most productive early Miocene localities in North Africa. The mammalian fauna includes cercopithecoid primates, carnivores, hyaenodontans, proboscideans, a rhinocerotid perissodactyl, and an array of artiodactyls. Among artiodactyls, the diversity of anthracotheres (Anthracotheriidae) is especially striking with at least four genera and five species present. One of these taxa represents an unusual new genus and species. The new taxon differs from all other anthracotheres in a number of important ways, including having multiple (six to ten) mental foramina present on both sides of the symphysis and in having the inferior boarder of the symphysis inflected inferiorly. The presence of numerous mental foramina suggests that this animal had an increased sensory capability, perhaps in the form of abundant vibrissae on the lower lips and soft tissues of the mandible. This morphological information, combined with evidence from stable isotope analysis of anthracothere teeth, supports the interpretation that this animal was adapted to foraging with its snout, most likely for shallow water plants in a riverine environment. The negative offset between enamel oxygen values for anthracotheres and other taxa from Wadi Moghra is similar in magnitude to that observed for hippos (living and fossil) and associated faunas, suggesting similar semiaquatic habits for these groups. A recently discovered, nearly pristine, skull of *Sivameryx* from Moghra shares both hippo (lacrimal separated from nasals by frontal process, superior margin of orbit high) and non-hippo (palatine foramen opens at P3, infraorbital foramen opens superior to P4-M1) characteristics. A detailed analysis of this skull holds great promise for contributing further information to assess the potential (and controversial) phylogenetic connection between anthracotheres and Hippopotamidae. Moghra has yielded more specimens (greater abundance) and more different kinds of anthracotheres (higher diversity), than any other early Miocene locality in Africa. As such it provides unique information about this wide-spread, yet still poorly understood, group of artiodactyls.

Symposium 3 (Thursday, November 3, 8:45 am)

THE CAMPANIAN VEGETATION OF LARAMIDIA

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The sequence of Campanian megafloral assemblages found on Laramidia represents the most complete sample for this time period in the world. Most megafloras show that angiosperms dominated floodplain settings comprising 60 to 90% of the species. Patterns included an exceptionally diverse platanoid clade; diverse and widespread aquatic plants; the radiation of palms; and the first megafossil appearance of gingers and several aquatic monocots. Megafloras also contained a varied bryophyte, lycopsid, sphenophyte, fern, and gymnosperm (conifers, cycads, bennettites, *Ginkgo* and *Sphenobaiera*, and *Sagenopteris*) component. Among non-angiosperms, ferns were most diverse, particularly in northern floras. Conifers were also common in backswamp deposits; and cycads and ginkgophytes showed an increase in abundance from low to high latitudes. The palynological record shows three major North American provinces (*Normapolles*, *Aquilapollenites*, continental margin), which divided Eastern North America and Laramidia into longitudinal belts. This record indicates that geographic barriers like the Western Interior Seaway and the mountains of Laramidia served to segment pollen provinces but latitudinal expanses did not. Plant-based climate estimates show a slight cooling through the Campanian but low latitudinal temperature gradients (0.3 °C/°N) and average high-latitude (>80 °N) temperatures of 2-8 °C. Precipitation was divided into a belt of low rainfall south of about 50 °N, high rainfall from 50-60 °N, and moderate to high rainfall north of approximately 60 °N. In a broad sense, megafloral assemblages yield climate estimates that correlate with latitude. Despite these patterns, major questions remain including: what is sample-size and facies normalized plant diversity and abundance? Are there gradients in deciduousness or leaf-life span? Were angiosperm forests closed canopy and multistratal or open canopy and fundamentally ruderal? Do vegetation patterns correlate with dinosaurian compositional or diversity gradients? The application of new paleoecological proxies to new systematic megafloral collections from Laramidia will hopefully produce quantitative answers to these questions.

Romer Prize/Technical Session 5 (Thursday, November 3, 11:30 am)

ARCTIC ANTLERS, CARIBOU CALVING GROUNDS, AND THE SPATIAL FIDELITY OF VERTEBRATE DEATH ASSEMBLAGES

MILLER, Joshua, Wright State University, Dayton, OH, USA

Death assemblages from diverse climatic and taxonomic settings have shown high ecological fidelity to their source communities, but the *spatial* fidelity of bone accumulations remains largely untested. Establishing the capacity of death assemblages to capture patterns of geographic use, including the identification of regions and habitats with significant ecological value, may lead to the collection of new kinds of paleoecological data. Bone and antler accumulations of caribou (*Rangifer*) may provide particularly extensive ecological data because both males and females annually grow and shed antlers; male antlers are shed post-mating, while pregnant females shed antlers at the time of calving. Caribou antlers can be common in Pleistocene deposits, offering the potential for identifying seasons-of-accumulation and even ancient mating and calving grounds. Using modern skull and antler collections (University of Alaska, Fairbanks; Field Museum; American Museum of Natural History) of caribou (*R. tarandus*) and bone surveys of modern caribou calving grounds (Arctic National Wildlife Refuge, Alaska), this preliminary study tests (1) if male and female caribou antlers are quantitatively distinguishable, and (2) if expansive arctic calving grounds produce concentrations of shed female antlers and neonatal skeletal remains. Results show that gender of adult caribou can be differentiated using linear measurements of the antler pedicle surface (antler-skull attachment). Bone surveys show that caribou calving grounds host abundant shed female antlers (up to 103/km2), with suitable calving habitats yielding significantly higher antler concentrations than poorer-quality habitats. Compared to other large-mammal death assemblages (Yellowstone National Park), arctic calving grounds contain anomalously high ratios of neonatal:adult skeletal remains. Season-specific skeletal contributions faithfully record biogeographic patterns at multiple scales and may provide (a) added ecological insight into Pleistocene deposits, and (b) a new tool for identifying critical regions and habitats for the management and conservation of poorly-understood caribou communities on modern landscapes.

Poster Session III (Friday, November 4)

A NEW LATE PLEISTOCENE VERTEBRATE SITE FROM COAHUILA, MEXICO

MILLER, Wade, Brigham Young University, Provo, Utah, UT, USA; DELGADO DE JESUS, Rene, Secretaria de Educacion y Cultura, Saltillo, Mexico; GOMEZ NUNEZ, Rosario, Secretaria de Educacion y Cultura, Saltillo, Mexico; VALLEJO GONZALEZ, Jose, Secretaria de Educacion y Cultura, Saltillo, Mexico; LOPEZ ESPINOSA, Jose, Secretaria de Educacion y Cultura, Saltillo, Mexico

Exceptionally sparse information has been published on Pleistocene vertebrates from the northern Mexican state of Coahuila. This is despite the fact that Coahuila ranks as the third largest Mexican state, has numerous intermontane basins with Pleistocene sediments, and lies adjacent to Texas with its abundant Pleistocene fossil sites. In most instances Pleistocene beds of Coahuila lie unconformably on fossiliferous late Cretaceous strata.

The newly reported fossil site here was discovered in October, 2006. It was named Hedionda del Lobo (HDL), and lies about 34 km west of the capital city of Saltillo. The highly dissected floodplain deposits at this locality trend east-west, and vary in width between 2 and 4 km. The exposed sediment depth is roughly 5 m. Sediments, consisting mostly of poorly consolidated muds and fine-grained sands, do include lenses of coarser sands and gravels. Fossils have been collected throughout a 300 m stretch within this intermontane basin. Vertebrate fossils thus far recovered are mainly disarticulated, but only show minimal erosional wear.

Fossils identified from HDL include several taxa not previously reported from Coahuila. These are: cf. *Rana,* ?*Chrysemys*, Serpentes indet., *Sylvilagus* ?audubonii, *Neotoma* cf. *albigula*, *Cynomys* cf. *mexicanus*, *Canis* cf. *lupus*, *Tapirus* cf. *haysii*, and *Bison antiquus*. Also included in this local fauna are *Pappogeomys* cf. *castanops*, *Mammut americanum*, *Mammuthus columbi*, *Equus* cf. *excelsus*, cf. *Camelops*, and *Capromeryx* cf. *Mexicana*. Horse and mammoth fossils represent the most abundant animals present. The faunal mix at HDL indicates primarily grassland conditions coupled with nearby moist woodlands. This differs significantly from the current Chihuahuan Desert habitat.

Poster Session IV (Saturday, November 5)

NEW INFORMATION ON LATE TRIASSIC TERRESTRIAL ECOSYSTEMS OF UTAH: TETRAPOD FOSSILS FROM THE CHINLE FORMATION OF LISBON VALLEY

MILNER, Andrew, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; IRMIS, Randall, Utah Museum of Natural History, Salt Lake City, UT, USA; JEFFREY, Martz, Petrified Forest National Park, Poncha Springs, CO, USA; BIRTHISEL, Tylor, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; LOCKLEY, Martin, University of Colorado at Denver, Denver, CO, USA

Exploration for paleontological resources in the Upper Triassic Chinle Formation of Lisbon Valley, San Juan County, Utah from 2004 to 2010 has produced ~170 sites. In addition to a high diversity of fishes, other important fossils include plants, invertebrates, tetrapods, and a variety of invertebrate and vertebrate traces. Detailed stratigraphic study indicates that the Chinle outcrops throughout the area are distinct from typical Chinle deposits elsewhere, and can be divided into only two units: (a) the basal "Kane Spring beds" that rest unconformably on the Permian Cutler Group and contain high concentrations of uranium ore; and (b) the overlying Church Rock Member, which itself is overlain by the Wingate Sandstone Formation.

Vertebrate fossils are not common in the "Kane Spring beds", but include two associated partial phytosaur skeletons and fragmentary aetosaur osteoderms; this unit also preserves important paleoenvironmental data in the form of abundant plant macrofossils and palynomorphs. Thick intraformational conglomerates and sandstones in the middle-upper Church Rock Member represent a large braided river system, and preserve the most significant vertebrate fossils. These include several well-preserved pseudopalatine phytosaur skulls (likely all *Redondasaurus*), the articulated hind limb and partial tail of a small *Gracilisuchus*-like basal crocodylomorph, and the skull of a new taxon of larger crocodylomorph similar to *Sphenosuchus* and *Hesperosuchus*. Other taxa based on fragmentary remains include metoposaurid temnospondyls and aetosaurs. As these conglomerate units thin laterally and change facies, vertebrate tracks increase in abundance. Tetrapod track types include both large and small *Grallator, Brachychirotherium, Apatopus, Rhynchosauroides*-like tracks, possible *Atreipus*, and tetrapod swim tracks. This new data suggests a diverse archosaur community during lat-

est Chinle time, which compares well with similar assemblages from the uppermost Chinle Formation of northern New Mexico, though with species-level differences.

Poster Session IV (Saturday, November 5)

NEW DISCOVERIES OF MICROCHOERINES (OMOMYIDAE, PRIMATES) FROM THE EOCENE OF THE IBERIAN PENINSULA

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Omomyids are one of the earliest groups of Primates, which were abundant and diverse in the Northern Hemisphere during the Eocene with some genera lasting into the Oligocene. Their main scientific interest focuses on their unresolved phylogenetic relationships with other members of the order, particularly anthropoids. The family Omomyidae is currently divided into three subfamilies, the Omomyinae, Anaptomorphinae, and Microchoerinae, this latter known exclusively from Europe. Fossil remains of microchoerines are scarce, so the knowledge of this group is still far from being complete. New fossil findings of primates from the Eocene of the Iberian Peninsula have contributed to increase the fossil record of microchoerines across Europe, allowing a better understanding of their biodiversity. Some of them are already published, such as the species *Pseudoloris pyrenaicus* from the Middle Eocene (Robiacian, MP14-15) of Sant Jaume de Frontanyà 3 (Ripollés-Berguedà Basin, southern Pyrenees), whereas others are still not described. This is the case of another new species of *Pseudoloris* found in the Middle Eocene (late Robiacian, MP15-16) site of Mazaterón (Almazán Basin), and the recent findings from the Late Eocene (Headonian, MP18) site of Zambrana (Miranda-Trebiño Basin). The material from the latter locality consists of two well-preserved right mandible fragments with relatively complete dental series, including p3-m3 and p4-m3. The overall tooth morphology and the presence of enamel wrinkling are similar to those observed in the genera *Necrolemur* and *Microchoerus*. New discoveries from Mazaterón and Zambrana constitute the first record of microchoerines in the whole Western Iberian Bioprovince, which includes several western and central Iberian basins that have yielded endemic mammalian fossils (mainly rodents and perissodactyls), unknown in the Southern Pyrenean Basins and elsewhere in Europe. The endemic nature of the primates in this bioprovince is mainly supported by the presence of the adapoid *Mazateronodon endemicus*. The study of microchoerine fossils found in Mazaterón and Zambrana will extend what is known in this matter.

Technical Session VII (Thursday, November 3, 3:15 pm)

REVISION OF *INDOBUNE* AND *CAMBAYTHERIUM* FROM THE EARLY EOCENE OF VASTAN (INDIA), AND THEIR AFFINITIES WITH ANTHRACOBUNID AND PERISSODACTYL MAMMALS

MISSIAEN, Pieter, Ghent University, Ghent, Belgium; ROSE, Kenneth, Johns Hopkins University School of Medicine, Baltimore, MD, USA; RANA, Rajendra, HNB Garhwal University, Srinagar, India; KUMAR, Kishor, Wadia Institute of Himalayan Geology, Dehradun, India; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The early Eocene vertebrates found in the Cambay Shale at the Vastan Lignite Mine represent the oldest Cenozoic Indian vertebrate fauna and their study has yielded major insights for the knowledge of Indian paleodiversity and paleogeography. In 2006, we described the new genus and species *Indobune vastanensis* based on a small collection of large, bunodont mammal teeth and referred this taxon to the enigmatic tethythere family Anthracobunidae. Nearly simultaneously, another paper described similar specimens as four distinct new species in the new genus *Cambaytherium*, which was furthermore placed in the new perissodactyl family Cambaytheriidae. Continued fieldwork has yielded additional adult and juvenile skulls, maxillae, dentaries, vertebrae and limb elements of these forms, allowing us here to clarify their evolution and classification.*Indobune* and *Cambaytherium* appear to represent a single genus, in which case the latter name takes nomenclatural priority. Many of the characters used to diagnose the different species of *Cambaytherium* seem to be less distinctive or variable, or seem to be based on misidentification of the dental position of specimens. Most or all of the reported specimens therefore probably belong to a single species. The dental morphology of *Cambaytherium* is similar to that of *Nakusia*, an enigmatic, early Eocene anthracobunid, and *Cambaytherium* resembles younger, better known anthracobunids by the specialized, transversely compressed lower premolars. The specialized premolars of *Cambaytherium* are markedly different from those of perissodactyls, and *Cambaytherium* also lacks typical perissodactyl synapomorphies such as distinct transverse lophs on the upper and lower molars or the loss of the astragalar foramen. Some similarities between *Cambaytherium* and perissodactyls do however remain and may suggest a phylogenetic link between Perissodactyla and Anthracobunidae.

Poster Session III (Friday, November 4)

USING PHYLOGENETIC CHARACTERS TO INFER EVOLUTIONARY RATES

MITCHELL, Jonathan, University of Chicago, Chicago, IL, USA

Phylogenetic character matrices represent a rich trove of morphological information, which evolutionary biologists could potentially mine to understand the tempo and mode of major transitions in the fossil record. However, the characters chosen are neither random, nor necessarily equally informative for evolutionary rates. Further, the standard protocol for computing evolutionary rate, patristic dissimilarity divided by length for each branch, uses the same characters that made the tree to also compute the rates of change along that tree. Using the most parsimonious tree generated from the same data automatically results in the lowest possible overall rates. More importantly, though, the repeated use of the same data biases changes towards internal branches which, in turn, leads to higher rates of change early in a clade's history not (necessarily) as a function of evolutionary dynamic, but as an artifact of analysis. I present a slight alteration to the standard procedure by advocating iterative partitioning. Each rate calculation is done by removing a small subset of the character data and finding the most parsimonious trees for the remaining characters, and then calculating evolutionary rates by using the sequestered character set. By performing this "jack-knife"-analogous technique multiple times, average rates of character evolution can be elucidated without concerns of preoptimization from the tree assembly procedure. Although this sounds time consuming, I also present the necessary function to perform the analysis in R using only a nexus-format character matrix and a vector of ages (with phylogenetic reconstruction performed by TNT), and present simulation results showing that the unaltered procedure is highly susceptible to falsely detecting declining rates. Further, I reanalyze several published datasets that have already had their rates calculated using the original methodology, and show how this simple, and necessary, alteration impacts the results. Despite this methodological advance, more work is needed and caution in interpreting phylogenetic data in non-phylogenetic contexts is urged, due to a plethora of potential pitfalls and biases.

Technical Session XIV (Saturday, November 5, 10:15 am)

CRANIAL MORPHOLOGY OF THE BASAL TYRANNOSAUROID *ITEMIRUS MEDULLARIS* AND EVOLUTION OF THE BRAINCASE PNEUMATICITY IN NON-AVIAN COELUROSAURS

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A redescription of *Itemirus medullaris* from the Turonian of Uzbekistan supports the hypothesis that this taxon represents a relatively derived non-tyrannosaurid tyrannosauroid. The exquisitely preserved braincase of *Itemirus* has a number of characters previously unique to tyrannosaurids among non-avian theropods, such as the separation of the branches of the trigeminal nerve within the endocranial cavity. The redescription also recovered a mosaic of coelurosaur plesiomorphies and tyrannosaurid apomorphies in *Itemirus*. For instance, tyrannosaurids had prominent pneumatic sinuses within the supraoccipital, otoccipital, and prootic, but these sinuses were either absent or less extensive in *Itemirus*. A wide taxonomic comparison led to mapping braincase pneumaticity onto a cladogram of the Coelurosauria. The anterior and posterior tympanic, basisphenoidal, and basipterygoid recesses tend to be conserved across coelurosaurian lineages, whereas other air sacs are highly homoplastic. The development of the cranial pneumaticity in modern birds suggests that the relatively conservative air sacs in Coelurosauria developed following the onset of ossification of the pneumatized element. The highly homoplastic air sacs are likely to represent secondary pneumatisation after the completion of prenatal ossification.

The parsimony analysis of Coelurosauria highlighted a few stem taxa with conflicting character information, which made plesiomorphic states ambiguous along the main stem of the tree. This ambiguity increased the number of alternative ingroup relationships and collapsed distant nodes under strict consensus. Removal of these problematic taxa substantially improved the resolution of the analysis. The second analysis recovered a phylogenetic signal for ingroup relationships that are historically challenging to resolve under strict consensus, including alvarezsaurids, compsognathids, and troodontids. The analysis also supported two tyrannosauroid radiations, Proceratosauridae and the rest of the Tyrannosauroidea, both of which dispersed across Laurasia by the Middle Jurassic times.

Technical Session XVII (Saturday, November 5, 3:30 pm)

***STEPHANORHINUS* CF. *HUNDSHEIMENSIS* FROM KURTAN, A NEW EARLY PLEISTOCENE SITE IN THE LORI PLATEAU, ARMENIA: IMPLICATIONS FOR THE BIOGEOGRAPHY OF RHINOCEROTIDAE SEDN AWARD**

MKRTCHYAN, Ruzan, Yerevan State University, Yervan, Aruba; BELMAKER, Miriam, The Collage of William and Mary, Williamsburg, VA, USA; HYNEK, Scott, University of Utah, Salt Lake City, UT, USA; BELYAEVA, Elena, University of St. Petersburg, St. Petersburg, Russia; ASLANIAN, Stepan, Center of Political and Strategic Research, St. Petersburg, Russia

The genus *Stephanorhinus* is a rhinocerotid known from the Plio-Pleistocene of Eurasia and has been used as a biochronological marker. Compared to its relative abundance in Western Europe, specimens from the Caucasus are relatively rare. Here we present preliminary results from a new locality, Kurtan, with evidence for an early presence of *Stephanorhinus* cf. *hundsheimensis*.

Situated in the Lori Plateau of Armenia is the new stratified site, Kurtan. The fossil bearing sediments contain pedogenic carbonates and overlie a pumiceous volcanic ash bed, which has been dated at 1.49 ± 0.01 Ma by 40Ar/39Ar laser fusion of single sanidine crystals. At

its base, this ash bed is in erosional contact with vesicular basalt. The western wall of the Kurtan quarry is directly overlain by a fine-grained volcanic ash bed for which a zircon U-Pb date of 1.371± 0.022 Ma has been obtained. The site yielded a small lithic assemblage attributed to the Early-Middle Acheulian tradition dated to ca. 1.0-0.8 Ma.

Fossils from Kurtan include lower dentition referable to *Stephanorhinus* cf. *hundsheimensis*. The taxon differs from *S. etruscus,* dated to 1.6-1.2 Ma, as well as from younger specimens attributed to *S. hunsheimensis* (=*S. bracycelphaus*), that post-date 0.8 Ma. Instead, specimens resemble older populations from Pietrafitta, Italy, dated to the Farentta faunal unit ca. 1.6-1.2 Ma, and which combines features of both taxa assigned to *Stephanorhinus cf. hundsheimensis*. This study sheds light on the biogeography of the taxon and suggests a wider distribution than previously assumed.

Poster Session II (Thursday, November 3)

A QUANTITATIVE APPROACH TO SAUROPOD NECK MORPHOLOGY

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Sauropod cervical vertebrae show considerable variation in number and proportion. Vertebral profiles, which plot centrum length for each position in the column, can be used to simultaneously capture variation in vertebral length and count. These profiles also allow comparisons amongst disparate groups and reveal several general neck morphotypes. These include necks with vertebrae of homogeneous size, as well as those with the most elongate vertebrae positioned anteriorly, posteriorly, or in the middle of the series. Comparison of vertebral profiles among sauropods reveals several basic patterns. Basal sauropods typically have similarly-sized cervical vertebrae, whereas more derived sauropods have several elongate cervical vertebrae that are positioned near the middle of the neck. Within-clade similarity in vertebral profiles was observed in both Macronaria and Diplodocoidea. Parallel analyses performed on other vertebrates with elongate necks indicate that sauropod necks are distinct in morphology from those of mammals and birds. Necks of modern long-necked mammals have the longest vertebrae positioned anteriorly, whereas long-necked birds have the longest vertebrae positioned posteriorly. The prolacertiform *Tanystropheus* was found to have a cervical profile comparable to that of sauropods. A standardized method of analyzing sauropod necks will facilitate their description in future work and provide a better understanding of neck elongation, mechanics, and structure in tetrapods.

Poster Session II (Thursday, November 3)

"EUHELOPODIDAE" (SAUROPODA) TEETH FROM THE UPPER JURASSIC OF PORTUGAL

MOCHO, Pedro, ALT-Society of Natural History, Torres Vedras, Portugal; ROYO-TORRES, Rafael, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; ORTEGA, Francisco, Facultad de Ciencias, Universidad Nacional de Educación a Distancia, Madrid, Spain; SILVA, Bruno, ALT-Society of Natural History, Torres Vedras, Portugal

Although previous studies of Portuguese Upper Jurassic sauropods assumed a close relationship with Morrison Formation taxa (USA), reassessment and new findings have established the presence of endemic taxa in the Iberian Peninsula. Contrary to the patterns in other dinosaur groups (e.g., theropods), the Iberian Upper Jurassic sauropods support a vicariance model to explain their diversity in this territory.

Two sauropod teeth from the Tithonian of Peralta (ALTSHN.122) and Cambelas (ALT-SHN.121) (Lourinhã Formation, Portugal) are discussed. The most complete tooth (ALT-SHN.122) consists of a premaxillary or maxillary tooth, based on lingual wear. It is a spoon-shaped tooth with a wrinkled crown surface and D-shaped cross section. The labial face is strongly convex, forming an apicobasal bulge, and the lingual face is slightly concave and preserves an apicobasal crest visible only on the apex. The mesial and distal edges of the first two-thirds of the crown are straight and parallel and exhibit leaf-shaped lingual crown buttresses. Apically, the edges converge, forming a nearly symmetric apex with a slight distal deflection. Crown-to-crown occlusion has produced V-shaped wear facets. The slenderness index is ~1.7. The general morphology of these teeth corresponds to those of the Camarasauridae and "Euhelopodidae", if it is accepted that a lingual crown buttress is an autapomorphy of *Euhelopus*.

At present, *Euhelopus* is considered a Somphospondyli taxon, and isolated Asiatic and European teeth from the Early Cretaceous have been assigned to "Euhelopodidae". If the relationship of these teeth with "Euhelopodidae" can be confirmed with more complete material, then they are the oldest record of this group, suggesting a more ancient presence (Tithonian) in the Iberian Peninsula than previously thought. However, an alternative hypothesis implies the presence of currently unassigned sauropods with *Camarasaurus*-like teeth and lingual crown buttresses in the Iberian Peninsula during the Upper Jurassic. If confirmed, this second hypothesis could explain the presence of 'euhelopid' teeth in the Iberian Early Cretaceous, restricting the "Euhelopodidae" distribution to Asia.

Technical Session II (Wednesday, November 2, 2:15 pm)

A NEODIAPSID REPTILE FROM THE LOWER PERMIAN OF OKLAHOMA

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The evolutionary history of Neodiapsida (recently redefined by the authors as the sister taxon of Araeoscelidia) during the Paleozoic Era is remarkably poor. Following the reclassification of the Early Permian *Apsisaurus witteri* as a synapsid last year, recognition of the Middle Permian species *Lanthanolania ivakhnenkoi* as the oldest known neodiapsid species resulted in a 38-million-year-long ghost lineage for Neodiapsida. That outcome was short-lived, however, with our description of *Orovenator mayorum*, a new, early neodiapsid based on two partial skulls from the Lower Permian of Oklahoma. Both specimens share a uniquely curved, anteriorly narrow lacrimal that distinguishes *O. mayorum* from other early reptiles. A phylogenetic analysis (188 characters, 30 diapsid taxa, and 4 outgroups) positions *O. mayorum* as the basal-most representative of Neodiapsida. Updating the character codings for *L. ivakhnenkoi*, using a recently collected skeleton, strengthens Neodiapsida with respect to our previous results (Bremer support index increased to 3 [from 2], and bootstrap support increased to 89% [from 63%]). Support for certain major clades, such as Sauria and Archosauromorpha (both of which collapsed with a single extra step in the prior analysis), was also increased slightly. Interrelationships among basal neodiapsids (*O. mayorum*, *L. ivakhnenkoi*, tangasaurids, younginids, and *Claudiosaurus germaini*) remain weak and collapse with the addition of a single extra step. An unexpected result of our analysis is the recovery of a clade of marine reptiles comprising ichthyopterygians, sauropterygians, and thalattosaurs, which falls within Archosauromorpha and requires three extra steps to collapse. Interestingly, our results suggest that the lower temporal bar was lost by the ancestral neodiapsid, and thus relatively soon after the evolution of the diapsid temporal morphology and, conversely, that the diapsid temporal configuration of the Late Permian neodiapsid *Youngina capensis* is a secondary condition.

Technical Session VIII (Thursday, November 3, 2:00 pm)

NEW FEATURES AND FUNCTIONAL MORPHOLOGY OF THE AXIAL SKELETON IN THE EARLY TETRAPOD *PEDERPES FINNEYAE*

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The axial skeleton of the basal tetrapod *Pederpes finneyae* is reconstructed in three dimensions from micro-CT scans. Previously unknown features are described, and the biomechanical implications of the vertebral morphology are examined. *Pederpes* is a rare fossil tetrapod from Romer's Gap, a period in the Early Carboniferous during which tetrapods emerged onto land and diversified greatly. It is one of only a few specimens that represent a vital link, both phylogenetically and biomechanically, between primitively aquatic stem-tetrapods such as *Acanthostega* and *Ichthyostega* and terrestrial stem-amphibians and -amniotes such as *Eryops* and *Seymouria*. The vertebral column of *Pederpes* is rhachitomous, with a central notochord and separately ossified neural arch, intercentrum, and pleurocentra. This arrangement is ancestral for tetrapods but is not found in any extant vertebrate. Digital separation of bone from matrix reveals for the first time the 3D surface of the zygapophyses and an almost complete series of intercentra and pleurocentra. Based upon the new reconstruction, characters linked to axial flexibility and locomotor style are used to build a vertebral functional profile, from which information can be gathered about the axial mobility of *Pederpes* in comparison to extant tetrapods. These characters and their functional correlates include: zygapophyseal angle (primary planes of movement and motion coupling), vertebral body dimensions, transverse process width, and distance between zygapophyses (stiffness in flexion and torsion), and transverse process width and deflection angle (muscle leverage). The results reveal that *Pederpes* had a locomotion profile most similar to those of the giant salamander and the salt water crocodile, which swim and walk using lateral undulations of the body. The zygapophyses of *Pederpes* are deflected more than 45º from the sagittal plane throughout the column, indicating greater resistance to dorsoventral movements in comparison to mediolateral movements. None of the measured parameters exhibit marked regional variation. Thus, we infer that *Pederpes* largely retained plesiomorphic intervertebral joint motions dominated by mediolateral flexion. This study of an important taxon lays the groundwork for future biomechanical comparisons between *Pederpes* and other early tetrapods.

Poster Session IV (Saturday, November 5)

DIETARY INFERENCES OF PROTOCERATOPSIAN DINOSAURS FROM THE LATE CRETACEOUS OF MONGOLIA BASED ON STABLE ISOTOPE GEOCHEMISTRY

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The dietary affinities of dinosaurs have remained elusive in the absence of preserved gut contents or coprolites. Protoceratopsian dinosaurs were ubiquitous in the Late Cretaceous environments of Mongolia's Gobi Desert. Their remains, including teeth, are frequently uncovered in the extremely fossiliferous red sandstones of the Djadokhta formation. Their dietary preferences can therefore be determined through geochemical analysis of tooth enamel, as is commonly done for extinct mammals. We analyze dinosaur tooth enamel, made of bioapatite, from the Djadokhta Formation for carbon and oxygen isotopes. Specifi-

cally, we analyze the teeth of the herbivorous dinosaur *Protoceratops andrewsi*. Statistical comparisons of the isotope ratios between different types of material, such as tooth dentine, tooth enamel, soil carbonate, and eggshell, along with SEM analysis are used to illustrate that diagenesis has not overwhelmed all primary isotopic signals. Carbon isotope values from teeth indicate the dinosaurs were subsisting on C3 plants adapted to arid climates, such as conifers, and drinking pools of water subject to evaporation. The stable isotopes values of dinosaur eggshells from the same localities are also compared and contrasted to illustrate the different environmental signals present in each type of fossilized material.

Technical Session XVIII (Saturday, November 5, 3:15 pm)

EVOLUTION OF THE OTIC REGION OF FOSSIL CROCODYLIFORMES

MONTEFELTRO, Felipe, FFCLRP-USP, Ribeirão Preto, Brazil; LARSSON, Hans, Redpath Museum McGill University, Montreal, QC, Canada

Transitions between terrestrial, semi-aquatic, and aquatic habitats had huge implications in numerous aspects of morphology, physiology, and sense organs in all vertebrates that experienced these shifts. These habitat shifts impose large constraints to hearing. The fossil record of Crocodyliformes has a myriad of body plans that reflect a widespread habitat occupation that spanned from fully terrestrial to fully aquatic. This distribution of inferred habitats contrasts to the semi-aquatic lifestyles of extant Crocodylia and implies multiple evolutionary shifts during the history of the group. This variation in habitats makes Crocodyliformes an attractive model to study the implications of the terrestrial, semi-aquatic, and aquatic habitats transitions for hearing. However, few studies have addressed hearing abilities of fossil crocodyliforms. Our firsthand analyses of major fossil and extant crocodyliform lineages revealed a great diversity of the external morphology of the otic region. In general, terrestrial taxa tend to have larger and more vertical otic apertures and recess and relatively larger tympanic membranes (e.g. *Sebecus icaeorhinus* and *Baurusuchus salgadoensis*), whereas semi aquatic and aquatic forms tend to have these structures reduced (e.g. *Amphicotylus lucasii*). The reduction is extreme in Metriorhynchidae (e.g. *Metriorhynchus superciliosum*) in which the hearing probably displayed a minor role in this fully marine group. Members of Notosuchia present the most extreme examples of verticalized and expanded otic regions with well developed scars in the lateral surface of the quadrate for the attachment of the tympanic membrane. A large tympanic membrane would have encompassed the many quadrate fenestrae present in basal crocododyliforms and derived notosuchians (e.g. *Protosuchus richardsoni*, *Pissarrachampsa sera* and *Mariliasuchus amarali*) suggesting these structures also played a role in hearing. We present a discussion of variation of relative hearing abilities within Crocodyliformes inferred from the entire external and internal temporal complex that correlates well with the terrestrial to aquatic habitat cline. Overall, the external morphology of the otic region and its peripheral structures are strongly linked to clade-specific habitat occupation across Crocodyliformes and emphasize auditory acuity as a major factor in the evolution of the group. These results suggest great potential for future work on anatomical and physiological comparisons of fossil and extant crocodyliformes.

E&O Poster Session

DEVELOPING ADULT EDUCATIONAL PROGRAMS: BEER & BONES, A COCKTAIL PARTY APPROACH TO PUBLIC OUTREACH

MOOTS, Hannah, Museum of Nature and Science, Dallas, TX, USA; BUCKLIN, Stacey, Museum of Nature and Science, Dallas, TX, USA; CAUGHRON, Sarah, Museum of Nature and Science, Dallas, TX, USA

In 2011, the Museum of Nature & Science in Dallas, Texas, initiated a new adult-only educational series, called *Beer & Bones*. The purpose of this series is to attract and present scientific information at the appropriate level for an adult constituency, with an effort to include young adults, age 18-30. This age range is often overlooked by science museums that have historically focused marketing and programming efforts on school children and families. Raising awareness of current research, traveling exhibits, and museum educational programming (camps, lectures, etc.) are key objectives of this public outreach series. This poster highlights the inaugural program held on March 24, 2011, a cocktail night which featured special access to *Dinosaurs Unearthed,* a traveling exhibition of animatronic dinosaurs. Visitors mingled with the MNS's Paleontology and Education staff and enjoyed the first public viewing of a *Pachyrhinosaurus* specimen that is the focus of ongoing research. The event afforded the MNS's Paleontology Department the opportunity to share their ongoing research, fieldwork and lab work with attendees and afforded the Education Department the opportunity to conduct hands-on activities and share information about programs and outreach events for adults, for families, and for schools. This poster details the creation and execution of this inaugural event, provides an evaluation and presents statistics based on organizer observations and attendee surveys, and discusses changes implemented in subsequent events in the series based on these evaluations.

Poster Session IV (Saturday, November 5)

ROLAND SPRINGS RANCH LOCALITY 1, AN EARLY PLEISTOCENE FAUNA FROM THE SOUTHERN PLAINS OF TEXAS

MORETTI, John, Museum of Texas Tech University, Lubbock, TX, USA; JOHNSON, Eileen, Museum of Texas Tech University, Lubbock, TX, USA

Roland Springs Ranch (RSR) Locality 1 is situated on Turtle Creek, an ephemeral contributory to the Clear Fork of the Brazos River, on the Southern Plains within the western Rolling Plains of Texas. Faunal material is encased within gleyed sand in an ancient channel. The surface of this ancient drainage and the plotted positions of specimens provide an opportunity to study the deposition patterns of a small early Pleistocene stream.

Over 50 taxa have been identified at least to the family level, demonstrating a strong record of biodiversity. Multiple species of *Hesperotestudo* and emydid turtles, primarily *Chrysemys picta*, are the dominant forms in the assemblage. Remains of the three-toed horse, *Nannippus peninsulatus*, are common, while those of a representative of the modern genus, *Equus simplicidens*, are rare. Carnivores are represented by *Taxidea taxus*, *Buisinctus breviramus,* and *Canis lepophagus*, as well as a small *Miracinonyx*, referred to *M. trumani*. Avian material is abundant, including primarily Passeriformes but also members of Ardeidae, Corvidae, and Accipitridae, and an extinct species of *Meleagris*. Microfaunal remains are abundant and diverse.

An approximate age is provided by faunal composition. *Ogmodontomys poaphagus*, *Prodipodomys centralis*, *Geomys (Nerterogeomys) minor*, *Scalopus (Hesperoscalops)* cf. *rexroadi*, and a small *Sigmodon minor*/*medius* indicate a middle to late Blancan age. The referred identifications of *Miracinonyx trumani* and *Lepus* would indicate a latest Blancan age, while *Nannippus peninsulatus* is confined to the late Blancan. Viewed together, these animals represent a late Blancan fauna of earliest Pleistocene age (2.6 – 1.8 million years ago).

The fauna indicates a riparian setting within a grassland environment, lacking seasonal extremes and perhaps with an increased moisture regime relative to today's continental climate. Fish (Ictaluridae), aquatic turtles, frogs (*Rana*) and the Ardeid bird indicate that the drainage was a regular, if not permanent, source of water. Hackberry (*Celtis*) bordered the drainage and perhaps existed throughout the bottomlands, providing habitat and roosts for wild turkey and raptors.

Poster Session IV (Saturday, November 5)

MIOCENE MICROVERTEBRATES FROM PANAMA

MORGAN, Gary, New Mexico Museum of Natural History, Albuquerque, NM, USA; RINCON, Aldo, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; MORSE, Paul, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; DENETCLAW, Utahna, New Mexico Museum of Natural History, Albuquerque, NM, USA; VALLEJO, Maria, Smithsonian Tropical Research Institute, Ancon, Panama

A screenwashing program initiated in 2010 has resulted in recovery of a moderately diverse fauna of early to medial Miocene terrestrial and freshwater microvertebrates from two geologic units along the Panama Canal in central Panama at about 9° North latitude. The older Las Cascadas Formation has produced a large mammal fauna of early Miocene age (late Arikareean NALMA, ~21-19 Ma). Small vertebrates identified from the Las Cascadas Formation include the dentary of an iguanid(?) lizard, a partial mandible of a bat, and an isolated tooth of a sciurid rodent. The bat is similar to a newly described genus from the Oligocene of Florida that is near the base of the radiation of Neotropical noctilionoid bats (e.g., Phyllostomidae, Mormoopidae). A more varied assemblage of microvertebrates is known from the Centenario Fauna derived from the younger Cucaracha Formation. Geochronological data indicate an age of ~17 Ma (late Hemingfordian NALMA) for the Cucaracha Formation, whereas the biostratigraphy of the large mammals from the Centenario Fauna suggests a possible age range from early Miocene to early medial Miocene (latest Arikareean to early Barstovian NALMAs, ~19-15 Ma). Small vertebrates from the Centenario Fauna include teeth of several species of bony fish, vertebrae of boid snakes, a tooth of the large petauristine flying squirrel *Petauristodon*, a tooth and proximal humerus of a smaller sciurid, teeth of the small geomyoid rodent *Texomys stewarti*, and teeth of a new species of larger rodent similar to *Texomys*. Although crocodilians are not generally considered microvertebrates, the most abundant small vertebrate fossils from the Centenario Fauna are isolated teeth of diminutive, presumably juvenile, crocodilians representing several taxa. The occurrence of *Petauristodon* and *Texomys* is reminiscent of several late Hemingfordian and early Barstovian faunas from the Texas Gulf Coastal Plain. A presumably tropical Mesoamerican Miocene vertebrate fauna that occurred from Panama north to Texas, and perhaps east to Florida, is supported by the presence of the small protoceratid artiodactyl *Paratoceras* in early to medial Miocene faunas in Panama, Mexico, and Texas.

Technical Session I (Wednesday, November 2, 11:30 am)

NEW STUDIES OF BRAIN AND INNER EAR STRUCTURE IN *STEGOSAURUS* (DINOSAURIA: ORNITHISCHIA) BASED ON CT SCANNING AND 3D VISUALIZATION

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The Jurassic dinosaur *Stegosaurus* has been emblematic of the small-brained dinosaur since it was remarked that its brain was the size of walnut. Virtual endocasts of four *Stegosaurus* specimens were examined using CT scanning and 3D visualization software (Avizo 6.3). This technique differs from those involving physical endocasts in that it allows the virtual endocast to be viewed in isolation as well as *in situ* with the surrounding semitransparent braincase. This unique perspective permits the tracing of cranial nerves and vessels through their corresponding canals and foramina within the anatomical context of the cranial bones, allowing unambiguous identification of external foramina. In contrast to physical endocast production, the construction of virtual endocasts can be accomplished even with damaged specimens and/or those obscured by matrix infilling. Having four specimens provides a rare opportunity to assess variation in endocast structure, and remarkably little variation is observed. The olfactory bulbs and tracts are small and flattened. The optic nerves exited through a combined opening. All other cranial nerves and endocranial vessels are visible and follow the typical rostral-to-caudal location pattern. The endocasts indicate a relatively small telencephalon, a region associated with information integration. Form and relative size of the endocasts, coupled with the structure of the endosseous labyrinths, provide new neurological insights that largely affirm the perception of *Stegosaurus* as having had modest cognitive and sensory capabilities. Unlike advanced maniraptorans, the brain of *Stegosaurus* clearly did not fill the endocranial cavity entirely. *Stegosaurus* endocasts are thus poor proxies for the brain itself. To estimate more realistically the brain morphology of *Stegosaurus,* future work will focus on the application and refinement of a technique known as Gross Anatomical Brain Region Approximation (GABRA), which establishes recognizable structures from the surface of endocasts as delimiting indicators for demarcation of the location and size of major brain regions (e.g., olfactory bulbs, optic lobes, cerebral hemispheres, cerebellum).

Poster Session III (Friday, November 4)

ONTOGENETIC VARIATION IN EPIPLASTRAL SHAPE AMONG EOCENE TESTUDINOID TURTLES (*ECHMATEMYS*) OF WESTERN NORTH AMERICA

MORRIS, Zachary, UC Berkeley, Museum of Paleontology, Berkeley, CA, USA; FERRER, Elizabeth, UC Berkeley, Museum of Paleontology, Berkeley, CA, USA

Testudinoid turtles are common in terrestrial North American Cenozoic and modern faunas, but there has been limited study of their geographic, sexual, and ontogenetic variability. If the morphological features used to distinguish among taxa are ontogenetically or geographically variable, our estimations of species diversity may be too high, especially for fossil taxa. Recent studies have shown age- and sex-related differences in skull morphology in kinosternid and testudinoid turtles, but little work on shell variability has been completed. This is problematic for fossil turtle taxa, which rarely preserve shells and skulls in association, and are usually represented by partial shells or isolated shell elements. In order to address this imbalance, studies of ontogenetic change in shell elements are needed. Epiplastron shape has previously been used to diagnose fossil testudinoids to the species level, but in the absence of statistical analyses of ontogenetic, sexual, or geographic variation, these characters may not be reliable. We performed a 2D geometric morphometric analysis of epiplastron shape (Procrustes principal components analysis) in the extant testudinoid *Actinemys* (= *Emys*) *marmorata* (to document age- and sex-related variability) and three Eocene testudinoids: *Echmatemys testudinea*, *E. euthneta*, and *E. wyomingensis*. To counter geographic and temporal variation, only *Echmatemys* samples from three stratigraphically distinct and geographically limited localities in southwestern Wyoming were used. The mean shape of *E. euthneta* epiplastra differed statistically from those of the other two taxa, corroborating visual assessments of shape differences, but *E. wyomingensis* and *E. testudinea* could not be distinguished with a limited, 5-landmark analysis. A general ontogenetic trend in the angle of the epiplastral horn and the expansion of the lateral side of the element were observed in all taxa, but there were distinct taxonomic differences in the ontogenetic trajectories.

Technical Session IV (Wednesday, November 2, 3:00 pm)

MIOCENE BEAVERS (CASTORIDAE, RODENTIA) FROM JAPAN

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The fossil record of Miocene terrestrial small mammals in Japan is very scarce, with some orders represented by only a single or two specimens. Castoridae are best documented in terms of taxon and specimen numbers, including the giant castoroidine beaver *Youngofiber sinensis*, which is also known from Sihong in East China. New findings from the Early Miocene Mizunami Group in central Japan reveal additional, but endemic taxa. A large-sized species from the Dota locality in the Kani Basin represents an anchitheriomyine beaver. It is much smaller than the North American *Amblycastor fluminis* and even smaller than the Eurasian *Anchitheriomys*. The dentition is characterized by large upper and lower premolars and subhypsodont molars with a regular, transversally oriented fossettid pattern. The convex incisors with no or very weak striations are less hypertrophic than in larger anchitheriomyines. Incisor enamel microstructure shows a mixture of derived and less derived features, e.g., weakly inclined Hunter-Schreger bands, but fewer confluences than in larger anchitheriomyines. The Dota beaver represents the smallest anchitheriomyine castorid outside North America. A medium-sized species from Matsugase in the adjacent Mizunami Basin documents a palaeocastorine beaver which is highly adapted to fossoriality, like or even more than North American species. Derived cranial features are a flattened skull, complete fusion of the nasals, and an extremely broadened and shortened occipital region due to the posterior extension of the zygomatic arches. The non-procumbent incisors are flat with a shallow sulcus. The Matsugase beaver is the first fossorial castorid outside North America. With an age of 17.5 Ma it represents the latest record of the group, about 2.5 Ma after the demise of fossorial beavers in North America. The two new castorids from the Mizunami Group indicate phylogeographic relations to North America. Together with the other small mammals from the Mizunami and Nojima Groups, the beavers share the pattern of paleobiogeographic links and endemisms, probably as a result of the separation of the Japanese island arc from the Asian continent during the Early Miocene.

Poster Session III (Friday, November 4)

PARTIAL HYAENODONTID (MAMMALIA, CREODONTA) SKELETON FROM THE PALEOCENE-EOCENE THERMAL MAXIMUM OF NORTH AMERICA

MORSE, Paul, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA

The creodont *Prototomus deimos* is one of several species of carnivorous mammals that first appear in North America at the base of the Eocene. Hyaenodontids, along with euprimates, perissodactyls, and artiodactyls, likely immigrated from Asia across a high-latitude land connection associated with global warming of 5-10°C during the Paleocene-Eocene Thermal Maximum (PETM, ~55.8 Ma). The PETM hyaenodontid fossil record is represented mostly by isolated teeth and dentary fragments, limiting our understanding of relationships and positional behaviors. Here we describe a partial skeleton of *P. deimos* from the PETM, Willwood Formation, southern Bighorn Basin, Wyoming, that includes a left dentary with P3-M3, a right maxilla with P4-M3, a left maxilla with M1-3, right and left mandibular condyles, a zygomatic arch, and a petrosal. Associated postcrania include a scapula, proximal humerus, acetabulum, proximal and distal femora, and vertebrae. The new specimen shows for the first time that *P. deimos* differs from other species of *Prototomus* in having a relatively reduced M3, an anteroposteriorly compressed M3, and anterior displacement of the protocone relative to the paracone. A reduced M3 is reminiscent of more primitive taxa, such as the Asian Paleocene limnocyonine *Prolimnocyon chowi*, and the North American proviverrine *Galecyon*, also from the PETM. However, the position of the protocone is similar to that of the more derived *Gazinocyon* from the early Eocene of North America, suggesting a possible relationship. Features of the humerus that are consistent with scansorial or arboreal locomotion include a greater tuberosity no taller than the head and a rugose insertion for the teres major muscle. In contrast, a long femoral neck and a femoral head projecting above the greater trochanter suggest the hindlimb was more generalized for cursoriality or scansoriality. This generalized or potentially arboreal locomotion, similar to that inferred for other later occurring species of *Prototomus*, appears to be primitive for the group and likely characterizes the positional behavior of the hyaenodontid immigrant from Asia that gave rise to *P. deimos*.

Poster Session IV (Saturday, November 5)

ANALYSIS OF VARIATION IN SNAKE VERTEBRAE USING GEOMETRIC MORPHOMETRICS

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Snakes comprise a vital component of the Cenozoic reptilian fossil record. Due to their relatively delicate skulls and lack of limbs, snake fossils are most frequently represented by vertebrae. Despite their relatively high abundance however, isolated snake vertebrae remain notoriously difficult to identify. This difficulty stems mainly from the inherent variability of snake vertebrae, specifically the wide range of morphological variation that exists not only between individuals of the same species, but also among the vertebrae of a single individual. Understanding and characterizing this variation is a critical step in improving our ability to identify fossil snakes. Here we present an analysis of the variation in snake vertebrae using geometric morphometrics, a method which has been utilized in similar studies, but rarely with snakes. We applied landmark data to selected vertebrae along the vertebral column of an individual snake specimen, and using thin-plate splines (TPS), we were able to characterize the patterns of morphological variation along the column. Repeating this method for numerous individuals representing several extant species allowed for comparison of these patterns of variation between multiple taxa. Applying relative warp analysis (RWA) and discriminant analysis (DA) to these data allowed for identification of those morphological characters which are most variable between taxa, as well as those most variable between different segments of the vertebral column; these characters thus hold the most potential for use in the identification of isolated snake vertebrae. The application of this method to a wider range of taxa in future studies will vastly improve our techniques for identification of snake fossils, and thus improve our understanding of snake evolution and diversity.

Poster Session III (Friday, November 4)

EXPERIMENTAL BONE DIAGENESIS: DIFFUSION PROFILES AND TIMING OF RARE EARTH AND TRACE ELEMENT UPTAKE

MOSES, Randolph, Museum of Geology, South Dakota School of Mines and Technology, Rapid City, SD, USA; KOHN, Matthew, Department of Geosciences, Boise State University, Boise, ID, USA

An increasing number of studies have attempted to characterize the uptake of rare earth elements (REE) and trace elements (TE) into bioapatite. Many studies measured elemental profiles in fossil bone analyses and attempted to draw conclusions regarding the mechanisms and timing of REE and TE uptake during the fossilization process. Very little controlled experimentation has been conducted to investigate the processes and mechanisms of the early fossilization process.

To investigate early stages of bone fossilization, sections of *Bos taurus* femora were sealed in plastic sample reactors for 18 months in aqueous solutions spiked with REE (Ce, Nd, Sm, Eu, Gd, and Yb) and TE (Sr, U). Addition of kaolin, plus slight impurities permitted investigation of several other trace elements, (Al, Y, the other REE, Pb, and Th). Three different sample preparation methods varied pH buffers and used fresh bone vs. bone from which collagen had been extracted. Elemental profiles were measured in reacted and unreacted bone using laser ablation ICP-MS as 100 µm depth profiles and as several mm-long line profiles, both parallel and perpendicular to the long-axis of the bone. Profile shape differences in reacted bone reflect differences in trace element diffusivities and rates of uptake.

REE and TE have relatively high diffusivities, typically 1x10-13 cm2/sec for bone with collagen perpendicular to the long bone axis; diffusion parallel to the bone axis is 1 1/2 to 2 times faster. U, Pb, and Al diffuse about 2 times faster than REE. In contrast to published data, no differences in diffusivities or partitioning were observed among the REE, possibly indicating different uptake mechanisms: diffusion plus adsorption in the experiments vs. diffusion plus recrystallization in nature. Prior removal of collagen decreases partition coefficients by a factor of ~2 for most elements, but ~50 for U, and increases diffusivities by a factor of ~2. These results confirm some expectations, including faster uptake in bone than in enamel (≤ 1x10-14 cm2/sec), and parallel to bone axes than perpendicular. Unexpected similarities in partition coefficients among REE recommend further synthesis experiments.

Technical Session XIX (Saturday, November 5, 4:00 pm)

PAST GLOBAL WARMING AND EMERGENCE OF MARINE MAMMALS AND REPTILES

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At least 24 lineages of mammals and reptiles invaded the sea during the last 250 million years (i.e., started to feed almost exclusively in the sea). These marine invasions occurred episodically, only during 11 specific time intervals. We previously suggested that marine reptile invasions had corresponded with periods of high sea levels recorded in rock sequences. However, the lack of paleotemperature reconstruction with sufficiently high resolution prevented a direct comparison between the historical records of temperature and marine invasion by tetrapods.

We reconstructed seawater paleotemperature curves over the Phanerozoic with the highest resolution permitted by the data. We incorporated updated δ18O data, geologic timescale, and pH correction based on atmospheric CO2 level. We also removed three previously unrecognized systematic biases, which sometimes result in errors greater than 10 °C in combination.

The reconstructed curves suggest that at least 19 of the invasions occurred near the temperature peaks, although they were usually located on the shoulders rather than coincident with the thermal peak. For ectotherms, higher temperatures probably allowed early invaders to thermoregulate in the water without physiological modifications. A similar physiological bias seems to be reflected in the latitude of invasions: reptiles usually invaded the tropical seawater, with exceptional temperate invasions occurring in the lineages with extra body insulation, such as turtles and crocodiles. In contrast, endotherms tended to invade the temperate or polar seawater first, with a few notable exceptions including cetaceans and sirenians. Given these observations, the low mean seawater temperatures during the Permian and the Carboniferous may explain the scarcity of marine reptiles during these periods. Endotherm invasions corresponded with high temperatures probably because of heightened sea level during these periods, which presumably increased the productivity of coastal waters. Thus, marine invasions by tetrapods seem to have been largely driven by temperature, either directly or through correlated physical conditions.

Romer Prize/Technical Session 5 (Thursday, November 3, 10:45 am)

THE SOUTH AMERICAN LOWLAND GOMPHOTHERE (MAMMALIA, PROBOSCIDEA, GOMPHOTHERIIDAE): TAXONOMY, PHYLOGENY AND BIOGEOGRAPHY

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The South American gomphotheres are classified into three genera and three species. Two biogeographic corridors are recognized for their dispersion in South America: *Cuvieronius hyodon* was found mainly by the highlands and west to the Andes, and *Stegomastodon platensis* and *Haplomastodon chimborazi*, in the lowlands. The aim of the present study is to review the taxonomy, systematics and biogeography of the South American lowland gomphotheres. We analyzed a large sample of specimens, which included crania, teeth and postcrania from several localities in Brazil, Ecuador, Colombia, Venezuela, Argentina and Uruguay. We reviewed the diagnostic characters proposed and found that they are variable in both species when large samples are considered. In this way, there is no support for more than one South American lowland gomphothere species, which shows a significant morphological variation in some characters. After a taxonomic review, a new combination name, *Notiomastodon platensis*, is validated. The cladistic analysis resulted in four most parsimonious trees. The family Gomphotheriidae is paraphyletic. The species *N. platensis* is positioned as the sister taxon to a clade composed of *Stegomastodon* spp. (represented here only by Central and North American taxa) and *C. hyodon*. These results disagree with several previous studies, in which the South American gomphotheres are a monophyletic clade. The South American gomphotheres are mainly recorded for the Pleistocene, although there are a few recorded from the Miocene and Pliocene. These records together with our phylogenetic results suggest that the ancestor of the clade that includes the South American gomphotheres originated in North America until the Late Miocene. Moreover, the South American gomphotheres had two independent biogeographic histories. A first arrival might have occurred during the short land connection between Central and South America during the Miocene, and a second arrival during a longer period, in the Great American Biotic Interchange (Pliocene/Pleistocene). However, the lack of a gomphothere record between the late Miocene and late Pliocene in South America is still an unexplained issue.

Technical Session I (Wednesday, November 2, 9:00 am)

PHYLOGENETIC CONGRUENCE BETWEEN CRANIAL AND POSTCRANIAL CHARACTERS IN ARCHOSAUR SYSTEMATICS

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To infer phylogeny, palaeomorphological character data are usually analyzed by maximum parsimony. Moreover, cladograms are usually inferred from a simultaneous analysis of all of the character data ('total evidence'), even when there may be some theoretical or operational reasons for comparing cladograms from subsets of it. For example, the cranial characters of vertebrates are often claimed to be more phylogenetically informative than those of the postcranium. We test this assumption for non-avian archosaurian taxa, re-analyzing 50 data matrices, most of which were published between 2010 and 2011, all in peer-reviewed journals. For cranial and postcranial characters, we compare Consistency Index (CI) and Homoplasy Excess Ratio (HER) statistics, showing that cranial characters do appear to be significantly less homoplastic than postcranial characters. One possible reason for these differences is the greater number of cranial characters compared with postcranial characters in most published datasets, a factor not controlled in previous studies. We investigate the effect of numbers of characters here using data rarefaction methods. These demonstrate that the strength of signal is more comparable once partition size is controlled. We also confirm here that the HER is a better indicator of homoplasy between datasets than the CI, because it is less biased by data set parameters including the number of characters and taxa. We next implement two randomized partition homogeneity tests: the Incongruence Length Difference (ILD) test and the new Incongruence Relationship Difference (IRD) test, the first of which measures difference in cladogram-length (steps) and the second of which is based on tree-to-tree distance metrics. In many cases, partition homogeneity tests return significant results (p-values < 0.05). Finally, we present a novel method for visualising taxonomic overlap between our tested datasets in the form of a network diagram, enabling us to understand their similarity in terms of taxon sampling.

Technical Session XIV (Saturday, November 5, 12:00 pm)

NEW DISCOVERIES AND INVESTIGATIONS ON THE LATE CRETACEOUS VERTEBRATE FAUNA OF NORTHERN SUDAN

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The Late Cretaceous (Cenomanian) Wadi Milk Formation in northern Sudan is known to yield a wide spectrum of aquatic and terrestrial vertebrates, yet the fauna remained poorly studied. Vertebrate fossils have also been reported from the Shendi Formation, putatively a lateral equivalent of the Wadi Milk Formation, but material from this formation is reportedly rare. A recent expedition to northern Sudan investigated the few known localities in these units, and also prospected intensively resulting in the discovery of several new sites that proved to be highly productive. In both formations, the vertebrate-bearing sediments consist of bonebeds containing both micro- and macrovertebrates, in some cases in extremely high abundance. Microsites and bonebeds in the Wadi Milk Formaiton yielded actinopterygians, snakes, and lissamphibians, whereas the larger faunal elements belong to lungfish, turtles and archosaurs. Among the turtles, at least 2 distinct taxa are represented, one freshwater and one potential terrestrial form, known from partly articulated shells and limb bones. Archosaur remains include both crocodiles and dinosaurs. The crocodilian fossils including several

partial skulls, teeth, and postcranial remains can be assigned to Dyrosauridae, and belong to at least 3 different taxa. The dinosaur fauna includes large ornithopods, Theropoda and sauropods. While the ornithopod remains are rather fragmentary and largely based on vertebrae, the Sauropoda, of titanosaurid affinity, are known from teeth, vertebrae and complete limb bones. Among theropods, spinosaurid teeth and jaw fragments, are of particular importance because they represent the first record of this clade from Sudan. The results of this expedition represent a significant extension of the previous knowledge of this region. Previously known only from a single theropod phalanx, the discovery of diverse, archosaur-dominanted bonebeds in the Shendi Formation contributes greatly to our knowledge of dinosaurs and other vertebrates in the unit. Also, the new findings add significant information to the Late Cretaceous vertebrate fauna of northeast Africa, and northern Gondwana in general.

Poster Session I (Wednesday, November 2)

TAPHONOMIC ANALYSIS OF SMALL MAMMAL PREY ASSEMBLAGES DERIVED FROM THREE RAPTORS (ACCIPITRIDAE) IN SOUTHEASTERN MADAGASCAR

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Small mammals are widely used as palaeoecological indicators, although this method has only recently been applied to the reconstruction of past environments in Madagascar. The occurrence of small mammals at paleontological sites is often mediated by predators, which can bias the representation of animals in an assemblage. Currently, there is a scarcity of research on the taphonomic patterns characteristic of Malagasy predators, despite some evidence that subfossil deposits were created by predatory birds, mammalian carnivores, or both. We present the first study of skeletal damage patterns recorded in the pellets of three raptor species (*Accipiter henstii*, *Buteo brachypterus*, *Polyboroides radiatus*) from Madagascar. Our objective was to determine if raptor-derived small mammal skeletal assemblages in Madagascar record statistically distinguishable predator-specific damage signatures. We collected data on skeletal part frequency and bone fragmentation from 60 raptor pellets collected in and around Ranomafana National Park between 1998 and 2003. Similar data was compiled from the published literature for avian predator species from around the world. We used principal components analysis to assess the similarity of small mammal prey assemblages produced by different predator species. Our results indicate that the prey assemblages from all three raptor species exhibit high amounts of bone destruction. Similar to results from continental prey assemblages, the ability to perform species-specific predator identifications was not supported by our analysis. However, the skeletal damage patterns documented in the Madagascar sample were similar to those inflicted by other diurnal raptors globally, confirming previous work that skeletal damage patterns are useful for identifying the general type of predator (e.g., diurnal raptor) responsible for creating a skeletal concentration. We conclude, therefore, that signatures other than relative frequency and breakage in bone assemblages should be used to discriminate specific predators in Madagascar.

Poster Session III (Friday, November 4)

THE PROBLEM OF FAUNAL LISTS

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A comprehensive review of all sources of mammalian fauna lists for the Anza-Borrego Desert State Park (ABD) vertebrate paleontology collection resulted in over 830 taxonomic names and format variants representing 110 mammalian taxa identified from the ABD. Approximately 50% of the taxonomic identifications were previously published without voucher catalogue numbers or fossil descriptions. A specimen-by-specimen verification of taxonomic assignments resulted in an updated faunal list of ABD terrestrial Mammalia including 110 taxonomic names, 66 unqualified (no cf., nr., or ?) genera, and 46 unqualified species. At least 178 previously published or listed taxonomic names and format variants were retired from the faunal list due to synonymy, reidentification of specimens, or lack of a voucher specimen. These conditions are not unique to ABD but constitute a widespread problem with faunal lists that has implications for general biochronological analyses and correlation.

Technical Session X (Friday, November 4, 11:45 am)

HOW MANY INDIVIDUALS LEFT THEIR FOOTPRINTS AT LAETOLI? REINTERPRETATION OF THE TRACKWAYS BASED ON RECENTLY ACQUIRED 3D DATA

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The Laetoli footprint site in Tanzania preserves footprints made by several individuals traveling across a layer of volcanic ash 3.6 million years ago. These fossil footprints are to date the earliest evidence of bipedal locomotion and upright posture of our human ancestors. The discovery of the fossil footprints in 1978, by members of Mary Leakey's team working at Olduvai Gorge and Laetoli paleontological site, marks a significant milestone in our understanding of the vertebrate fossil record. The footprints are embedded in a volcanic air-fall tuff layer (Tuff 7), characterized by lava globules cemented by calcite and phillipsite. At the time of their discovery, the footprints were systematically documented, photographed, and reburied by the Leakey team for conservation purposes. Maps published at the time documented trackways made by three individuals. It was suggested that the G 2/3 trackway was made by a large individual, followed by a smaller individual, walking in the steps of the larger. A third individual walked, instep, but to their side (G1). Sex, relative age, and family relationships were immediately assumed and a family group was depicted traveling together in the Pliocene of East Africa. In February of 2011, at the direction of the Ministry of Natural Resources and Tourism in Tanzania, a 3.5 meter-long section of the Footprint Tuff was re-excavated to evaluate and document the current condition of the footprints. This project pulled together scientists from around the world and provided a third opportunity to conduct close-range photogrammetric documentation of the footprints. Also documented at this time were casts which reside within the National Museum of Tanzania and House of Culture. Preliminary examination (foot-length, step, stride, pace angulations, and morphology) of the footprint surface, along with similar data from early generation casts, is now possible using close-range photogrammetric documentation. Evidence suggests that at least four individuals of similar foot length and size, with a consistent stride length created the trackways at Laetoli.

Technical Session I Wednesday, November 2, 11:15 am)

THYREOPHORAN JAW MECHANICS AND THE FUNCTIONAL SIGNIFICANCE OF THE PREDENTARY BONE

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Thyreophoran jaw mechanics is poorly known. Stegosaurs have been described as orthal processors due to offset occlusion of maxillary and dentary teeth, absence of major tooth wear, and reduced buccal emargination. In addition, previous tooth wear analyses of ankylosaurs have shown them to be propalinal shearers with medial pivoting of the tooth rows to provide occlusion. To test these hypotheses and explore other possible mechanisms, a morphological analysis of articular surfaces of the jaw, focusing on the predentary-dentary and quadrate-mandibular joints, was conducted. Various stegosaur and ankylosaur specimens as well as computed tomography (CT) data and three-dimensional digital models were used to visualize and measure morphologies of all articular surfaces of the predentary, dentary, and post-dentary bones as well as tooth row curvature along the maxilla and dentary. Morphology that promoted or restricted movement of the jaw elements during mastication was interpreted accordingly. Based on the flat, open predentary-dentary joint and the ball-socket quadrate-mandible joint, medial rotation of both dentaries around their long axis is plausible. The predentary would have acted to allow both dentaries to rotate independently of each other. This would have increased feeding efficiency as it allowed the animal to process vegetation on both sides of the mandible simultaneously. In stegosaurs, these features plus the long snout and shallow tooth row curvature agrees with an orthal feeding mechanism incorporating slight medial long-axis rotation of the dentaries to maneuver vegetation into the oral cavity. In ankylosaurs, the snout is broader and the tooth row has a more distinct curvature than stegosaurs. A dorsal lip on the lateral border of the articular bone restricts the previously suggested pivoting motion of the dentaries. Instead, rotation of the dentaries in association with the predentary while simultaneously shearing propalinally is more likely in ankylosaurs. Further analysis of more primitive thyreophorans will shed light on the evolution of this novel chewing, thus revealing the importance of retaining the predentary throughout Ornithischia.

Poster Session III (Friday, November 4)

ISOTOPIC INDICATORS OF SEASONALITY IN THE LATE PLEISTOCENE OF NORTHWEST ETHIOPIA

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Recent excavations along the Shinfa River in NW Ethiopia have uncovered a diverse vertebrate fauna dating to the late Pleistocene. The fauna includes members of several vertebrate classes including Mammalia, Pisces, Reptilia, and Aves. Much of this fauna is found in association with evidence of hominin occupation, including lithics and cut-marked bone. Both the temporal and spatial aspects of this locality are important not only in terms of expanding our understanding of vertebrate evolution in late Pleistocene Africa, but also for informing debates surrounding the route modern humans took when our species migrated out of Africa to colonize the Old World. Furthermore, evidence of seasonality in hominin occupations and its effect on foraging strategies can help elucidate the nature and extent of interactions between humans and the vertebrate community at large. The modern climate in this area is highly seasonal and Shinfa River water δ18O values show strong shifts from wet season to dry season. A central focus of this study is to determine whether the existing climate system is a reasonable representation of late Pleistocene environments as deduced from fossil herbivore tooth enamel, which acts as a proxy for bio-available H20 and plant type utilization by these animals across the paleolandscape. The selection of fossil tooth enamel reflects the fact that it is resistant to diagenesis and more likely than other fossil vertebrate material to preserve original isotopic values that are relevant to reconstructions of paleoenvironment, including habitat openness and aridity (carbon) and temperature and seasonality (oxygen). We present data from carbon and oxygen isotope measurements taken from fossil bovids.

Our data show a wide variety of δ18O values, though all are greater than typical rainfall and groundwater levels, indicating evaporative enrichment consistent with a long dry season. δ13C values also vary, with some individuals indicating a mix of C3/C4 plant diets but the majority feeding on C4 plants exclusively. The isotopic data are consistent with a warm and dry environment, similar to what is found during portions of the modern area's dry season.

Poster Session III (Friday, November 4)

A GIGANTIC BIRD FROM THE UPPER CRETACEOUS OF CENTRAL ASIA

NAISH, Darren, University of Portsmouth, Portsmouth, United Kingdom; DYKE, Gareth, University College Dublin, Dublin, Ireland; CAU, Andrea, Museo Geologico e Paleontologico "Giovanni Capellini, Bologna, Italy; ESCUILLIÉ, François, Eldonia, Gannat, France; GODEFROIT, Pascal, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium

Birds are small compared with other dinosaurs. Among extant species, the average mass is 37 g. However, giant size (mass > 30 kg) has evolved independently five times or more. Despite a rapidly improving fossil record, virtually all known Mesozoic birds were small; only *Gargantuavis* and the larger hesperornithids weighed more than a few kilograms.

We present a gigantic bird from the Late Cretaceous of Kazakhstan, represented by two edentulous mandibular rami from the same individual. As each ramus exceeds 275 mm, their owner was clearly enormous. The presence of two distinct mandibular cotyles, fusion of mandibular elements, articular pneumaticity and absence of mandibular fenestrae place the specimen in Avialae. It lacks the characters of other edentulous tetrapods (Testudines, Pterosauria, Ceratosauria, Ornithomimosauria, Oviraptorosauria). Large size and an elongate mediodorsal sulcus are autapomorphies of a new taxon. While the rami are edentulous, the dentary symphysis is unknown, so it remains possible that the animal possessed teeth in this position (or in its upper jaw).

Incorporation of the specimen in a phylogenetic analysis of Theropoda leads to a hypothesized position at the base of Ornithuromorpha, outside the clade that includes Ornithurae. This position shows that size and toothless mandibular rami evolved independently within Ornithurae. This new taxon is significant for several reasons. Firstly, it augments our poor knowledge of central Asian Cretaceous terrestrial faunas. Secondly, it demonstrates independent evolution of giant size in non-ornithuromorphan birds. This not only increasing our knowledge of size and trophic diversity in Mesozoic birds, it also indicates that the survival of neornithines across the K-Pg boundary (and the concomitant extinction of enantiornithine and ornithurine lineages) was not necessarily related to greater morphological diversity and ecological adaptability. Thirdly, the existence of a gigantic Cretaceous bird provides additional support that the Mesozoic was not a 'non-avialian-dinosaurs-only theme park': large, terrestrial birds evolved alongside non-avialian dinosaurs, as did synapsids, lepidosaurs and crocodyliforms.

Poster Session I (Wednesday, November 2)

OSTEOSCLEROSIS IN THE LIMB BONES OF TERRESTRIAL AND AQUATIC TURTLES

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The internal limb bone structure of tetrapods varies depending on their habitat and manner of locomotion; limb bones of terrestrial taxa tend to show tubular structure with open medullary cavity, which enables both reduction in mass and resistance to stress; whereas, some aquatic taxa have anomalously dense limb bones. Here I conducted microanatomocal and histological analyses of limb bones of modern and extinct turtles (32 species of 14 families), of which the habitat preferences cover a wide range (terrestrial, semi-aquatic and aquatic), via microfocus computed tomography and thin sectioning. Regardless of habitat preferences, turtle limb bones lack open medullary cavity with few exceptions. The most common patterns of long bone internal structure in turtles is 1) double cone-like distribution of cancellous bone resulting in extreme thickness of the cortex locally in the mid shaft. Another major pattern of turtle long bone internal structure is characterized by 2) columnar distribution of cancellous bone surrounded by compact cortex. These two patterns of long bone histology were observed in each of the ecological groups. Limb bones of the primitive terrestrial turtles, *Proganochelys quenstedti* and *Mongolochelys efremovi* are not exception, and fall into patterns 1) and 2), respectively. The results show that turtle limb bones generally tend to be compact, heterogeneously in some cases, and that they are not applicable to the general observed relationship between habitat preference and bone internal structure in other tetrapods. One exception is the extremely aquatic turtle (Dermochelyidae), whose limbs are composed entirely of cancellous bone. This suggests an absence of evolutionary pressure to reduce the density of the limb bones in terrestrial turtles, possibly due to the restrictive nature of the carapace and plastron in terrestrial environment.

Poster Session II (Thursday, November 3)

PALEOENVIRONMENTS OF THE LATE MIOCENE NAKALI AND SAMBURU HILLS, KENYA, FROM RODENT FAUNA AND HERBIVORE MESOWEAR

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Early Late Miocene large ape (hominoid) fossils are rare in Sub-Saharan Africa. We reconstructed the paleoenvironments of early Late Miocene hominoid sites in the Namurungule Formation of the Samburu Hills and the Nakali Formation, Kenya, from rodent fauna and mesowear analysis of herbivore cheek teeth. The geologic ages of both formations are almost identical and their general faunal compositions are similar. However, in contrast to the Namurungule Formation from which only one hominoid fossil has yet been found, fossils of two hominoids and those of several other catarrhine taxa have been found from the Nakali Formation. Although only two rodent taxa (several specimens) are known from the Namurungule Formation, eight rodent taxa (more than 600 specimens) are known from the Nakali Formation. The paleoenvironment of Nakali inferred from the rodent fauna is a wet environment with upland forests, with wet climate and rainy-dry seasonality. An analysis of mesowear of *Hipparion* and bovid cheek teeth indicate that those from the Nakali Formation tended to be browsers. The paleoenvironment of the Nakali Formation may have been a wet woodland environment, while the Namurungule Formation may have been an arid open environment. This environmental difference between the Namurungule Formation and Nakali Formation probably indicates the environmental change through geological age and/or the topographic difference between highland and lowland at a similar age. This result is supported by stable isotope analysis of mammalian tooth enamel, pollen analysis and sedimentary analysis from both formations.

Poster Session II (Thursday, November 3)

MASTICATORY MUSCLE MORPHOLOGY AND FUNCTION AMONG THE FOUR TYPES OF SABER-TOOTH AND CONICAL-TOOTH FELIDS: COMPARISON OF CONSTRAINTS ON THE BITING CAPABILTIES OF REPRESENTATIVE COOKIE-CUTTER, SCIMITAR-TOOTH, DIRK-TOOTH AND CONICAL-TOOTH CATS

NAPLES, Virginia, Northern Illinois University, DeKalb, IL, USA

Until recently, three cat-like carnivore morphotypes, based on canine features and postcranial skeletal proportions were known. *Xenosmilus hodsonae* (Early Pleistocene of Florida), a new saber-tooth genus and species, that combines bear-like postcrania with comparatively short, coarsely serrated upper canines, a semicircle of enlarged serrated incisors and plantigrade hind feet has recently been described as a fourth morph. The biting apparatus of this cookie-cutter cat differs from previously described forms because in *X. hodsonae* the incisors and canines work in unison to remove a semicircular bolus of flesh; this bite rather than a stabbing movement constitutes the killing system. Other cranial features correlating uniquely with the cookie-cutter cat killing apparatus include lack of a diastema between incisors and canines, coarse serrations on both of these tooth types, an overhanging occiput and an anteroposteriorly elongated temporal fossa. The changes in skull proportions that resulted in a relatively larger M. temporalis in *X. hodsonae* also allowed acquisition of a more horizontal line of action for this muscle than in previously studied saber-tooths such as species of the genus *Homotherium*, the dirk-tooth saber-tooth *Smilodon fatalis* and the conical-tooth cat *Panthera atrox*. Reorientation of the temporalis increased the muscle's ability to elevate the mandible with greater force toward the end of closure by maximization of pull posteriorly in a more direct line as the mandible approached occlusion. The superficial masseter of *X. hodsonae* is also reoriented when compared to other saber-tooth and conical tooth morphs, improving the ability of this muscle to permit more effective force generation at initial mandibular closure. Therefore, both of the muscles responsible for effecting mandibular closure in *X. hodsonae* have been able to maintain lines of action at 90o to one another, as in other cats, while simultaneously maximizing their effectiveness in generating more consistently high pressures at all gapes, as well as being able to generate maximized initial closing pressures.

Technical Session IX (Friday, November 4, 8:45 am)

THE BRAINCASE OF *PLACODUS GIGAS* AGASSIZ, 1833 (SAUROPTERYGIA: PLACODONTIA) - A NEW RECONSTRUCTION BASED ON µCT SCANNING

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Placodus gigas is a non-armored placodont marine reptile (Diapsida: Sauropterygia) known from the Middle Triassic of Europe, most commonly found in the shallow marine carbonate facies of the German Muschelkalk. The skull is generally very well understood, with the exception of the braincase, which is partly obscured by dermatocranial elements, thus rendering a complete osteological description difficult. Controversy also exists over other features, such as the exact morphology of the sphenoid region, which appears to vary between specimens. Two skulls that display well-preserved and intact chondrocranial elements were scanned using industrial micro-computed tomography (µCT), thus revealing the parts of the braincase that were previously obscured and allowing accurate osteological reconstruction. A new 3D reconstruction of the ossified elements of the chondrocranium is presented, along with the first reconstruction of the placodont vestibular apparatus. The morphology of the braincase has been revised, especially with regard to the proportions that the prootic and opisthotic contribute to the lateral wall. One of the specimens also displays a distinct fenestra anteroventral to the fenestra vestibule, which is tentatively identified as the fenestra rotunda. The parabasisphenoid, a large amount of which is obscured by the pterygoid and palatine bones, is revealed as being rather short, lacking a cultriform process, the ethmoid cartilage instead being supported by a v-shaped groove of the strongly raised palatines. However, an unusual, ring-like structure is visible at the anterior margin of the parabasisphenoid. Since

placodonts are the sister group to all other sauropterygians, including the fully marine plesiosaurs, these new data are of great comparative and phylogenetic significance as it gives insight into some of the morphological and functional changes that took place at the base of the sauropterygian clade, before the group became fully aquatic.

Technical Session II (Wednesday, November 2, 3:45 pm)

AN ENIGMATIC ARCHOSAURIFORM FROM THE MANDA BEDS (MIDDLE TRIASSIC) OF SOUTHWESTERN TANZANIA: CHARACTER CONFLICT AT THE BASE OF PSEUDOSUCHIA

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The presence of derived pseudosuchians and ornithodirans in Anisian beds of South America and Africa shows that the archosaur radiation was well underway by the beginning of the Middle Triassic. The phylogenetic placement of many Middle Triassic archosaurs (e.g., *Gracilisuchus*, *Turfanosuchus*) is poorly understood, with most assigned to the enigmatic and likely paraphyletic "Rauisuchia." Only a few are suggested to be basal members of younger clades, whereas nearly all Late Triassic taxa can be placed into clearly diagnosed clades (e.g., Aetosauria, Ornithosuchidae, Dinosauromorpha). Here, we introduce a new archosauriform with an unusual mix of character states found within Pseudosuchia, and just outside Archosauria. The specimen consists of parts of the mandible, pterygoid, pectoral girdle, humerus, pubis, vertebrae from much of the axial column, osteoderms, and a nearly complete hindlimb including a complete ankle. The ankle is of crurotarsal type and the calcaneum and astragalus articulate similarly to members of Phytosauria. There are five leaf-shaped osteoderms per two vertebrae and neural spines feature lateral expansions at their dorsal ends. The length of the pubis is short (~35%) relative to that of the femur. The pterygoid bears three anteroposteriorly oriented rows of teeth and the surangular bears a large lateral shelf. Including the new specimen in an extensive analysis of basal archosaurs (412 characters, 80 taxa) results in its placement as a basal pseudosuchian more closely related to paracrocodylomorphs than to aetosaurs. Constraint trees and other sensitivity analyses resulted in little change in the relationships of other Triassic clades but drastically changed optimizations of certain character states or complexes (e.g., dual origin of a phytosaur-like ankle, osteoderm shape). Our analyses suggest that high rates of homoplasy and incomplete specimens are hindering understanding of the origin and early evolution of Pseudosuchia and, in turn, Archosauria.

Poster Session II (Thursday, November 3)

A GEOMETRIC MORPHOMETRIC ANALYSIS OF *CROCODYLUS NILOTICUS*: OSTEOLOGICAL EVIDENCE FOR A CRYPTIC SPECIES COMPLEX

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The Nile crocodile *Crocodylus niloticus* currently has an extensive range throughout the African continent and Madagascar, though fossils reveal a larger historical range including parts of the Sahara Desert, Mediterranean coast, and Arabian Peninsula. Recent molecular studies have yielded genetically distinct populations of *C. niloticus*, suggesting that it is a cryptic species complex. However, morphological variation remains unassessed. Although long thought to be part of a lineage present in Africa since the Paleogene, recent work on the East African crocodylian fossil record indicates divergence of *C. niloticus* within the past two million years. A geometric morphometric analysis of cranial variation in *C. niloticus* demonstrates populational variation broadly bound by river basins, with at least three distinct populations present. The morphometric analysis is coupled with a geographic analysis to determine if the species is morphologically variable by geographic region. These results agree with molecular analyses, supporting the methods employed herein as an effective way to distinguish cryptic species in the fossil record. At least two of these are more morphologically distinct from each other than they are to other members of the genus *Crocodylus*, which supports the presence of a cryptic species complex. Because threats to *C. niloticus* vary by region, at least one of these species may be endangered. The greatest potential for the survival of these populations lies in a thorough understanding of the evolutionary history, interrelationships, and biogeography of these animals. These results demonstrate that paleontology has the ability to inform and improve our decisions about conservation, and allow us to assess the diversity of a species or species complex across time and space.

Poster Session IV (Saturday, November 5)

STRATIGRAPHY OF A FOSSILIFEROUS LATE WASATCHIAN (LOSTCABINIAN) FLUVIAL SECTION IN THE RED DESERT, NORTH EASTERN GREEN RIVER BASIN, WYOMING

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Fossil vertebrates from the early Eocene Wasatchian Land Mammal Age (Lostcabinian Subage, Wa7) occur in the Pinnacles area in the Green River Basin. This series of localities represents one of the most fossiliferous latest Wasatchian successions in the world and has produced well over 1000 tetrapod fossils including 17 orders, 30 families and 57 species of mammals. The Pinnacles represent the uppermost 40-50 meters of the Main Body of the Wasatch Formation in the South Pass area. The exposures are dominated by overbank mudstones overprinted by weakly to well-developed paleosols, thin crevasse splay sandstones, and repeating sequences of golden colored ribbon sandstone bodies representing high sinuosity meandering stream channels. The buttes are capped by stromatolitic limestones and shales of the lower 5-10m of the Tipton Shale Member (Green River Formation) providing an easily identified upper boundary to the Wasatch Formation (Main Body) and recording local environmental change, from meandering fluvial to dominantly lacustrine. Accumulation of fossil material in paleosols represents *in situ* skeletal debris, whereas fossils from the lower parts of channel sequences commonly exhibit signs of reworking from adjacent paleosol units. Although vertebrates have been recovered from the floodbasin deposits, the vast majority come from a few densely fossiliferous localities within the channel sandstone bodies exposed throughout the study area. Mammalian representatives of the Lostcabinian subage are abundant in the lower section of the Pinnacles, while fossil material from the upper section is currently absent. Measured sections indicate that several distinct ribbon sand bodies occur in the area and that productive horizons occur in at least two of these. The stratigraphic correlation between these localities and the lateral extent of fossiliferous beds at the Pinnacles has not previously been well constrained. Detailed stratigraphic and sedimentological analyses provide additional context to more accurately interpret the taphonomy of these accumulations, which facilitates faunal comparisons with the classic Lostcabinian assemblages.

Poster Session I (Wednesday, November 2)

AVIFAUNAS OF THE MIDDLE PLEISTOCENE IRVINGTON AND FAIRMEAD LANDFILL LOCALITIES IN CALIFORNIA

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Two avifaunas in the University of California Museum of Paleontology (UCMP) and Madera County Paleontology Collection (MCPC), namely Irvington and Fairmead Landfill, provide insight into the middle Pleistocene birds of the coastal and interior areas of central California. Located in the San Francisco Bay area in Fremont, California, the Irvington biota was recovered from fluvial deposits in a gravel quarry. The type locality of the Irvingtonian land mammal age, Irvington fossils were preserved in reversely magnetized strata interpreted to be within the upper part of the Matuyama magnetic polarity chron (>0.78 Ma). Irvington records 55 taxa (31 mammals, 8 birds, 4 fish, 4 amphibians, 3 reptiles, 5 mollusks). The eight bird taxa are represented by 15 bird specimens which include Ardeidae (UCMP 67817 distal ulna), Anserinae (UCMP 80995 left humerus, UCMP 67817 radius, UCMP 80997 distal ulna, UCMP 80996 proximal femur), Canada Goose *Branta canadensis* (UCMP 38336 left humerus), American Neophron *Neophrontops americanus* (UCMP 80998 left humerus), Phasianidae (UCMP 80994 partial coracoid), Meleagridae (UCMP 80993 distal femur), Scolopacidae (UCMP 80992 distal femur), and Passeriformes (UCMP 80986 carpometacarpus, UCMP 80988 left ulna, UCMP 80989 left humerus, UCMP 80990 coracoid, UCMP 80991 coracoid). In the San Joaquin Valley of California, 10 miles north of Madera, Fairmead Landfill has yielded thousands of specimens from a site 0.78 Ma to 0.55 Ma in age. The biota consists of 57 taxa (27 mammals, 5 birds, 3 reptiles, 2 amphibians, 1 fish, 1 bivalve, 1 gastropod, 1 plant macrofossil, 16 diatoms). Among the finds are 10 bird specimens, representing at least five taxa, including small goose cf. *Branta* sp. (MCPC A1102 synsacrum), Canada Goose *Branta canadensis* (MCPC A1103 left distal humerus), Common Shelduck *Tadorna tadorna* (UCMP 140414 right distal humerus, UCMP 141403 right humerus, UCMP 194432 right humerus), diving duck cf. *Aythya* sp. (UCMP 194433 right tarsometatarsus), Mourning Dove *Zenaida macroura* (MCPC A1560 left proximal tarsometatarsus), and burrowing owl *Athene cunicularia* (MCPC A1300 left distal tarsometatarsus).

Poster Session IV (Saturday, November 5)

***HYPSELOSPINUS FITTONI*: AN EXEMPLAR OF NOMENCLATURAL CONFUSION AND STANDARDS OF TAXONOMIC PRACTICE IN WEALDEN IGUANODONTIANS**

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The generic name *Iguanodon* bears an historic legacy linked to its having been a founder member of Richard Owen's 'sub-class' Dinosauria. During the late decades of the 19th century a number of new *Iguanodon* species were proposed on the basis of incomplete skeletal remains recovered from a discrete area of south-east England known as The Weald; among these new taxa were *I. fittoni* and *I. hollingtoniensis*. These two species were described comparatively briefly in short notes and have, for most of the intervening time, resided relatively inconspicuously in taxonomic compilations of dinosaurs.

During the past three years several researchers have reassessed these (and other, closely related) English taxa and proposed a number of nomenclatural remedies to what are perceived to be taxonomical problems or shortcomings originating in the original descriptions. The approaches that have been published by these researchers will be shown to be varied and inconsistent, leading to contradictory outcomes. This raises concerns about the standards that should be required in order to maintain reasonable levels of consistency of taxonomic practice. Given that reliable and accurate taxonomy underpin most aspects of synthetical palaeobiology it is self-evidently important that a reasonable degree of consistency of approach is maintained in the scientific literature.

The full taxonomic history of *Hypselospinus* and closely related Wealden iguanodontians exemplifies both good and bad practice, and serves as a timely reminder of the place and fundamental importance of objective taxonomic procedures.

Poster Session I (Wednesday, November 2)

MORPHOLOGICAL VARIATION IN THE SKULL OF *AELUROGNATHUS* (THERAPSIDA, GORGONOPSIA) AND ITS REPERCUSSION ON THE TAXONOMY OF THE GENUS

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Gorgonopsia represent a group of specialised carnivores that fulfilled the role of the dominant predator during the Late Permian in the terrestrial realm of what is now southern Africa, East Africa and Russia. Skull size in the Gorgonopsia ranges from that of a cat, to larger than any terrestrial mammalian predator. Despite this variation in size, morphological variation in the skull is very conservative. This study aimed to better understand the degree of variation among species attributed to the South African genus, *Aelurognathus*, and to possibly refine the taxonomy of the genus. *Aelurognathus* was chosen as it contains the most number of recognised species (six) and the largest number of specimens (16). All specimens were examined in order to identify morphological variation within species (intraspecific), as well as variation between species (interspecific). Differences observed at the 'interspecific' level allowed for the division of the six species into two taxa, predominantly on the presence or absence of a prearietal. Occurrence of supernumerary bones has been documented in the skull roof of extinct and extant taxa, with the presence or absence of a prearietal varying even within a breeding population of *Procavia*. Taking this into account, the hypothesis that all 16 specimens represent a single taxon, exhibiting a high degree of morphological variation, was tested using allometric techniques. Seventy linear measurements of the skull were selected, such that variation in skull size and shape could be accounted for in all dimensions. Results of the analyses showed that the specimens plotted on a growth curve, supporting the single taxon hypothesis. While *Aelurognathus* has previously been divided into six species using morphological characters, this study has shown that characters used can be variable within a population. As it is seldom that a population is preserved in the fossil record, using morphological characters too strictly to describe specimens has likely led to the number of recognised gorgonopsian taxa being larger than expected. As such it is proposed that all species attributed to *Aelurognathus* be synonymised with the type, *Aelurognathus tigriceps*.

Poster Session II (Thursday, November 3)

LIFE AND DEATH IN A CRETACEOUS COASTAL SWAMP: EXAMPLE FROM THE WOODBINE FORMATION OF TEXAS

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During the Cenomanian, the Dallas-Fort Worth area was situated along a subtropical coastline. Part of this ecosystem is preserved at a fossil locality called the Arlington Archosaur Site (AAS). Sedimentary data suggests the climate was distinctly seasonal. The wet season experienced increased precipitation, sometimes with intense tropical storms that felled large trees. Periodic wildfires occurred in the dry season, as shown by numerous charcoal fragments and burned root systems. A diverse fauna of dinosaurs, crocodyliforms, turtles, sharks, rays, lungfish, and invertebrates have been recovered to date.

Here we present a preliminary description of the paleoecology and taphonomy of the AAS fauna, focusing on trophic interactions represented at the site. Most fossils are concentrated in a time-averaged peat bed and are well preserved but disarticulated. Numerous specimens exhibit tooth marks diagnostic of feeding by a large crocodyliform, consistent with the size of skeletal remains from the site. Feeding traces consist of pits, scores, and a puncture that occur on multiple turtle fragments and two dinosaur limb bones. The pattern of marks and breakage on turtle shells suggests inertial feeding followed by crushing. Marks on the dinosaur bones indicate possible disarticulation, which is consistent with marks produced by living crocodylians. The co-occurrence of bite marks and skeletal remains from adult and juvenile individuals suggests this area was inhabited by an active breeding population.

The ecology of AAS crocodyliforms appears most similar to that of generalist crocodylians inhabiting delta-plain ecosystems. Theropod dinosaur remains are rare and diagnostic tooth marks absent. Therefore AAS crocodyliforms were the likely apex predators in this ecosystem, not unlike the situation reconstructed for similar environments dominated by gigantic crocodyliforms in the Late Cretaceous. AAS crocodyliforms also played an important taphonomic role in the assembly of vertebrate remains from the surrounding community, possibly through the creation of caches. The AAS provides a critical window into the workings of a middle Cretaceous coastal ecosystem.

Poster Session II (Thursday, November 3)

A VARIED ICHNOCOENOSIS IN THE CRETACEOUS KEM KEM BEDS OF MOROCCO

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The Cretaceous (Cenomanian to Turonian) deposits of the Kem Kem in SE Morocco have been studied since the 1950s and have yielded an extremely varied fossil assemblage of terrestrial and aquatic animals: fish, turtles, crocodiles, pterosaurs, non-avian dinosaurs, including very large theropods (*Spinosaurus*, *Carcharodontosaurus*) and birds.

Footprints of fossil reptiles are also common near the top of the Kem Kem beds. Though known for many years, the fossil traces present in these levels have never been analyzed despite claims about the unique nature of the Kem Kem ecosystem.

In May 2011 we collected vertebrate traces at several localities in the Kem Kem region, at Gara Es Sbaa and in new localities. Trampled levels (carbonate-cemented fine-grained quarzarenites with ripple cross-lamination) occur just a few meters below bivalve and gastropod-rich marly-limestones that cap the section in almost vertical cliffs. No large track surfaces were found due to the almost flat attitude of bedding and to the often scarce cementation of the layers which break into relatively small (max 1.5-2 m2) slabs.

More than forty tracks were recorded at three different sites, alongside many others that were not collected or measured due to poor preservation. Still others occur on completely dinoturbated surfaces where individual prints cannot be discerned. All tracks are isolated and preserved as natural casts: many were collected from scree, very close to the original level. Amongst our collection, most tracks were made by medium (fl~25 cm) to large (fl~40 cm) theropods, especially at Gara Es Sbaa. Other vertebrates are also represented by swimming traces of turtles and crocodiles coeval with theropods. It is likely that while the theropods were large enough to walk in some of the large Kem Kem ponds and swamps of the coastal mudflat, whereas their smaller counterparts had to swim. One putative sauropod manus print was also recorded.

Though our work in the Kem Kem is preliminary and ongoing, the ichnocoenosis recognized here does reflect previous ecological reconstructions for the area as theropod-dominated, even though no tracks comparable in size with the largest theropods were found.

Poster Session IV (Saturday, November 5)

AGE, STRATIGRAPHY, DEPOSITIONAL ENVIRONMENT AND VERTEBRATE ICHNOLOGY OF THE MIOCENE-PLIOCENE COPPER CANYON FORMATION, DEATH VALLEY, CALIFORNIA

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Extremely well preserved fossil tracks and trackways of mammals and birds are preserved in playa mud flat deposits of the Copper Canyon Formation. Twenty-six ichnospecies of cat, camel, horse, mastodon, and bird tracks have been identified from 60+ localities spanning over 1200 m of lacustrine deposits. The formation is composed of approximately 1800 m of conglomerates, basalt flows, and fluvial-lacustrine sediments exposed within Copper and Coffin Canyons on the west side of the Black Mountains in southern Death Valley National Park, California. It is exposed in a tectonic basin associated with right steps within a low angle normal fault system that extended Death Valley and uplifted the Black Mountains and portions of the Funeral Mountains. Basalt flows, paleomagnetic analysis, and a tuff bed stratigraphically above the formation, constrain the age between ~5 and 3Ma. The abundance and diversity of fossil mammal and bird tracks was previously only superficially recognized. Detailed measured sections within the Copper Canyon and Coffin Canyon reveal that the distribution of the tracks is much more widespread and is coincident with spring deposits and freshwater limestone, suggesting a fresh water source in an otherwise brackish to saline lake environment. The limestone contains invertebrates, plant material, tufa mounds, and stromatolites. The tufa mounds provide evidence of a significant spring water source to the lake. Animals were attracted to the freshwater and associated food, leaving their tracks in the playa mud flat. Rapid burial of tracks by local flash floods and associated sheet wash across the mud flat probably were responsible for the preservation of the trackways.

Symposium 3 (Thursday, November 3, 9:45 am)

DIVERSITY AND DISTRIBUTION OF CAMPANIAN (LATE CRETACEOUS) SQUAMATES OF LARAMIDIA FROM CANADA TO MEXICO

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Squamates (lizards/snakes) are a common component of the microvertebrate faunas from the Campanian of western North America. Generally these fossils are disarticulated and fragmentary remains of jaws, vertebrae, and skull elements recovered through bulk sampling and screen wash concentration. The taxa recovered include ?Iguania, Cordylidae/Paramacellodidae-grade, Borioteiioidea (polyglyphanodontines/chamopsiids), Contogenidae, ?Scincidae, Anguidae, Xenosauridae, Platynota, and Serpentes. Additionally, many localities include unnamed morphotypic specimens. Rock formations from which squamates have been recovered are the Oldman (Alberta; 23 taxa/morphotypes), Kaiparowits (Utah;

20 taxa/morphotypes), Aguja (Texas; 9 taxa/morphotypes), Judith River (Wyoming; 5 taxa/morphotypes), Fruitland (New Mexico; 3 taxa/morphotypes), and El Gallo (Baja California; 1 taxon)—numbers are approximate as some records are difficult to confirm. When comparing the squamate faunas from north to south there are recognizable trends: (1) iterative and balanced presence of anguids, platynotans, and snakes; (2) iterative presence of chamopsiids with decreasing diversity from north to south; (2) presence of polyglyphanodontines limited to southern regions; (3) presence of xenosaurids and cordylid/paramacellodid-grade taxa limited to more northern regions; (4) ?iguanians present only in Alberta; and (5) the Utah fauna is taxonomically transitional between those of the north and south. Many of the taxonomic trends are recognizable only at or above the family level with regional endemism of many genera and/or species. The various north-to-south differences in the squamate faunas appear to be correlated with latitude (and the presumed associated broad-scale environmental diversity). However, differences in specific depositional environments (e.g., meandering river systems versus backwater lagoons) likely are also responsible, in part, for the variation in taxa from locality to locality. While the last 20 years has seen much improvement, the squamate record is still limited and requires continued recovery of additional specimens throughout Laramidia, particularly in the more southern latitudes.

Poster Session III (Friday, November 4)

ADVANTAGEOUS ARTIODACTYL ANATOMY: ASSESSING THE FUNCTION AND EVOLUTIONARY HISTORY OF THERMOREGULATORY CRANIAL VASCULATURE WITHIN THE RUMINANTIA

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Artiodactyls are considered the most successful extant ungulates, in both geographic range and species-level diversity. This success has been attributed to derived anatomical structures, such as the ruminant digestive tract, hypothesized to have sheltered the clade from extinction by enhancing their capacity to digest vegetation. Recently, the subdural carotid rete (CR) has also been hypothesized to impart artiodactyls with a fitness advantage. The CR is a meshwork of small arteries that plays an important homeostatic role by selectively maintaining cooler cranial blood temperatures even as body temperature increases via metabolic activity or exposure to high environmental temperatures. The present study reviews and models the anatomy and functions of the CR, and uses osteological correlates to explore the distribution and evolutionary history of this potentially advantageous structure in extant and fossil ruminants.

The CR completely replaces the internal carotid artery (ICA) and vertebral arteries in supplying the brain with oxygenated blood, resulting in significant changes in cranial osteology. Unlike the ruminant digestive tract, osteological correlates are identified for the carotid rete—an important advantage for paleontological studies relying on hard part anatomy. Presence of the sphenoidal foramen orbitorotundum is indicative of the CR, whereas foramen lacerum morphology and internal sphenoidal canals indicate presence of an ICA. To investigate the evolutionary history of ruminant cranial vasculature, the sphenoid and temporal bones were isolated from computed tomographic (CT) scans of extinct basal ruminants *Leptomeryx* and *Hypisodus*, documenting evidence of a CR prior to the Eocene-Oligocene boundary. Next, the external carotid artery of a domestic goat (*Capra hircus*) was injected with a radio-opaque latex/barium solution, CT scanned, and reconstructed using Amira 4.0. Cranial arteries were isolated, and volume and area of the CR were calculated. Based on mathematical models of blood flow and heat transfer within the carotid rete/cavernous sinus, the CR conveys a distinct thermoregulatory advantage, but no difference in overall hemodynamics.

Poster Session I (Wednesday, November 2)

SMALL THEROPOD WITH BIRD IN STOMACH INDICATES BOTH LIVED IN TREES

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Preserved indicators of diet are extremely rare in the fossil record; even more so is unequivocal direct evidence for predator-prey relationships. Here, we report on a new specimen of the small non-avian theropod *Microraptor* from the Early Cretaceous Jehol Biota, China that has the remains of an adult enantiornithine bird in its stomach. The new specimen helps to further reconstruct the dietary preferences of *Microraptor*. Furthermore, because Jehol enantiornithines were distinctly arboreal, in contrast to their ornithurine counterparts which were cursorial, this fossil suggests that *Microraptor* hunted in trees and strongly supports inferences that this taxon was also an arborealist. This discovery provides further support for the arboreality of basal dromaeosaurs and a 'trees down' origin for bird flight.

Technical Session IX (Friday, November 4, 9:00 am)

VIVIPARITY AND CETACEAN-LIKE LIFE HISTORY IN A MESOZOIC MARINE PLESIOSAUR (REPTILIA: SAUROPTERYGIA)

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Although live birth has been documented in several clades of Mesozoic aquatic reptiles, no evidence exists for viviparity in the derived sauropterygian clade Plesiosauria despite an excellent fossil record and a collection history spanning almost two hundred years. Here we report the first definitive evidence of plesiosaurian viviparity. The fossil described here was discovered in Logan County, Kansas, at the base of the Sharon Springs Member of the Pierre Shale (Campanian). It consists of the largely articulated remains of two plesiosaurs, an adult and a juvenile displaying early ontogenetic features. The adult is a large polycotylid referable to *Polycotylus latippinus* and is complete save for the head and anterior 21 cervical vertebrae. The juvenile consists of a largely disarticulated mass of poorly ossified bones spilled from the body cavity of the adult, and is also referable to *Polycotylus latippinus*. There are no gastroliths associated with the embryo, and no maceration of cartilaginous surfaces attributable to stomach acid. The taxonomic identity of adult and embryo, the location of the embryo within the adult body cavity, the early ontogenetic stage of the embryo, and the lack of evidence for a gastric mass all support the conclusion that the adult was a gravid female.

Utilizing morphometric data from the vertebral centra, we calculate a conservative embryo length of 150 cm at time of death (32% of the 470 cm maternal length). Length at full term would have been significantly longer; we calculate a rough estimate of 40% of maternal length or more. *Polycotylus* therefore gave birth to very large, probably single progeny, a reproductive strategy unique among marine reptiles. The mammal-like traits of viviparity, small brood size, and large embryo size are rare in modern lizards, but this combination does occur in the scincid *Egernia* species group. This clade also exhibits mammal-like social behaviors, including stable, kin-related group structures and parental care. Because both cetaceans and *Egernia*-group lizards are highly social and engage in significant maternal care, we hypothesize that plesiosaurs may have behaved similarly.

Poster Session II (Thursday, November 3)

X-RAY VISION SEES THROUGH 'THE FEROCIOUS PONY HYPOTHESIS'

O'SULLIVAN, Jay, University of Tampa, Tampa, FL, USA

Previous work indicates that the ethology of the small Miocene equid *Archaeohippus blackbergi* differed substantially from that of the contemporaneous equid *Parahippus leonensis*. Studies of mortality curves based on fossils collected from the Thomas Farm site and housed in the vertebrate paleontology collection at the Florida Museum of Natural History represent two distinct mortality distributions. The population of *A. blackbergi* experienced a sharp increase in mortality in young adults compared to *P. leonensis*. Such a pronounced mortality spike is typical of mammals in which males fight for access to females. This interpretation for *A. blackbergi* is supported by the presence of strong sexual dimorphism in canine size. Further support comes from a recent study that shows that the mandibles of specimens with large canines (males) are relatively thicker at the back of the diastema, presumably to resist loading of the anterior mandible during bite attacks. The present study uses x-ray imaging to further test the hypothesis that male *A. blackbergi* used their mandibles for fighting behaviors that were not displayed by females of the species or by *P. leonensis*. Further support for the hypothesis comes from the observation that cortical bone thickness in the diastema of males is relatively thicker than in either female *A. blackbergi* or in *P. leonensis*.

Poster Session III (Friday, November 4)

A MULTI-TAXON THEROPOD DINOSAUR ACCUMULATION FROM THE LATE CRETACEOUS OF MADAGASCAR: NEAR-INSTANTANEOUS ENTOMBMENT OF SMALL-BODIED AVIALANS

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Recent field efforts conducted as part of the Mahajanga Basin Project have resulted in a significantly improved sampling of theropod dinosaurs from the Maevarano Formation. Both avialan and nonavialan taxa have been recovered from MAD 05-42, a locality exhibiting a mixed taphonomic signature that includes a range of preservational styles. Small (< 4 cm), isolated avialan specimens are routinely found in close proximity to large (> 15 cm) disarticulated nonavialan elements. Perhaps most striking is the co-occurrence of multiple semi-articulated to articulated partial avialan skeletons within the quarry. The most exquisite degree of preservation is exemplified by articulated phalangeal series consisting of individual elements < 2 mm in length.

In this study we profile the co-occurrence of small-bodied, semi-articulated to articulated avialans among large-bodied disarticulated specimens within a single quarry. High-resolution x-ray computed tomography was used to generate detailed sub-millimeter spatial characterizations and preliminary anatomical assessments of unprepared specimens. High-resolution spatio-anatomical data are combined with detailed quarry mapping, field collection data (e.g., orientation), and both field- and laboratory photography to evaluate hypotheses related to previously proposed burial models.

Selected small, multi-element specimens (MOS) reveal remarkable preservation in the form of articulated vertebral, costal, and gastralial series and multiple limb segments, with many retaining the original three-dimensional organization. Other MOS exhibit slight (~ 2 cm) dissociation across joints, with yet others consisting of fragmentary, partial elements displaying the effects of sheer stresses and/or compressive forces applied during burial and in the post-burial environment. The small size of avialan specimens, combined with their lightly-built skeleton and degree of articulation, strongly indicate that minimal transport occurred during burial. Data are consistent with interpretations of viscous mass flows as entombing agents, with microCT analysis providing novel perspectives on depositional kinematics.

Poster Session I (Wednesday, November 2)

NEW INFORMATION ON THE PLOTOPTERIDAE SKULLS FROM THE OLIGOCENE KISHIMA GROUP AND ASHIYA GROUP OF NORTHERN KYUSHU, JAPAN

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Plotopteridae is an extinct family of seabirds found from the Middle Eocene to Middle Miocene of the North Pacific region. Five species have been described previously, but many of them comprised fragmentary and postcranial materials. Therefore, their phylogenetic position in avian phylogeny is debatable. A recent phylogenetic study pointed out their relationship with Sphenisciformes, in contrast to most other studies that suggest their relationship with Pelecaniformes.

We studied three skull specimens of plotopterid birds obtained from the Oligocene Kishima Group and Ashiya Group of northern Kyushu, Japan. Two of the specimens essentially are preserved frontal-parietal parts and neurocranium. The other specimen is almost completely preserved. These specimens provided new information on the skull of plotopterid birds.

Two plotopterid species *Copepteryx hexeris* and *C. titan* are known from the Ashiya Group. The skull elements of these specimens were not preserved. The holotype of *C. titan* is one left femur, which is larger than that of *C. hexeris*. The orbital margin length of each skull studied by us is different. The relationship between these skulls and *Copepteryx* is not obvious, but judging from their skull size, these skull specimens are possibly of a different kind from each other.

Poster Session I (Wednesday, November 2)

CRANIAL GROWTH AND DEVELOPMENT IN *PANTYLUS CORDATUS* (LEPOSPONDYLI: TETRAPODA)

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Incorporation of ontogenetic data into analyses of tetrapod relationships and the ancestry of extant amphibians is becoming increasingly common. However, the utility of those data is limited by lack of developmental information for many Paleozoic taxa. Although ontogenetic data for lepospondyls is increasing, nearly all of those data are for primarily aquatic taxa that required water for at least part of the life cycle. Almost nothing is known about skeletal growth in terrestrial taxa, such as *Pantylus cordatus*, that are inferred to have been direct developers. In order to characterize skull growth, investigate shape change, and evaluate evidence for metamorphosis in *P. cordatus*, skulls of five individuals (skull lengths 32-89 mm) were scanned using High Resolution X-ray Computed Tomography, and a preliminary 3D geometric morphometric analysis was performed. In the two smallest specimens the otic capsule is incompletely ossified, and in the smallest individual the septomaxilla may be unossified. Increase in size is correlated with increasing sutural complexity, but contacts between bones exhibit few changes. Dermal sculpture strengthens during ontogeny, but there are no changes in the type or pattern of dentition. Morphometric analysis of the skull indicated that cranial growth was generally isometric in *P. cordatus*, mirroring results for other early tetrapods and *Eusthenopteron*. Despite overall isometry, there were localized changes in the skull proportions of *P. cordatus* during growth. The orbit either slightly expanded or rotated dorsomedially, the posterior half of the skull deepened owing to ventral expansion of the jugal, and there was outward expansion of the posterolateral corner of the skull. Expansion of skull dimensions at the junction of the maxilla, palatine, and temporal muscle opening suggests that jaw muscles increased in volume during growth, but no other changes correlated with function were detected. In *P. cordatus* there is no evidence for an extant amphibian-like metamorphosis, consistent with the hypothesis that metamorphosis is a derived feature of amphibians and their close relatives, rather than ancestral for early tetrapods.

Romer Prize/Technical Session 5 (Thursday, November 3, 8:30 am)

THE PRESENT IS NOT ALWAYS THE KEY TO THE PAST: MAMMAL BODY SIZE AND CLIMATE IN NEOGENE NORTH AMERICA

ORCUTT, John, University of Oregon, Eugene, OR, USA

One of the oldest debates in ecology centers on the question of whether climate drives body size evolution in animals. This question was first addressed by Christian Bergmann, who famously hypothesized a causal relationship between temperature and mammal body mass. Bergmann's rule, as this hypothesis has come to be known, predicts that larger taxa should be favored in colder climates, while smaller taxa should be favored in warmer climates, but subsequent research has suggested that other variables – both climatic and biotic –may also play a role in shaping body mass trends. Predicting biotic responses to environmental change is a non-trivial matter in the face of anthropogenic global warming, but previous research on the relationship between climate and body mass has focused almost exclusively on neontological data. Applying a paleoecological perspective to Bergmann's rule allows the inclusion of both an extra dimension (time) and of climatic data reflecting fluctuations of a far greater magnitude than anything recorded by historic climate data. I have analyzed body size trends in three families of mammals (equids, canids, and sciurids) through time and across space in western North America during the Late Oligocene and Miocene (Arikareean-Hemphillian land mammal ages), an interval that encompasses several intervals of both global warming (e.g. Late Oligocene warming, Mid-Miocene climatic optimum) and cooling (e.g. Late Miocene cooling). Paleoclimatic proxies were used to reconstruct local trends in temperature, precipitation, and seasonality during the same interval. Not only is there no evidence for the latitudinal body mass gradients observed in modern mammals, but in none of the taxa studied did body mass correlate with any climatic variable. This suggests that ecological trends observed in modern ecosystems, as products of an exceptionally cold and climatically volatile interval, may not be the norm under most climatic regimes. As a consequence, models of biotic responses to future climate change that do not incorporate paleoecological data may lack predictive power.

Technical Session VII (Thursday, November 3, 3:30 pm)

ENDOCRANIAL STRUCTURES OF *DIACODEXIS* (MAMMALIA, ARTIODACTYLA)

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A complete skull of *Diacodexis* recovered from the Early Eocene of the Clark's Fork Basin (Sand Coulee Formation, Wyoming) was studied with computed tomography. This technique reveals the endocranial structures of *Diacodexis*, the oldest known member of the mammalian order Artiodactyla. The endocranial petrosal and inner ear of this taxon are also described for the first time. Comparison of the peculiar features of *Diacodexis* to ungulates and to other artiodactyls groups, including extinct Eocene taxa (e.g., *Homacodon*, *Dichobune*, *Cebochoerus*, *Gobiohyus*, *Helohyus*), provides a good picture of the primitive morphology of the artiodactyl middle ear and inner ear complex. We reconstructed a virtual endocast of the braincase, which is only slightly deformed. This demonstrates the external morphology of the entire brain including the olfactory bulbs, and cranial nerves, which have been previously described only from fragmentary composite specimens. *Diacodexis* is characterized by the important size of the rhinencephalon and the rudimentary fissuration of the neopallium. The brain has no individualization of the coronal sulcus, and a linkage of the lateral sulcus to the suprasylvia (girus III).

Poster Session III (Friday, November 4)

EGGSHELL ABRASION: AN EXPERIMENT TO CHARACTERIZE THE RESULT OF SEDIMENT INTERACTION ON FRAGMENTARY FOSSIL AND MODERN EGGSHELL

OSER, Sara, Montana State University, Bozeman, MT, USA; JACKSON, Frankie, Montana State University, Bozeman, MT, USA

Fossil egg horizons in the Cretaceous Wayan and Two Medicine formations of Idaho and Montana occur in fine-grained alluvial deposits and contain hundreds of eggshell fragments whose origin remains enigmatic. Possible explanations include 1) *in situ* eggshells from hatched clutches or 2) fluvial transported material (pre- or post-fossilization). To investigate these possibilities, I conducted actualistic experiments using modern and fossil eggshell fragments. Eggshell presents a unique opportunity in that modern eggshell has a significant organic structural component both surrounding and within the shell structure, therefore transport-induced abrasion occurring pre-fossilization should leave marks distinct from abrasion after fossilization.

Thirty chicken (*Gallus gallus domesticus*) and three ostrich (*Struthio camelus*) eggshell fragments were used to determine the effects of abrasion pre-fossilization, while ten (presumably untransported) hadrosaur (*Maiasaura peeblesorium*) eggshell fragments from the Two Medicine Formation were used to determine the effects of abrasion after fossilization. These were divided into 3 groups and placed in a rock tumbler with water and quartz sand (0.5-1.0 mm) for one to three weeks (groups removed after 168, 336, and 504 hours). The fragments were then imaged using a JEOL JSM-6100 scanning electron microscope at 20 kV.

The organic components of the eggshell had a drastic effect as to how it responded to abrasion. The chicken eggshell lost the cuticle after 1 week and then experienced edge rounding and a loss of surface detail, similar to the fossilized eggshell. The ostrich eggshell (with a substantially thicker cuticle) developed small grooves on the cuticle surface and experienced crack propagation at the edges. The chicken eggshell displayed a higher degree of abrasion around the pore openings, which were protected by infill in the fossilized material and by the cuticle in the ostrich eggshell. The organic component of the cuticle may cause damage due to abrasion to be more minor and localized. Further research will extend the tumbler time with an expanded sample size and sediment variety.

Poster Session I (Wednesday, November 2)

REGIONAL VERSUS TAXONOMIC VARIATION IN VERTEBRAE OF ALBULOID (TELEOSTEI, ELOPOMORPHA) FISHES

OSTROWSKI, Summer, Michigan State University, East Lansing, MI, USA

Teleost vertebrae are common in many vertebrate paleontology collections, but quite often remain unidentified beyond "Teleost indet." which is not useful to researchers. Fossil albuloid (bonefish) vertebrae are relatively common and the group as a whole has a global distribution and is represented at many localities, yet their vertebrae have not been studied in detail. Albuloid vertebrae are distinctive from most teleosts due to their "simple" shark-like appearance, and relatively short and compact proportions. The Late Cretaceous deposits of northwestern Madagascar have produced an intensely studied and highly diverse vertebrate

fauna, which includes multiple albuloid taxa (based on dental morphology). There is considerable variation among the vertebrae of albuloids collected from the sites in Madagascar, and these have yet to be assessed in the context of whether or not they are diagnostic in distinguishing between taxa or represent regional variation within a taxon. The Madagascar vertebrae range from small (<0.5 cm in diameter) and simple round-edged structures to large (> 2.5 cm in diameter), robust vertebrae with a sigmoidal outline. This study assesses whether these variations are likely to occur within an individual (or individual genus), or whether it is more likely that these vertebral morphotypes correspond to the albuloid diversity seen in the Late Cretaceous deposits. Geometric morphometrics is applied to quantitatively compare the Madagascar albuloid vertebrae with one another, and with vertebrae of identified recent albuloids from comparative collections. It appears that the vertebral differences do reflect taxonomic distinctions, a conclusion that is supported by the morphological differences in toothplates found at the same sites.

E&O Poster Session

FOSSIL HORSES, ORTHOGENESIS, AND PUBLIC UNDERSTANDING OF EVOLUTION

OVIEDO, Luz, Florida Museum of Natural History, Gainesville, FL, USA; SEYMOUR, Grace, Cornell University, Ithaca, NY, USA; MCFADDEN, Bruce, Florida Museum of Natural History, Gainesvllle, FL, USA

Since the late 19th century, the fossil record of horses (Family Equidae) has been widely considered to be a classic example of macroevolution. As a result of Marsh and Huxley's influence in the 1870s, fossil horses in North America were originally depicted as an orthogenetic (straight-line) sequence starting with "eohippus" in the Eocene and ending with modern day *Equus*. In the early 20th century, however, paleontologists studying fossil horses, such as Gidley (and then Simpson, for example), depicted fossil horse evolution as a branching phylogenetic tree, and not an orthogenetic pattern. Nevertheless, up to the present day, horse evolution is still communicated to other scientists, K16 students, and the general public as being orthogenetic in a wide variety of media. In addition, an orthogenetic pattern is also used to depict the evolution of other groups with a fossil record, including of great societal relevance, humans.

In this study we describe and evaluate how horse evolution is portrayed in different types of media and how its depiction influences the public understanding of evolution. Much of the public (mis)understanding of evolution as it pertains to the fossil record stems from scientists' failure, or inability, to communicate up-to-date and correct evidence for the pattern of evolution in diverse media including museum exhibits, textbooks, and web-based content. The explanation for this miscommunication may stem from the fact that orthogenesis is perhaps easier to grasp as a simple concept than a complexly branching phylogenetic tree, despite the fact that, depending upon one's point of view, orthogenesis is either an oversimplification, or wrong. The challenge for researchers is to communicate complex concepts in a way that make these more accessible to a broad audience of scientists and the general public.

Technical Session XVIII (Saturday, November 5, 3:45 pm)

MICROSTRUCTURE OF THE FEMORAL GROWTH PLATE IN THE AMERICAN ALLIGATOR: EFFECTS OF GROWTH RATE, LOCOMOTOR ACTIVITY AND CIRCULATORY PATTERN

OWERKOWICZ, Tomasz, University of California, Irvine, CA, USA; YANG, Johnny, University of California, Irvine, CA, USA; BLANK, Jason, California Polytechnic State University, San Luis Obispo, CA, USA; EME, John, University of North Texas, Denton, TX, USA; HICKS, James, University of California, Irvine, CA, USA

Avian and non-avian dinosaurs possess long bone growth plates with a highly irregular border at the chondro-osseous junction. This similarity has been used to argue that the avian-style developmental pattern, in particular the rapid and determinate skeletal maturation, evolved before the origin of birds. In order to test whether such growth plate microstructure is indeed a synapomorphy of dinosaurs, and whether growth plate thickness can be used as an indicator of skeletal growth rate, we studied the microstructure of the femoral growth plates of juvenile alligators raised for two years under laboratory conditions. Some of the animals (n=24) had undergone surgery to ablate their left aorta and alter their circulatory pattern from in-parallel to in-series, whereas others (n=36) were sham operated. Some animals remained sedentary, while others were exercised to exhaustion every other day either on a treadmill or in a flume (n=20 per group). All animals received injections of fluorochrome dyes (alizarin and calcein), to allow determination of mineral apposition rates. We quantified the height of the calcified cartilage columns (CCC) of the growth plate, and longitudinal growth rate (LGR) of the femur. We found that the alligator growth plate exhibits a highly irregular chondro-osseous border and CCC height is significantly correlated with LGR. CCC height is reduced (-17%) in alligators engaged in routine locomotor activity, both terrestrial and aquatic, when compared to sedentary animals. CCC height, however, is augmented (+36%) in alligators with in-series circulation compared to those with in-parallel circulation. This implies growth plates are sensitive to systemic arterial oxygen tension, which is likely depressed by exhaustive exercise but elevated by loss of cardiac shunting. We suggest the irregular chondro-osseous junction is an ancestral character of archosaurs and its presence in fossils of non-avian dinosaurs does not imply an avian-style physiology. We propose thicker growth plates appeared concurrently with the origin of in-series circulation, and may thus have set the stage for later acquisition of fast growth and endothermic metabolism of birds.

Technical Session X (Friday, November 4, 8:15 am)

PHYLOGENETIC DISTRIBUTION OF ECOLOGICAL TRAITS IN THE ORIGIN AND EARLY EVOLUTION OF BATS

PADIAN, Kevin, University of California, Berkeley, CA, USA; DIAL, Kenneth, University of Montana, Missoula, MT, USA

Living bats differ from other flying vertebrates (birds and pterosaurs) in having poor sight, echolocating, stressing slow, maneuverable flight, and seldom gliding. It has generally been assumed that gliding is a necessary precursor to flight, but phylogenetic analyses show that no gliding forms are found among the closest relatives of flying forms, and many gliding lineages have evolved with no apparent tendencies to powered flight. The most basal known bats could fly, but the most basal *Onychonycteris* lacked bony specializations for echolocation, which has suggested that flight evolved first. However, other mammals such as the tenrec do not fly but can echolocate in a more rudimentary way, and they lack chiropteran bony specializations for this. Nocturnal animals generally evolve enhanced vision, but animals that live in almost total darkness (e.g., caves) tend to reduce sight. Cave insects also tend to lose flight capacity. The visual capabilities of the earliest bats are ambiguous, but nearly all living bats are crepuscular, roosting in dark places.

We mapped traits related to echolocation, locomotion, vision, diet, and habitat in crown and stem bats. Results suggest that echolocation may be an "evolvable," modular trait that has been hard-wired to various degrees in mammals. Basal bats are inferred to have been insectivorous, but they may have hunted differently than living bats do. Phylogenetic mapping shows that neither the ability to fly well nor to echolocate well may have been basal to bats; living in caves and feeding on poorly mobile insects may have been basal habits at least for crown-group bats. No outgroups to bats are or apparently were bipedal; thus the forelimbs of bats could only be freed to evolve powered flight if they were no longer necessary to standard quadrupedal locomotion. All bats can climb quadrupedally and this seems basal for crown-group bats. Caves have fewer predators than trees, and the ability to suspend the body from the roofs of caves appears to have been possible for all known Chiroptera, living and extinct. The features of cave habitats, although poorly fossilized, may explain much about the origin of bats.

Poster Session III (Friday, November 4)

CONCORDANCE OF DIETARY SIGNALS BETWEEN TOOTH CREST LENGTHS AND ENAMEL MICROWEAR OF EOCENE AND OLIGOCENE UNGULATES

PAPAZIAN, Jacqueline, Suffolk University, Boston, MA, USA; DEWAR, Eric, Suffolk University, Boston, MA, USA

The shapes and wear of the teeth of fossil mammals preserves information about their likely diets. While dental morphology reflects evolutionary adaptations toward particular dietary modes, tooth wear is evidence of how those dental tools were actually used during a short interval of the animal's life prior to death. We compared the lengths of tooth crests vs. the low-magnification enamel microwear of four Eocene and Oligocene genera: the artiodactyls *Poebrotherium* (Camelidae), *Merycoidodon* (Oreodontidae), and *Leptomeryx* (Leptomerycidae), as well as the perissodactyl *Mesohippus* (Equidae).

We measured the crown features of these genera from digital micrographs of epoxy casts using a stereomicroscope. Differences in body size were accounted for by creating an index of the length of the lingual crests divided by the crown's occlusal area. The likely adaptations of these genera come together using ecological observations and morphometric information about modern analogues and knowledge of food fracture mechanics. Longer tooth crests are known from modern grazers; such dental adaptations are effective in shredding fibrous foods. We predicted that longer crests would also indicate adaptations toward grass chewing in these fossil species. We also expected that more grass in the diet would be reflected in the enamel microwear, especially in the number of scratches: living grazers incur more scratching than browsing ungulates.

We found that the smaller "crest length/crown area" indices of *Poebrotherium* and *Leptomeryx* differed significantly from the larger indices of *Merycoidodon* and *Mesohippus* ($F3,49 = 29.20$, $p < 0.0001$). In terms of microwear, we found the significant differences between *Leptomeryx* and *Poebrotherium* vs. *Mesohippus* again at the ends of our range, but similar counts of scratches and pits between *Poebrotherium* and *Merycoidodon*. None of these species was a committed grazer as living equids are. We found similar signals of browsing in *Leptomeryx* and *Poebrotherium*, trending toward more grass-eating in *Merycoidodon* and *Mesohippus*, but even these species were probably mixed feeders rather than committed grazers.

Technical Session VIII (Thursday, November 3, 2:45 pm)

THE MORPHOLOGY AND RELATIONSHIPS OF THE CARBONIFEROUS-PERMIAN NECTRIDEAN *DIPLOCERASPIS BURKEI*

PARDO, Jason, Carnegie Museum of Natural History, Pittsburgh, PA, USA

The Nectridea are a clade of aquatic tetrapods from the Carboniferous and Permian of North America, Europe, and North Africa known for extremely elongate caudal regions, conspicuous holospondylous vertebrae and, in some taxa, bizarre hornlike extensions of the lateral skull. Despite including some of the most abundant and iconic components of the Carboniferous-Permian tetrapod fauna, the morphology of the Nectridea is poorly known. Here I present new data on the skull and postcranium of *Diploceraspis burkei* from the Upper Carboniferous and Lower Permian of Pennsylvania, Ohio, and West Virginia. The

skull of *Diploceraspis* differs from previous descriptions in the identity several bones of the skull roof, occiput, and palate. The nasals and supratemporals are not lost, contra previous descriptions. The epipterygoid, dorsal process, and otic capsule situated between the parietal and pterygoid and co-ossified with those elements. The 'pharyngobranchial pouch' of the horn complex is enclosed anterolaterally by the lamina ascendens, posteriorly by paroccipital processes of the exoccipital and tabular, and medially by the fenestra vestibuli, and may enclose the stapedial canal. Other important features include a broad anteriorly-flaring cultriform process, carotid foramina at the base of the cultriform process, labyrinthine infolding of the teeth, a quadrate foramen in occipital view, loss of the ectopterygoid, and an alary process of the jugal excluding the palatine from the subtemporal vacuity. Relationships of *Diploceraspis* were investigated with cladistic analysis of several existing matrices, including matrices heavily sampling both lepospondyls and temnospondyls. Strong support is found for a temnospondyl origin of *Diploceraspis*, and by extension other nectrideans, within the Dvinosauria instead of the traditional placement within the Microbrachomorpha. No strong support exists for a monophyletic Lepospondyli, suggesting important and previously understated instability in the phylogeny of early tetrapods.

Poster Session I (Wednesday, November 2)

EARLY CRETACEOUS ICHTHYOSAURS FROM THE TYNDALL GLACIER IN TORRES DEL PAINE NATIONAL PARK, SOUTHERNMOST CHILE

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The Tyndall Glacier is located within Torres del Paine National Park in Chilean Patagonia and represents an exceptional Early Cretaceous ichthyosaur fossil area. In 2003, researchers from Stanford University found a fragmentary ichthyosaur skeleton in the banks of a river close to the Tyndall Glacier. After this discovery, several expeditions to this locality were made. During field campaigns in 2009 and 2010, 46 articulated and partially articulated ichthyosaur skeletons were discovered, comprising adults, juveniles, neonates and even females with embryos. The majority of the ichthyosaur specimens preserve diagnostic features permitting their systematic identification. So far, a complete specimen of *Platypterygius hauthali* and ?*Caypullisaurus bonapartei* have been identified. Moreover, an isolated forefin that could represent a new species and another hitherto unknown specimen with anatomical characteristics from ichthyosaurs of Jurassic age, have been found.

The ichthyosaurs are associated with ganoid and teleost fishes, as well as abundant belemnites. Ammonites and inoceramids are also frequent. Tree trunks partially encrusted and remains of land plants indicate a close shoreline, probably combined with a river that formed a submarine canyon. The enormous abundance of life is documented in Neptunian dykes full of belemnites and ichthyosaur bone fragments.

The abundance of ichthyosaur skeletons in the Tyndall area suggests mass mortalities caused by mudflows running at high speeds through submarine canyons. The ichthyosaurs were captured by this mud flow or were sucked by it into the abyss. The bodies were deposited in an anoxic environment, where they were rapidly covered by sediment, which explains their excellent preservation.

The discovery of this site as well as the quality and quantity of specimens is unique to South America and may represent one of the best sites of Early Cretaceous ichthyosaurs.

Poster Session II (Thursday, November 3)

A NEWLY RECOGNIZED SPECIMEN OF THE PHYTOSAUR *REDONDASAURUS* FROM THE UPPER TRIASSIC OWL ROCK MEMBER (CHINLE FORMATION) AND ITS BIOSTRATIGRAPHIC IMPLICATIONS

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Historically, relative dating and lithostratigraphic correlation of Triassic terrestrial strata in the western United States was accomplished through vertebrate biostratigraphy. Currently four biozones are recognized and defined by the first appearances of phytosaurian taxa, from oldest to youngest *Paleorhinus* (Otischalkian), *Leptosuchus/Smilosuchus* (Adamanian), *Pseudopalatus* (Revueltian) and *Redondasaurus* (Apachean). Several localized erosional surfaces in the Upper Triassic Chinle Formation have been proposed as regional unconformities (Tr-4, Tr-5) based primarily on the purported association of major faunal reorganizations and thus equivalence to biozone boundaries: the Tr-4 as the Adamanian/Revueltian boundary and the Tr-5 as the Revueltian/Adamanian boundary. These unconformities have been argued to represent major sequence boundaries and tie points for correlations to marine units for the purposes of dating the terrestrial sequences. Recent detailed lithostratigraphic and biostratigraphic work In the Chinle Formation of Arizona and the Dockum Group of Texas has demonstrated that there is no basin-wide Tr-4 unconformity, and the associated faunal change actually occurs above the proposed level of the Tr-4. Re-preparation of a phytosaur skull from the hypothesized Revueltian Owl Rock Member (Chinle) in Arizona reveals that it represents *Redondasaurus* and not *Pseudopalatus* as previously supposed. Therefore most of the Owl Rock falls within the Apachean Biozone and is biostratigraphically equivalent to the purportedly younger siltstone member (Chinle) and the Redonda Formation (Dockum) of New Mexico and the base of the Wingate Sandstone in Utah. This drastically changes existing biostratigraphic correlations of the upper parts of the Chinle and Dockum. Moreover, as the Owl Rock fauna is now very similar to the faunas of these upper units, there is no major faunal reorganization associated with the hypothesized Tr-5 unconformity. Finally, lithostratigraphic work suggests that in the center of the depositional basin there is no evidence for a hiatus in these upper units as well, thus the significance of these proposed unconformities is ambiguous.

Poster Session I (Wednesday, November 2)

HOW THE ANATOMY OF THE FIRST CERVICAL VERTEBRA INFORMS US ABOUT THE LOCOMOTION AND POSTURE OF A FOSSIL PRIMATE

PARKS, Hillary, Western Illinois University, Macomb, IL, USA; WHITESIDE, Jessica, Western Illinois University, Macomb, IL, USA; BONNAN, Matthew, Western Illinois University, Macomb, IL, USA

The morphology of the first cervical vertebra, or atlas, is an indicator of taxonomic affiliation, locomotor and postural behavior in primates. The function of the atlas (C1) has a direct effect on its form, as the atlas serves as a point of attachment for muscles that control the movement of the head and neck. It is an integral component of the atlanto-occipital and atlantoaxial joints. These factors shape the morphology of the atlas. The range of motion possible for the head and neck limits the locomotor and postural modes that can be employed in life. Data was gathered from 2-D digital photographs of the superior and inferior faces of primate atlases, which were then digitized with eight landmarks. Analysis methods including thin plate spline regression and relative warps analysis for shape analysis, principal component analysis, Anderson's test and discriminate factor analysis were used to test three hypotheses. The hypotheses are: (1) there are significant differences in atlas shape among primate taxonomic, locomotor, and postural groups; (2) atlas shape can be used as a tool to place primate specimens into their correct taxonomic, locomotor and postural groups; and (3) the fossil adapiform *Leptadapis magnus* was a pronograde arboreal quadruped. The shape of the first cervical vertebra is shown to be significantly different among taxonomic, locomotor, and postural groups of primates based on a broad sample (N=173). Although significantly differences were found, only the first principal component in the inferior dataset was found to be significant. Results suggest that the morphology of the superior surface of the atlas may be indicative of taxonomic placement and that the morphology of the inferior surface of the atlas is likely indicative of locomotor and postural behaviors. Trends also suggest that the effect of locomotor behaviors on the morphology of the inferior face of the atlas transcends the inferior postural and taxonomic groupings. Discriminate factor analysis supports the hypothesis that *L. magnus* was an pronograde, arboreal quadruped, which suggests that this method can be used to determine the locomotor and postural behaviors of other fossil primates.

Poster Session III (Friday, November 4)

NEUROANATOMY OF A PTEROSAUR FROM THE JURASSIC OF PATAGONIA USING COMPUTERIZED TOMOGRAPHY

PAULINA CARABAJAL, Ariana, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie and Department of Earth and Environmental Sciences, München, Germany; CODORNIU, Laura, CONICET-Dpto. Geología, FCFMyN, Universidad Nacional de San Luis, San Luis, Argentina; POL, Diego, CONICET-Museo Paleontológico "E. Feruglio", Trelew, Argentina

The neuroanatomy of pterosaurs is known from very few 3D preserved braincases. We describe the endocranial anatomy and inner ear of a new pterosaur from the Middle Jurassic of the Cañadón Asfalto Formation, Chubut Province, Argentina. The endocast has a volume of approximately 1.2 ml and has the generalized morphology described for the other known pterosaur brains, being bulbous, with short olfactory tract and bulbs, cerebral hemispheres with large optic lobes that are ventrolaterally displaced, and an extremely enlarged flocculus. The dorsal head veins enter the longitudinal sinus, forming two horns on the posterodorsal section of the hind-brain, and are clearly related with the optical lobes areas. Comparisons with the brains of *Ramphorhynchus* and *Anhanguera* reveal a mosaic of characters in the Argentinean specimen, which shares some traits with both taxa, but also has intermediate states for other characters. The disposition of several cranial nerves can be traced on the endocast. The three semicircular canals of the inner ear are preserved. They are remarkably large in comparison with the endocranial cavity. The anterior semicircular canal is markedly larger than the other two canals and is located dorsal to the posterior canal. The anterior and posterior semicircular canals form an angle of 94 degrees. The position of the lateral semicircular canal suggests that the long axis of the skull roof remained horizontal in life, as in *Rhamphorhynchus*. The CT scans also reveal some aspects of the pneumaticity of the braincase, which affects the paired frontals, supraoccipital, and basisphenoid, including the presence of well developed tympanic pneumatic cavities.

Poster Session III (Friday, November 4)

RECONSTRUCTING THE DIVERSITY OF THE EARLIEST TERRESTRIAL HERBIVOROUS TETRAPODS

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Terrestrial herbivorous tetrapods first appear in the fossil record during the Late Carboniferous and while there is little consensus on how this adaptation originated, it is known that a change to an exclusively plant-eating diet evolved independently many times throughout the Phanerozoic. The abundance of herbivores makes them important because of their suitability as index fossils. However the diversity history of the earliest terrestrial herbivores is poorly understood except for a few studies that focus on specific clades. It is known that herbivore diversity did not reach significant levels until the Late Permian when the trophic levels seen in modern ecosystems were established. A new data set of 226 species of herbivorous tetrapods including, Anomodontia, Dinocephalia, Pareiasauria, Diadectomorpha, Therocephalia, Bolosauridae, Captorhinidae, Cynodontia and Pelycosauria, their age and location has been assembled and analysed for diversity patterns for the Late Carboniferous to the Mid-Triassic, taking into account the effects of potential sampling biases. The results show the diversity of the herbivorous clades in relation to the number of total tetrapod-bearing formations, as a proxy for the rock record. Modelling of observed diversity as a function of sampling enabled the estimation of residual diversity scores. This results in a better understanding of where data might be missing and where observed diversity might be inflated due to local sampling effects. The results support an initial rise in abundance of herbivorous taxa from the Late Carboniferous, through a dip in diversity around the Guadalupian, into an increase to a peak in the Permian. A gradual increase in taxic diversity in the Palaeozoic indicates that establishment of diversity in terrestrial ecosystems occurred progressively and not exponentially. The end-Permian extinction event shows as a marked decrease in diversity over the boundary, with species numbers recovering in the Triassic even though residual diversity estimates suggest that the diversity of tetrapod herbivores might be underestimated during this crucial Late Permian-Early Triassic transition.

Poster Session II (Thursday, November 3)

NEW DATA ON THE ARCHOSAUR FAUNA OF THE MIDDLE TRIASSIC (ANISIAN) NTAWERE FORMATION OF ZAMBIA

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The Luangwa Basin of Zambia is one of several rift basins in southern and eastern Africa that preserves Triassic strata. Collections made in the 1960s recovered therapsid fossils from the Ntawere Formation, including diademodontid and traversodontid cynodonts and kannemeyeriid and stahleckeriid dicynodonts, as well as a mastodonsaurid temnospondyl. Biostratigraphic correlation with the main Karoo Basin of South Africa suggested that the Ntawere includes at least two faunas, correlating with those of the *Cynognathus* B and C subzones. The upper unit of the Ntawere has also been correlated with the better-sampled Manda beds of Tanzania. In 2009, we collected from the upper unit a new, derived traversodontid and the first diagnostic remains of archosaurs, including teeth, a large pseudosuchian vertebra, as well as pelvic and vertebral material of a silesaurid. The Ntawere silesaurid has a clear brevis fossa on the postacetabular process of the ilia, among other apomorphies, and phylogenetically groups with more derived silesaurids such as *Silesaurus*, to the exclusion of the coeval *Asilisaurus* (from the Manda beds). However, the Ntawere silesaurid retains a number of plesiomorphies in its pelvic girdle, such as a vertical ilial blade and lack of an antitrochanter within the acetabulum, which distinguish it from more derived forms. Ilial autapomorphies of the Ntawere silesaurid include rugose ends to the pre- and postacetabular processes and a relatively high blade. It has been well established that the major lineages within Archosauria had diversified by the early Middle Triassic and quickly achieved a worldwide distribution. Such rapid radiation after the Permo-Triassic mass extinction and the relative rarity of archosaur fossils has made the reconstruction of phylogenetic relationships difficult. Silesauridae is recognized as the sister group to Dinosauria, and so pelvic and hindlimb character distributions within the group will likely affect interpretations of character evolution and polarity within Ornithodira. Both the Ntawere and the Manda beds of Tanzania seem to have higher levels of archosaur diversity than the well-sampled Karoo Basin of South Africa.

Poster Session I (Wednesday, November 2)

A NEW TROODONTID (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS DJADOKHTA FORMATION OF MONGOLIA

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Troodontids are widely distributed bird-like dinosaurs that are known from Late Jurassic to the end of Cretaceous. A new troodontid specimen was discovered from the Late Cretaceous bed of Djadokhta Formation, Ukhaa Tolgod, Mongolia, where many important dinosaur fossils were reported. This specimen represents a new troodontid taxon with juvenile features. The specimen is preserved with an almost complete skull, dorsal ribs, sacral and caudal vertebrae, the pelvic girdle and partial hindlimbs. The skull is about eight centimeters long, comparable to that of *Mei long,* but less than half the size of the skull of *Byronosaurus jaffei*, another troodontid taxon reported from the same locality. Like *Byronosaurus jaffei,* this new taxon has unserrated maxillary and dentary teeth, but a recessed maxillary interfenestral bar and much fewer cheek teeth differ these two taxa. This new troodontid is unique in having a distinct spike-like process on the anterior edge of the ischium. The proximal chevrons are elongated, more than twice of the length of the attached caudal centra, which is a primitive condition of maniraptoran dinosaurs. A preliminary phylogenetic analysis reveals that this new taxon is the sister group of the clade of *Byronosaurus jaffei*, *Sinornithoides*, *Saurornithoides*, *Zanabazar* and *Troodon*, and is more derived than *Mei*, *Anchiornis* and *Sinovenator*. This result also indicates the unserrated teeth is a plesiomorphy of troodontids that are more derived than *Sinovenator*, and serrations of teeth were evolved in derived troodontid forms secondarily. A comparison with the perinatal troodontid IGM 100/972 shows that IGM 100/972 is more closely related to this new taxon than to *Byronosaurus jaffei,* evidenced by the shape of the snout and the number of maxillary teeth. The discovery of this new specimen increases the diversity of troodontid theropods of Late Cretaceous in Mongolia, and provides an opportunity to further examine the ontogeny of coelurosaurian dinosaurs.

Poster Session IV (Saturday, November 5)

ENAMEL AND DENTINE HISTOLOGY OF A MOSASAUR PTERYGOID TOOTH: IMPLICATIONS FOR DEVELOPMENT

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The distributions and features of palatal and pterygoid teeth in amniotes have been used as phylogenetic characters and as a means of interpreting dietary specializations, yet very little is known about them, especially in fossil groups. Questions abound about whether pterygoid teeth develop in similar ways to maxillary and dentary teeth, particularly with regard to implantation, growth rates, and what factors affect crown morphology. To begin to rectify this, we sectioned a pterygoid tooth of *Mosasaurus maximus* from the Cretaceous of New Jersey, along with a maxillary/dentary tooth of the same taxon to control for preservational effects that may possibly bias interpretations. Like maxillary/dentary teeth, the pterygoid tooth is conical and recurved, with an enamel surface texture that contains longitudinal grooves and crests everywhere except for the regions near the tip and very base of the crown. This has the same appearance seen in some other squamate teeth, including *Dracaena* and *Uromastyx.* As in *Dracaena* and *Uromastyx*, the enamel-dentine junction (EDJ) is smooth in both teeth and enamel thickness varies, indicating that this surface morphology is primarily due to enamel development, not underlying dentine structure like that seen in archosauriforms. In the dentine, incremental lines of von Ebner are visible in the pterygoid tooth, and these are uneven in thickness. This may possibly represent a period of accelerated growth, although further studies of tooth families of pterygoid teeth will be needed to confirm this.

Poster Session IV (Saturday, November 5)

TARSALS OF *NIPTOMOMYS* (MAMMALIA: MICROSYOPIDAE) FROM THE CASTLE GARDENS LOCALITY, WYOMING (EARLY EOCENE)

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Microsyopidae is a family of relatively generalized Plesiadapiformes that is known from the Paleocene and Eocene of North America. Microsyopids are generally considered to be relatively basal in the radiation of plesiadapiforms, a determination supported by dental and cranial evidence. Possible postcranial material of microsyopids has been reported but remains undescribed.

The diminutive uintasoricine microsyopid *Niptomomys* is well-represented by dental remains recovered via screen-washing from the Castle Gardens locality in north-central Wyoming (early Eocene, Willwood Formation). Proximal tarsal bones from the Castle Gardens assemblage are identified as probable postcranial elements of *Niptomomys*. These identifications have been based on relative abundance, which is comparable to that of the dental remains of *Niptomomys* from Castle Gardens, appropriately small size of the elements (approximately 2.9 mm in length for astragali; 4.0 mm in length for calcanei), and on a combination of features associated with of arboreality and traits specific to archontans.

Possible tarsal elements of *Niptomomys* from Castle Gardens show features that unambiguously indicate arboreal habits such as: an essentially ungrooved astragalar trochlea; a nearly flat astragalus; a short calcaneal tuber; a long calcaneal peroneal process. Additionally, features typical of "archontan" tarsals are present, including a relatively narrow astragalar body; a lateral rim on the astragalar body with a greater radius of curvature than the medial; a trochlear articular surface that extends onto the astragalar neck; the sustentacular facet and the cuboid facet on the astragalus are nearly continuous distally; and a lack of a calcaneal fibular facet. Notably, there is also a ventral excavation of the calcaneal cuboid facet, similar to that in the calcanei of mixodectids, consistent with a basal position for Microsyopidae among Plesiadapiformes.

Poster Session III (Friday, November 4)

NEW AGE CONSTRAINTS FOR THE EARLY MIOCENE FAUNAS OF RUSINGA AND MFANGANO ISLANDS (LAKE VICTORIA, KENYA)

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More than 90 species of mammals, including the stem hominoid *Proconsul*, have been documented from early Miocene deposits on Rusinga and Mfangano Islands (Lake Victoria, Kenya). The significant number of holotypes, the diversity of represented orders, as well as the quality and quantity of material recovered in these sites are some of the reasons why these faunas form an important comparative reference for understanding the evolution of Miocene mammalian lineages in East Africa. Thus, accurate determination of the age of the faunas is crucial for developing an understanding of Miocene mammalian paleobiology. Previous researchers used five select K-Ar dates from Rusinga to suggest that all of the Miocene fossiliferous beds were deposited during an interval of less than 500 kyr at ca.17.8 Ma. However, the dates were from a limited stratigraphic interval, and all were obtained by the conventional K–Ar bulk total-fusion technique, preventing any investigation of internal argon systematics of the samples.

Our recent field studies aimed at clarifying the paleoecological and geochronological contexts of Early Miocene mammalian evolution have yielded new age constraints for the faunas from Rusinga and Mfangano. Preliminary 40Ar/39Ar incremental heating analyses of biotite from the top of the Hiwegi Formation, and paleomagnetism analyses from the Hiwegi and Wayando Formations indicate that most of the fossiliferous deposits on both islands were likely deposited from ~18 – 20 Ma. These results suggest that the deposits are considerably older and represent more time than previously thought. Further, it implies that taxa from Rusinga and Mfangano may be closer in age to species from other early Miocene localities (i.e. Songhor, Napak, and Koru). Thus the taxonomic dissimilarities noticed by previous studies between these sites may be related to paleoenvironmental differences and/or relatively rapid (<~100 kyr) turnover in faunal composition.

Poster Session III (Friday, November 4)

FIRST CTENOCHASMATOID PTEROSAUR FROM THE EARLY CRETACEOUS OF SPAIN: *PREJANOPTERUS CURVIROSTRA* REVISITED

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Prejanopterus curvirostra, from the Early Cretaceous of La Rioja province, is so far the only pterosaur genus and species described from Spain. The material, which consists of disarticulated cranial and postcranial remains from several individuals, was collected in 1993 from the Fuente Amarga site, near the village of Préjano. Geologically, the locality is assigned to the Leza Formation (Enciso Group) and lies within the northern sector of the Eastern Cameros Basin (NW margin of the Iberian Range). The Leza Formation shows a lacustrine facies, with episodes of marine influence. It is generally regarded as Aptian, but an older age (Berriasian-Valanginian) has been recently suggested on the basis of stratigraphic evidence. *Prejanopterus curvirostra* was diagnosed on the basis of a combination of characters of which the most significant was considered to be the lateral curvature of the rostrum. Reexamination of the holotype (rostrum) and paratype (partial rostrum with teeth) indicates that there is no genuine sideways bend of the preserved premaxilla-maxilla segments. However, the tip of the upper jaw does show a little dorsal curvature. *Prejanopterus* is also characterized by a rostrum with a toothless tip, blunt upper teeth, rectangular sternum, and limb bones with a relatively thick cortex (none is autapomorphic). Our preliminary results suggest that *Prejanopterus curvirostra* is closer to some Late Jurassic pterodactyloids (e.g., *Cycnorhamphus suevicus* from Germany, *Gallodactylus canjuersensis* from France) than to the ornithocheiroids. It represents the first evidence of a ctenochasmatoid in the Early Cretaceous of Iberia, where only Azhdarchoidea (Tapejaridae) and Ornithocheiroidea (Ornithocheiridae and Istiodactylidae) have been recorded to date.

Technical Session IV (Wednesday, November 2, 3:30 pm)

DIVERSIFICATION PATTERNS AND THE ORIGIN OF CAVIOIDEA SENSU STRICTO: FOSSILS, GHOST LINEAGES, AND MOLECULAR CLOCK ESTIMATES

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Cavioidea sensu stricto is broadly distributed in South America and is currently represented by cavies, maras and capybaras. These forms are divergent and include the largest body size range among rodents. Extant species are divided into three distinct lineages that define the crown group of Cavioidea s.s., which has an abundant fossil record in post-Colloncuran sediments of South America. The stem group includes an assemblage of fossil taxa recorded from the Deseadan to the Colloncuran in the southern half of South America. The diversification patterns of Cavioidea s.s. are analyzed using calibrated phylogenies from a morphological cladistic study. Although previous studies characterized the evolution of Cavioidea s.s. along a single phyletic line, our analysis shows that the history of the group was characterized by three major radiations. The first radiation occurred during the Deseadan (late Oligocene), was previously undetected, and generated the basal cavioid *Asteromys* and all major lineages leading to later appearing protohypsodont species. The second radiation can be traced back to the Santacrucian (early Miocene), marking the appearance of numerous euhypsodont lineages. The third radiation is evidenced by the early appearance of *Prodolichotis* of Laventan age (middle Miocene) and indicates the minimum age for the origin of crown cavioids. Bayesian relaxed molecular clock estimates (using four genes of ten cavioids) provided 95% highest posterior density (HPD) for the age of this node that range between 11.6 and 24.7 Ma, with a maximum probability estimate of 17 Ma (predating the first crown fossil by 4 Ma). Such discrepancy may be caused by a violation of the molecular clock assumptions or by a faulty fossil record. The geographic distribution of Oligocene-early Miocene localities with fossil rodents is restricted to high latitudes in South America, but the first fossil crown cavioid is found in northern South America. A putative origin of this group at low latitudes, coupled with the scarcity of microvertebrate localities in the Oligocene-early Miocene in this region, may explain the discrepancy between the divergence times of crown cavioids based on the fossil record and molecular clocks.

Technical Session X (Friday, November 4, 10:15 am)

COMPUTED-TOMOGRAPHY SCAN ANALYSIS OF THE INTERNAL FACIAL ANATOMY OF THE MIDDLE MIOCENE APE *PIEROLAPITHECUS CATALAUNICUS* (PRIMATES: HOMINIDAE): PHYLOGENETIC IMPLICATIONS

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The Middle Miocene (11.9 Ma) dryopithecin ape *Pierolapithecus catalaunicus* (Primates: Hominidae), from the Vallès-Penedès Basin (Catalonia, Spain), has been interpreted as a stem great ape on the basis of external cranial and postcranial morphology. The internal anatomy of the face—paranasal sinuses size and shape, nasolacrimal duct orientation, palate configuration and turbinals development—provide additional informative features for further clarifying the phylogenetic position of this taxon. Here we report the internal morphology of the splanchnocranium of *P. catalaunicus* (IPS21350, holotype) by using non-invasive, computed-tomography techniques. This specimen displays a restricted maxillary sinus that expands posteriorly occupying the ethmoidal area, as in the Miocene pongine *Sivapithecus* and extant orangutans (*Pongo*). The frontal area of *Pierolapithecus* is characterized by the lack of a true frontal sinus, being occupied by a slight porosity, thus differing from the pneumatized condition of most fossil and extant great apes (except for *Pongo* and *Sivapithecus*). The nasolacrimal duct is less vertically-oriented than in extant African apes (*Pan* and *Gorilla*), thus more closely resembling the procumbent condition of orangutans, which might be interpreted as a pongine synapomorphy correlated to the greater projection of the nasals. The largest development of the turbinals is attained quite posteriorly, over the distal M2 level, thus more closely resembling orangutans (M3 level) than African apes (M1 level). Due to bone damage, it cannot be ascertained whether the premaxilla minimally overlaped the hard palate, althought it surely displayed a more primitive condition than extant great apes. Overall, the internal facial anatomy of *Pierolapithecus* more closely resembles that of the *Pongo*-clade than that of African apes (Homininae), by displaying several putative pongine synapomorphies that suggest that the former might be interpreted as a stem Ponginae s.l. (including both Dryopithecini and Pongini) instead of a stem Hominidae or Homininae (as previously suggested).

Poster Session III (Friday, November 4)

A NEW LARGE CRYPTODIRAN TURTLE FROM THE LOWER CRETACEOUS OF SPAIN

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The early Aptian 'Arcillas de Morella' Formation, in the Maestrazgo Basin (Iberian Range, Eastern Spain), is one of the European areas with a greater diversity and abundance of vertebrates from the Lower Cretaceous. So far, representatives of two groups of turtles have been identified. There have been described fragmentary elements of a solemydid taxon closely related to *Helochelydra*, and a complete shell and isolated plates assigned to an indeterminate basal member of Eucryptodira. Two large skulls, one of them preserving the jaw, are presented here. The interpreted character combination cannot be assigned to any taxon known to date. The presence of pterygoid-basioccipital contact and of medial contact of the prefrontals allows its identification as a Eucryptodira (Pancryptodira). Other characters, such as the absence of external process of pterygoids, are exclusively shared by the members of the Trionychoidea (Cryptodira), whose Lower Cretaceous record is poorly known. It shares with members of Trionychia some characters, such as the presence of a closed incisura columellae auris or a tall coronoid, but there are others, such as the presence of medial contact of the pterygoids, that are absent in this group. The cryptodiran skulls from Morella are herein preliminarily considered as the first Trionychoidea members from the Iberian Mesozoic.

Another Lower Cretaceous turtle known from a skull, *Sandownia harrisi*, from the early Aptian of the Isle of Wight (England), has been identified as a member of the Trionychoidea. Both taxa share the presence of a large secondary palate and the sagittal contact of the pterygoids ahead of the basioccipital. However, it differs in many characters, such as the size, the

width/length ratio of the skull, the cranial morphology in lateral view, the relative size of the orbits, the ornamental pattern, and the morphology and arrangement of several skull bones.

Sandownia was considered one of the oldest known cryptodiran turtles. The new Spanish taxon may provide additional insights into the evolution and diversity of this group in the Lower Cretaceous, and probably on the origin and diversity of the Trionychoidea.

Poster Session I (Wednesday, November 2)

SHAKE YOUR TAIL FEATHERS: THE FLAMBOYANT, ATHLETIC, AND POSSIBLY FLIRTATIOUS CAUDAL MORPHOLOGY OF OVIRAPTOROSAURS

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A short series of fused posterior caudal vertebrae, tentatively indentified as a pygostyle, has been previously described in the oviraptorosaurs *Nomingia* and *Similicaudipteryx*. Two additional oviraptorid specimens from Mongolia, plus a second *Nomingia* specimen with a pygostyle, confirms the conclusion that the original was not simply an injury or some other osteological aberration. These new finds show that pygostyles and, by associational inference, tail-tip feather-fans were widespread amongst both advanced and primitive oviraptorosaurs. In addition to pygostyles, oviraptorosaur caudal osteology is unique among theropods and is characterized by a distal transition point, exceptionally wide caudal ribs, and anteroposteriorly short centra. The results of a morphological study indicate a high degree of flexibility across the pre-pygostyle caudal vertebral series. New three-dimensional digital muscle reconstruction techniques reveal that, while oviraptorosaur tails were reduced in length relative to the tails of other theropods, they were more muscular. Critically, the relative size of the *M. caudofemoralis* was maintained in oviraptorosaurs, despite overall caudal length reduction. Similarities between the tails of oviraptorosaurs and birds appear to be convergent and, contrary to previous assertions, provide no evidence that supports the phylogenetic placement of oviraptorosaurs within, or as a sister group to, the Avialae. Combined, these results indicate that oviraptorosaurs had the necessary anatomy to dexterously flaunt their caudal plumage, and that the tails of oviraptorosaurs were uniquely adapted to serve as dynamic intraspecific display structures.

Symposium 1 (Wednesday, November 2, 9:00 am)

COMPARATIVE LIMB RANGE OF MOVEMENT IN THE DEVONIAN TETRAPOD *ICHTHYOSTEGA* AND THE EVOLUTION OF TERRESTRIAL LOCOMOTION

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The origin of tetrapods and the transition from swimming to walking was a pivotal step in the evolution and diversification of terrestrial vertebrates. During this time, modifications of the limbs - particularly the development of joints and the structures that guide their motions - fundamentally changed the ways in which early tetrapods could move. Nonetheless, little is known about the biomechanical consequences of limb anatomy in early tetrapods and how that anatomy influenced locomotor capabilities. We examined the maximum range of movement in the shoulder and hip joint of the Devonian tetrapod *Ichthyostega* and compared it to a broad array of extant aquatic and semi-aquatic animals with distinct modes of locomotion (e.g. amphibians, reptiles and mammals). Joints were modelled in 3D musculoskeletal software, without cartilage or other soft tissue, and segments were articulated in a 'resting' pose. Range of movement was quantified by rotating each joint about its defined flexion/extension, ab/abduction and long axes. The angle of maximum movement was determined by either bone-to-bone contact or joint disarticulation. We address the subjectivity in this method (and in fossils more generally), as well as the potential influence of articular cartilage morphology on joint movement using x-ray studies. Our results show that the shoulder and hip joint of *Ichthyostega* had a reduced range of movement as compared to the extant taxa and that the maximum range of movement in the humerus and femur occurred in opposing directions. In particular, the shoulder joint of *Ichthyostega* exhibited limited movement in flexion, abduction and long axis rotation, while the hip joint was more restricted in extension and adduction. These results suggest that the limb movements, and ultimately locomotion mode, in *Ichthyostega* were distinct from those in extant tetrapods, but that the fore and hindlimbs performed functionally divergent roles similar to extant tetrapods. The degree of walking capabilities in *Ichthyostega* remains to be determined, with further investigation of the elbow and knee joint and the integration of movement parameters from both the appendicular and axial skeleton.

Poster Session I (Wednesday, November 2)

ECOLOGY OF EARLY EOCENE SAN JUAN BASIN, NM *PHENACOLEMUR JEPSENI* WITH *PHENACOLEMUR CITATUS* AND *PHENACOLEMUR PRAECOX* FROM BIGHORN BASIN, WY -A STUDY OF MICROWEAR AND DENTAL VARIATION

PILBRO, Clayton, University of New Mexico, Albuquerque, NM, USA

Phenacolemur was a widespread genus of Plesiadapiformes (primate-like animals) that lived from the late Paleocene to early Eocene of North America and Europe. Members of this genus were small, varying in size from that of a mouse (121 grams for *Phenacolemur jepseni*) to that of a large squirrel (414 grams for *Phenacolemur praecox*). *Phenacolemur* developed enlarged incisors and a reduced dentition. *Phenacolemur* species superficially appear to have a strong similarity in their dental characteristics but with closer observation, it becomes clear that there is significant variation in tooth number, morphology, and dental wear between *Phenacolemur* species. These variations can be interpreted to be adaptations for different diets and evidence of evolutionary adaption to paleo-environments. Teeth are involved in food acquisition and their morphology reflects food acquisition strategy. Using SEM dental microwear analysis, along with dental morphology and statistical analysis, I show distinctions between three of the closely related species (*P. jepseni*, *P. citatus*, and *P. praecox*). These differences in dentition between *Phenacolemur* species reflect differences in diet, and indicate paleo-environmental/evolutionary adaptations in this early primate that permitted closely related (basal and derived) *Phenacolemur* species to live in the same areas of the San Juan Basin, NM and Bighorn Basin, WY concurrently.

Poster Session II (Thursday, November 3)

MIOCENE CHONDRICHTHYANS FROM PANAMA

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During the Miocene, a marine seaway connecting the Pacific Ocean and the Caribbean Sea existed in Panama. Consequently, the Panamanian Miocene marine faunas existed during a time of active transoceanic interchange and dispersal before the time of the full closure of the Isthmus about 4 million years ago. This closure was a key vicariant event for tropical biotic evolution that resulted in increased habitat and biogeographic complexity. Fossil chondrichthyans from Panama are poorly represented in the literature. We have sampled three different Miocene sites from Panama. These include new localities from the well-known Gatun Formation (12-9 Ma) that have been exposed as a result of the Canal expansion project and local quarrying operations. Furthermore, we studied the early Miocene Culebra Formation (21-19 Ma) from the canal area, and the late Miocene Chucunaque Formation (6-7 Ma) from Darien Province. Based on surface prospecting and screen-washing techniques, we have collected more than 1000 isolated teeth and vertebra centra from these three localities. We found high biodiversity including ~ 35 taxa of sharks and batoids. Of these, only six species are extinct, indicating the presence of relatively long-lived taxa. The three sites have similar faunistic compositions, with mixed Pacific and Caribbean affinities. Most of the taxa have a neritic habitat preference (i.e. below the 200 m) in agreement not only with the associated fossil fauna (e.g. mollusks and benthic foraminifera), but also with other shark assemblages of the region. Because of the paleogeography of the area, we interpret the occurrence of some pelagic taxa, particularly in the younger sites, as a result of local changes in circulation patterns. All data suggest that the seaway that was located across the Panamanian isthmus comprised a variety of shallow coastal habitats, including mangrove, estuary, and reef ecosystems.

Poster Session II (Thursday, November 3)

MIOCENE CHONDRICHTHYANS FROM PANAMA

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During the Miocene, a marine seaway connecting the Pacific Ocean and the Caribbean Sea existed in Panama. Consequently, the Panamanian Miocene marine faunas existed during a time of active transoceanic interchange and dispersal before the time of the full closure of the Isthmus about 4 million years ago. This closure was a key vicariant event for tropical biotic evolution that resulted in increased habitat and biogeographic complexity. Fossil chondrichthyans from Panama are poorly represented in the literature. We have sampled three different Miocene sites from Panama. These include new localities from the well-known Gatun Formation (12-9 Ma) that have been exposed as a result of the Canal expansion project and local quarrying operations. Furthermore, we studied the early Miocene Culebra Formation (21-19 Ma) from the canal area, and the late Miocene Chucunaque Formation (6-7 Ma) from Darien Province. Based on surface prospecting and screen-washing techniques, we have collected more than 1000 isolated teeth and vertebra centra from these three localities. We found high biodiversity including ~ 35 taxa of sharks and batoids. Of these, only six species are extinct, indicating the presence of relatively long-lived taxa. The three sites have similar faunistic compositions, with mixed Pacific and Caribbean affinities. Most of the taxa have a neritic habitat preference (i.e. below the 200 m) in agreement not only with the associated fossil fauna (e.g. mollusks and benthic foraminifera), but also with other shark assemblages of the region. Because of the paleogeography of the area, we interpret the occurrence of some pelagic taxa, particularly in the younger sites, as a result of local changes in circulation patterns. All data suggest that the seaway that was located across the Panamanian isthmus comprised a variety of shallow coastal habitats, including mangrove, estuary, and reef ecosystems.

Poster Session I (Wednesday, November 2)

INFERRING LOCOMOTION IN MIOCENE APES: THE FEMUR OF *HISPANOPITHECUS LAIETANUS*

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Locomotion has been one of the spotlights in the study of Miocene apes in recent years. Non-invasive technologies (i.e., CT-scanning) have allowed new ways to infer postural behaviours and locomotor adaptations by means of the internal structure of postcranial remains in extinct species. These techniques are mainly related to the measure of the cortical thickness of long bones, such as the femur or tibia. The femur, especially femoral neck cortical thickness, has traditionally been used as a proxy indicator of fossil primate locomotion, since external morphology and internal structure not only reflect loads of transmission of body mass to the substrate, but also stresses produced during motion and range of movements experienced by the hind limb. For this reason, the internal structure of the right femur of the Late Miocene *Hispanopithecus laietanus*, which belongs to the IPS 18800 partial skeleton (9.5 Ma from Can Llobateres-2, Spain), was analyzed by CT-scanning in this study. CT-slices were taken from both the femoral neck and the diaphysis to quantify cortical thickness and were compared with the cortical bone distribution of extant species. Here we show that cortical thickness in the femoral neck of *H. laietanus* is markedly homogenous and relatively robust supero-inferiorly and antero-posteriorly. Moreover, cross-sections of the proximal diaphysis also show a homogenous distribution of the cortical bone (between medial and lateral halves). Among living taxa, this pattern is comparable with the cortical bone distribution of *Pongo*, suggesting a very important arboreal component in the locomotion of *H. laietanus*, and that it was probably adapted to climbing and suspension. Consequently, and in agreement with previous studies based on external morphology, the internal structure of the femur suggests that suspension constituted an important part of the locomotor repertoire of this taxon. From a phylogenetic point of view, these results tend to confirm the placement of *Hispanopithecus laietanus* in the *Pongo* clade.

Poster Session I (Wednesday, November 2)

EVOLUTION OF HYPSODONTY IN A CRICETID (RODENTIA) LINEAGE: PRELIMINARY RESULTS USING PATCH ANALYSIS

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Hypsodonty is considered to be an adaptive response to cope with the excessive rates of dental wear brought about by a new diet (grazing) in more open and dry environments (grasslands). A number of lineages of rodents underwent a convergent evolution toward increased crown height during the last 20 million years coinciding with the expansion of grass-dominated ecosystems in Eurasia. This work focuses on the evolution of hypsodonty in the cricetid (Muroidea, Rodentia) lineage defined by *Cricetulodon hartenbergeri – Cricetulodon. sabadellensis- Rotundomys montisrotundi – Rotundomys bressanus* during the Vallesian (early Late Miocene) in the Vallès-Penedès Basin (NE Iberian Peninsula). A sample of lower second molars of each species is scanned using a 3D laser scanner. Then, the scans are processed with GIS software which provides orientation maps of the slopes of the occlusal surface. Contiguous points with the same orientation are grouped into a 'patch' that represents a functional structure of the molar crown, so the number of patches relates to dental complexity. This parameter is found to decrease in the lineage coupled with increased crown height. We conclude that this is related to from crown planation and loss of cusp interlocking in *Rotundomys* coinciding with the development of higher-crowned teeth.

Technical Session XVIII (Saturday, November 5, 1:45 pm)

A NEW BASAL CROCODYLOMORPH FROM THE LATE JURASSIC OF PATAGONIA AND ITS IMPLICATIONS FOR THE EVOLUTION OF THE CROCODYLIFORM BRAINCASE

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Crocodyliformes is a group of highly modified archosaurs that achieved a remarkable taxonomic and ecological diversity during the Mesozoic. The sequence of transformations leading from the typical basal archosaurian skulls of "sphenosuchians" to the derived and akinetic skull of crocodyliforms is still poorly understood, with only the late Middle Jurassic Chinese form *Junggarsuchus* providing some information. A new crocodylomorph from the Late Jurassic Cañadón Calcáreo Formation of Patagonia is reported here that is represented by the posterior region of the skull (including a well preserved braincase), and fragmentary remains of the rostrum, palate, mandible, and postcranium. The skull remains bear autapomorphic features (e.g., laterally concave extermal margin of the squamosal and postorbital, large quadrate fenestra) combined with a unique combination of plesiomorphic characters of basal crocodylomorphs (e.g., paired frontals, supraoccipital participating from the foramen magnum, absence of well developed skull table) and apomorphies previously known only in Crocodyliformes (e.g., absence of basipterygoid process, highly pneumatic basisphenoid, posterior closure of otic notch by triple contact of squamosal, quadrate, and otoccipital). A phylogenetic analysis that includes both "sphenosuchians" and representatives of the major lineages of Crocodyliformes depict the new taxon as the closest relative of Crocodyliformes, being closer to this clade than *Junggarsuchus*. The morphology of the braincase of the new taxon coupled with its phylogenetic position reveals that modifications in the articulations of the braincase with both the palate and the quadrate occurred before the origin of Crocodyliformes and therefore predated the remarkable changes in the snout, jaws, and dentition of the phylogenetically more derived crocodyliforms.

Symposium 2 (Wednesday, November 2, 11:30 am)

STANDING UP TO CLIMATE CHANGE: COMMUNITY LOCOMOTOR ECOMORPHOLOGY AND PALEOENVIRONMENT IN THE PLIO-PLEISTOCENE

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Ecological domains are broad geographic areas with coarsely similar macroclimates. While classifications differ in detail, North America has approximately four such domains, each with it's own characteristic pattern of temperature and precipitation. The Polar Domain has no warm season, the Humid Temperate Domain is rainy with mild to severe winters, the Humid Tropical Domain is rainy with no winters, and the Dry Domain is arid regardless of temperature. Macroclimate has an affect on the macrovegetation and, in turn, the animal species that inhabit an area. We showed previously that in mammalian Carnivora, the average locomotor morphology of local faunas is strongly correlated with macrovegetation and ecological province, suggesting that the locomotor morphology of a community or guild can serve as a proxy for macroenvironment.

We tested the usefulness of locomotor morphology as a proxy by using maximum likelihood to estimate the most likely ecological domain for faunas of living North American carnivorans. We measured calcaneum gear ratio (the position of the sustentacular process relative to the length of the calcaneum) in non-marine North American species of carnivoran and measured its mean, standard deviation, skewness, and kurtosis in 8,148 carnivoran faunas sampled at 50 km intervals across North America, from which characteristic distributions of calcaneum gear ratio were extracted for each domain. Cross-validation correctly identified domain in 70.6% of the 50 km faunas.

We used these data to estimate ecological domain of four Pleistocene carnivoran assemblages. The most likely estimates based on the distribution of calcaneum gear ratio for Rancho La Brea (California), McKittrick (California), Friesenhahn Cave (Texas), and Little Box Elder Cave (Wyoming) were all Humid Temperate Domain. While the cross-validation test showed that certain domains can sometimes be difficult to distinguish ecometrically, broad categorization of macroenvironment are feasible based on taxon-free measurements of the locomotor system.

Poster Session II (Thursday, November 3)

MIOCENE - EARLY PLIOCENE CHIMAEROID FISHES (HOLOCEPHALI, CHIMAEROIDEI) FROM CALIFORNIA AND A REVIEW OF THE GLOBAL NEOGENE CHIMAEROID DIVERSITY AND DISTRIBUTION

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A study of unpublished material of Neogene chimaeroid fishes (Chimaeroidei) from California totaling 120 specimens, in the collection of the Natural History Museum of Los Angeles County, shows the presence of 3 genera and species. Both Miocene (Arikareean: Jewett Sand and Vaqueros Formations; Clarendonain: Monterey Formation; Hemphillian: Capistrano Formation) and early Pliocene (Blancan: Capistrano Formation) deposits contain chimaerid (*Hydrolagus* cf. *colliei*) and rhinochimaerid (*Harriotta* cf. *raleighana*) species. Additionally, a single fin spine of *Edaphodon* sp. was earlier published from the late early Miocene (Hemingfordian: Olcese Sand) of the region. The recent chimaeroid association from the North Eastern Pacific consisting of *Hydrolagus colliei*, *Harriotta raleighana* and *Rhinochimaera pacifica* was already established by the early Miocene. The global Neogene chimaeroid assemblage consists of 6 genera (*Callorhinchus*, *Ischyodus*, *Edaphodon*, *Hydrolagus*, *Chimaera*, and *Harriotta*) and about 12 species. *Chimaera deleta* (Miocene of Germany) as well as *Ch. javana* (Miocene, Java) are both regarded as nomena dubia. Other known Neogene chimaeroid associations include ones from Maryland, USA (middle Miocene: *Edaphodon* sp. 1 and *Chimaera* sp.), Chile (middle-late Miocene: *Callorhinchus* sp.), Argentina (Miocene: *Callorhinchus crassus*), Australia (early Miocene: *Ischyodus sweeti*; latest Miocene – early Pliocene: *Callorhinchus* cf. *milii*, *Ischyodus sweeti* and *Edaphodon mirabilis*) and Italy (Pliocene: *Edaphodon pliocenicus, Harriotta* sp. and *Chimaera pliocenica*). There is a differentiation of chimaeroid assemblages in the Northern (*Edaphodon*, *Harriotta, Chimaera*, *Hydrolagus*) and Southern (*Callorhinchus*, *Ischyodus*, *Edaphodon*) Hemispheres. *Callorhinchus* and *Ischyodus* can be traced back to the Southern Hemisphere before the Miocene. It is however possible that chimaerids extended into the Southern Hemisphere only after the early Pliocene.

Poster Session IV (Saturday, November 5)

A 3D SKULL OF *LESOTHOSAURUS DIAGNOSTICUS*: DIGITAL PREPARATION, RECONSTRUCTION AND FEEDING MECHANICS

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Ornithischian dinosaurs evolved a diverse range of feeding strategies to process vegetation. Recent studies on several ornithischian clades have utilized skull morphology, tooth wear, and various modeling methods to better understand cranial and mandibular mechanics, determine jaw movements, and elucidate diet in these dinosaurs. Early ornithischians are often poorly preserved, and some clades (notably the heterodontosaurids) exhibit cranial and dental specializations. In contrast, *Lesothosaurus diagnosticus,* widely recognized as one of the most basal ornithischians, features a primitive skull morphology and dentition, and presumably used simple jaw movements. Although several skulls are known, no single specimen of *L. diagnosticus* preserves a skull which is complete, undistorted, and articulated, and many specimens have yet to be fully prepared, hampering efforts to carry out biomechanical analyses. Using 3D visualization software, CT scans of two *L. diagnosticus* specimens were segmented to identify and separate individual cranial and mandibular bones, revealing new anatomical details (such as sutural morphology and a substantial coronoid process on the mandible) as well as the presence of several previously undescribed elements. Bones from both specimens were scaled appropriately, missing elements were duplicated across the sagittal midline, broken areas were repaired, and cranial and mandibular bones articulated to produce the first 3D reconstruction of the *L. diagnosticus* skull. Reconstruction of the jaw elevator musculature, using both osteological correlates preserved on the specimens and information from related extant taxa, allows bite forces to be calculated and compared to estimates obtained for *Heterodontosaurus* and basal ceratopsians. The 3D reconstruction will serve as the basis for future finite element modeling, producing for the first time a baseline of cranial and mandibular mechanical behavior to which models of more derived ornithischians may be compared.

Technical Session I (Wednesday, November 2, 8:15 am)

VASCULAR ANATOMY AND ITS PHYSIOLOGICAL IMPLICATIONS IN EXTANT AND EXTINCT DINOSAURS AND OTHER DIAPSIDS

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Current evidence indicates that dinosaurs were possibly tachymetabolic animals. But even without elevated metabolic rates, the great size and low surface-to-volume ratios of many dinosaurs would have resulted in elevated heat loads that required efficient thermoregulatory mechanisms. In extant taxa, vascular systems play a key role in such thermal processes as evaporative and convective cooling and basking. Thus, we hypothesize that dinosaurs had vascular physiological devices to deal with heat. To test this hypothesis, dinosaur vascular anatomy is being investigated and characterized by observing dinosaur fossils, using modern CT scanning, and the Extant Phylogenetic Bracket approach. By comparing specimens of extant taxa (turkey, pheasant, alligator, iguana), vascular anatomy was investigated and osteological correlates (OCs) were identified. Similar vascular OCs were identified in fossils and CT data, and the vascular anatomy was restored in a 3D environment using Avizo 6.3 and Maya. The results of our preliminary findings are presented in the Cretaceous abelisaurid *Majungasaurus crenatissimus*, the Cretaceous hadrosaurid *Edmontosaurus regalis*, and the Jurassic sauropod *Diplodocus longus*. The OCs related to the vasculature of the orbit indicate vascular patterns similar to extant archosaurs, with the supraorbital artery anastomosing with the ethmoid artery. Venous drainage of the braincase was found to form an anastomotic loop around the parietal and otoccipital. The nasal vasculature is hypothesized to anastomose with the vasculature of the palate, creating an extensive loop, similar to that displayed in both birds and crocodilians. The presence of a palatal plexus and a narial plexus are both reconstructed in the sample taxa based on their presence in extant taxa and key OCs in the fossils. These preliminary results indicate that study of vascular anatomy in dinosaurs has the potential for further refinement, resulting in a robust model, and, with the inclusion of more taxa, a more accurate picture of the circulatory system and physiology in dinosaurs.

Poster Session II (Thursday, November 3)

CLIMATIC CHANGE AND PLEISTOCENE MAMMAL DIVERSITY IN THE PAMPEAN REGION OF ARGENTINA

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Our knowledge of the fossil mammals from the Pampean Region of Argentina has greatly increased in recent years. To analyze the patterns of changing climates and environments through the Quaternary, we used the fossil record of land mammals as a source of information. The association of mammal diversity with periods of global climatic change is suggestive of a causal relationship. Several authors have proposed a climatic hypothesis to explain mammal diversity changes during the Pleistocene and Holocene. Two of the important aspects to test the climatic model during this interval are the timing and the way in which the diversity patterns occurred, and which climatic variables are used, since different patterns of climatic evolutionary interactions would be expected depending on what variables are used. In order to analyze the relationship between climate change and faunal events, we need to establish a set of comparable data. By splitting climatic change as revealed in deep ice cores from the Antarctic into a number of distinct variables and examining the relationship of each one to changes in mammal diversity and turnover, it is possible more accurately investigate the effect of climatic changes on faunal events. Climatic stability was measured in these analyses in terms of cycles per unit of time, the amount of variation in temperature per unit of time, and the magnitude of change between the modal temperature of one interval less the modal temperature from the preceding interval. The data presented here suggest that the primary effect of climatic change is on the levels of extinction of large mammals and diversity of small mammals.

Technical Session XII (Friday, November 4, 3:45 pm)

A LITTLE BIRD TOLD ME: WETLANDS DOMINATED THE PLIO-PLEISTOCENE LANDSCAPE (LOWERMOST BED II DEPOSITS, ~1.75MA) AT OLDUVAI GORGE, TANZANIA

PRASSACK, Kari, CHES/Rutgers University, New Brunswick, NJ, USA

Fossil birds are used here to reconstruct the Pliocene-Pleistocene landscape (Lowermost Bed II (LMBII), ~1.75Ma) at Olduvai Gorge, Tanzania. These birds come from small-scale, landscape archaeology style trench pits that were excavated by the Olduvai Landscape Paleoanthropology Project (OLAPP). Excavations covered an area of ~4km leading out from the eastern extent of paleo-Lake Olduvai. These resulting paleontological and archaeological data provide a unique opportunity to assess landscape scale habitat variability at this early hominin site. Of the approximately 900 avifaunal specimens recovered, 136 could be identified to the level of genus. The majorities of specimens are of extant wetland or water taxa, many of which occur in East Africa today. Cormorants are most common (58%) and represented by at least three species. There are eight genera of anatids and four of rallids, in addition to grebes, flamingos, and pelicans. The distribution of these birds differ in ways that suggest deep water marsh/swamp lands were widespread, but interspersed with areas of higher ground capable of supporting nesting and roosting trees. Fossil birds can provide paleoenvironmental data on a fine spatial scale, especially at Olduvai, where primarily extant birds occur. Many of the taxa described here provide important paleo-environmental and ecological information that will greatly aid in interpreting changes in early hominin land usage at Olduvai. For example, these birds point to locations where potable water, safety trees, and food resources, such as water lilies and bird nests, may have occurred. This is the first study to use fossil birds to reconstruct the LMBII landscape and to help understand hominin land use for this time period at Olduvai.

Poster Session IV (Saturday, November 5)

USING SUBADULT SPECIMENS FOR PHYLOGENETIC INFERENCE IN HADROSAUROID DINOSAURS: *BACTROSAURUS* (LATE CRETACEOUS OF CHINA) AS A CASE STUDY

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Understanding ontogenetic variation is crucial in phylogenetic inference. Characters that are ontogenetically variable need to be distinguished from those containing diagnostic and phylogenetic information. In the case of hadrosauroid dinosaurs, a substantial proportion of their rich fossil record consists of subadult specimens, allowing for detailed analyses of ontogenetic variation in the skull and postcranial skeleton. Here, I evaluate the extent to which subadult material in hadrosauroids may be a reliable source of phylogenetically informative characters. Growth changes are documented in an extensive sample of cranial and postcranial elements of the basal hadrosauroid *Bactrosaurus johnsoni* (Late Cretaceous of northern China). The following characters, previously used for estimating hadrosauroid interrelationships, are variable ontogenetically: development of the annular ridge; position of the maxillary dorsal process; slope of the dorsal margin of the maxillary rostroventral process; curvature of the ventral margin of the jugal; ventral expansion of the posteroventral flange of the jugal; curvature of the caudal margin of the quadrate; length/width proportions of the predentary; dorsoventral depth of the anterior predentary surface; number of denticles on the oral predentary margin; deflection of the ventral margin of the dentary; curvature of medial margin of the surangular; dentary and maxillary tooth count and number of teeth per alveolus; development of the deltoid ridge of the scapula; lateroventral expansion of the humeral deltopectoral crest; overall length/width proportions of the humerus; length/dorsoventral thickness ratio of the ulna; and depth of the proximal region of the preacetabular process of the ilium. Most other characters preserved in *Bactrosaurus* do not change ontogenetically. This study suggests that, at least for *Bactrosaurus johnsoni* (and perhaps in basal hadrosauroids in general), most characters used for estimating hadrosauroid relationships are not affected by ontogeny. Therefore, subadult material may provide a substantial amount of reliable information for phylogenetic inference in these animals.

Poster Session II (Thursday, November 3)

THE PALATE AND BRAINCASE IN GONIOPHOLIDID CROCODYLIFORMS: INSIGHTS FROM A NEW SKULL OF *EUTRETAURANOSUCHUS DELFSI*

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Goniopholidids are a group of Laurasian basal neosuchians that were common in the Jurassic and Early Cretaceous. With long snouts and sprawling gaits, goniopholidids occupied a semiaquatic carnivorous niche currently allocated to crocodylians. Some species of Asian and North America goniopholidids possess a partially-incomplete secondary palate, a unique condition among neosuchians. Despite a phylogenetic position critical for understanding

neosuchian origins and highly unusual palatal conditions, the cranial osteology of a goniopholidid has not been fully described.

A well-preserved, complete skull of the North American goniopholidid *Eutretauranosuchus* (AMNH 570) is described. The skull was subjected to CT scans, which revealed a well-preserved palate and braincase.

As in *Calsoyasuchus valliceps*, *Amphicotylus* spp., and other specimens of *Eutretauranosuchus*, the secondary palate in AMNH 570 is incompletely formed, with the palatal processes of the palatines approaching but not contacting one another in the midline. As in *Calsoyasuchus*, the anteriormost portion of the open trough exposes the primary choana. Posteriorly the vaulted nasopharyngeal passage is exposed ventrally, as in primitive crocodyliforms (e.g. *Orthosuchus*). A complex septal complex divides the nasopharyngeal passage in the midline. Bilateral vomeral laminae divide the passage anteriorly. At the anterior margin of the suborbital fenestra, the vomeral laminae diverge to fit around a midline pterygoid-derived septum.

Dorsoventral crushing has distorted certain braincase elements, such that the rostrum of the parabasisphenoid is somewhat dorsally displaced. However, most of the elements are preserved in anatomical position. The capitate processes of the laterosphenoid are transversely broad and the laterosphenoid bridge is angled ventromedially, resembling the condition in *Gavialis*.

Incorporation of AMNH 570 into a phylogenetic analysis recovers the specimen in a clade of derived goniopholidids including *Amphicotylus*, *Calsoyasuchus*, *Eutretauranosuchus*, and *Sunosuchus*. Such a position is congruent with the unique palatal morphology shared among these animals.

Poster Session III (Friday, November 4)

A NEW SPECIES OF THE PECCARY *MACROGENIS* FROM THE LATE CLARENDONIAN (LATE MIOCENE) BLACK HAWK RANCH LOCALITY, CONTRA COSTA COUNTY, CALIFORNIA

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Numerous nearly complete skulls and jaws in the University of California Museum of Paleontology collections from Black Hawk Ranch (near Mt. Diablo) pertain to a new species of *Macrogenis*, a diverse genus of late Miocene peccaries. The Black Hawk Ranch fauna, recovered from a large quarry in the Sycamore Formation, has been paleomagnetically dated as latest Clarendonian (9.0-9.5 Ma). The new species is referable to the *Macrogenis-Tayassu* clade, but is distinguished by its broad dentary and cheek teeth. In addition, it is distinct from other species in lacking a contact between the maxillary and the suborbital bulla, which is anteriorly narrower, and a narrow tympanic process. The prominent facial crest extends anteriorly over the rostral muscle fossa, but is not as wide and flaring as the facial-zygomatic crests of other late Miocene *Macrogenis* species. This taxon is one of numerous species of *Macrogenis* from the late Clarendonian, including an additional newspecies from Love Bone Bed in Florida, from *Machaerodus* Quarry in Nebraska, and *Leptarctus* Quarry in Nebraska. The high diversity of peccaries at this time is largely a function of their diverse array of facial-zygomatic crests in males.

Technical Session XVI (Saturday, November 5, 11:30 am)

CRANIAL ANATOMY OF A PRIMITIVE OSTEICHTHYAN *PSAROLEPIS* BASED ON HIGH-RESOLUTION COMPUTED TOMOGRAPHY

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Psarolepis, from Upper Silurian and Lower Devonian strata of China and Vietnam, exhibits a unique character combination for the understanding of the origin and early evolution of osteichthyans. Together with other primitive osteichthyans (e.g., *Ligulalepis, Dialipina, Achoania, Meemannia* and *Guiyu*), *Psarolepis* provides a morphological link between osteichthyans and non-osteichthyan groups, and highlights a possible morphotype for the common ancestor of actinopterygians and sarcopterygians. Based on high-resolution computed tomography and three-dimensional digital reconstructions, here we present the internal morphology of the braincase of *Psarolepis*, and provide many informative features previously unrecognized among primitive osteichthyans. Shared with basal chondrichthyans and placoderms, *Psarolepis* has the forebrain cavity (housing telencephalon and diencephalon) close to the ventral floor of the neurocranium, a short prehypophysial portion of the sphenoid, and a shallow hypophyseal fossa. A pair of canals arising from the anterior extremity of the cerebral cavity and passing anterolaterally to the nasal capsule might represent separate canals for the terminal nerve, as in the placoderms *Brindabellaspis* and *Latocamurus*. Other possible plesiomorphic gnathostome features shared with many placoderms include large nasal capsules, short olfactory tracts, short and broad telencephalon, elongate mesencephalon, and an anteriorly-positioned optic nerve root. These new anatomical data will have a broad impact on osteichthyan phylogeny and character evolution, although they need to be tested within a rigorous cladistic analysis.

Poster Session II (Thursday, November 3)

WHAT IS A PORE-CANAL SYSTEM?

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Traditionally, the pore-canal system is described as a structure that forms part of the so-called 'cosmine' characterizing early lobe-finned fishes. There are two main defining characteristics of the system: (1) it lies in the dentinous upper part of the dermal bone or scale and opens onto the outer surface; and (2) the pore-cavities are connected by horizontal 'Maschenkanäle'. This terminology has long been confined to lobe-finned fishes, although disagreement exists for its function. Even though in many primitive actinopterygian taxa, scattered small openings have been frequently reported to exist on the surface of dermal bones and scales, they are called 'small vascular openings'. This is partly because the covering tissues on dermal elements of actinopterygians and sarcopterygians are considered different (ganoine vs. cosmine), and also because detailed work to reconstruct the canal system in actinopterygians is missing.

Here we report the 3D reconstruction of the canal system in the trunk scales of three early osteichthyan taxa: *Lophosteus, Andreolepis* and *Psarolepis*. *Psarolepis* is considered a basal sarcopterygian, and a true 'pore-canal system' exists in the scale. Comparison with the canal systems in *Lophosteus* and *Andreolepis* shows many similarities. Each of them possesses a well-developed horizontal canal-system just above the bony tissue, although in *Psarolepis* it is much more regular than in the other two taxa. In addition, *Psarolepis* has a connected, weakly developed and less regular canal system at a slightly deeper level within the bone. This thin layer may correspond to the thicker spongia layer in crown sarcopterygians, such as *Porolepis*. The horizontal canal system, which we argue is part of the vascularization of the scale, is most likely homologous across early osteichthyans. The use of phylogenetically restrictive but poorly defined terminology like 'pore-canal system' should be avoided, and focus should be placed instead on reconstructing the canal architecture in different taxa to identify phylogenetically informative characters.

Poster Session III (Friday, November 4)

THE FIRST MAJOR VERTEBRATE FOSSIL FROM THE PLIOCENE OF ICELAND: AN ODONTOCETE (CETACEA: ODONTOCETI) FROM THE TJÖRNES FORMATION

RACICOT, Rachel, Yale University, New Haven, CT, USA; FIELD, Daniel, Yale University, New Haven, CT, USA; VINTHER, Jakob, Yale University, New Haven, CT, USA; BEHLKE, Adam, Yale University, New Haven, CT, USA; GAUTHIER, Jacques, Yale University, New Haven, CT, USA

Toothed whales (Cetacea: Odontoceti) are a disparate and species-rich group. Despite their diversity, including ranges that extend into the northernmost Atlantic Ocean, their fossil record in that region is largely enigmatic. Field exploration of the early Pliocene Tjörnes Formation in northeastern Iceland revealed the partial skull of an undescribed odontocete. The Tjörnes formation includes near-shore and terrestrial deposits that alternate with lava flows. A new age model for the outcrops was recently determined using palynological and paleomagnetic analyses, constraining the sections to 4.5-4 million years old. The fossil discovery is important both in terms of exploring the evolutionary history and biogeography of cetaceans in the North Atlantic, and the fossil record of Iceland itself. The specimen represents the northernmost occurrence of a Pliocene odontocete, bringing the fossil record into closer agreement with modern distributions. As a volcanic island, fossiliferous strata containing vertebrates are uncommon in Iceland, thus this specimen represents both a unique discovery and an opportunity to contribute to our understanding of the former biodiversity of the North Atlantic. In addition, this is the first major fossil vertebrate from the Pliocene of Iceland, and implies promise for the discovery of a more extensive fauna in the region.

Poster Session II (Thursday, November 3)

STASIS IN THE LATE PLEISTOCENE GROUND SLOTHS (*PARAMYLODON HARLANI*) FROM RANCHO LA BREA TAR PITS, CALIFORNIA

RAYMOND, Kristina, East Tennessee State University, Johnson City, TN, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA

Stasis in Pleistocene mammals in the face of climatic change during the glacial-interglacial cycles has been widely documented. We examined the size and shape changes of the bones of common large ground sloth, *Paramylodon harlani*, from Rancho La Brea. We measured multiple dimensions of most of the adult unbroken astragali, patellae, and the major limb bones; only the astragali, patella, and radii were abundant in enough well dated pits for analysis. In every dimension, these bones show stasis in linear dimensions, as well as in robustness of limb elements. Statistical analysis by ANOVA confirmed that the means of all the temporally sequential samples were not significantly different from each other, so stasis prevails. These results, together with those of every common large bird or mammal from

Rancho La Brea, show that stasis prevailed in the region from 35,000 to 11,000 years ago, despite climate changes that caused the region to go from oak-chaparral at 35 ka, to closed-cone snowy piñon-juniper forest at peak glacial 21 ka, and then back to oak-chaparral-sage scrub vegetation over the past 10,000 years.

Technical Session VIII (Thursday, November 3, 3:30 pm)

A NEW DISSOROPHID TEMNOSPONDYL FROM THE LOWER PERMIAN OF OKLAHOMA

REISZ, Robert, University of Toronto Mississauga, Mississauga, ON, Canada; FRÖBISCH, Nadia, Museum für Naturkunde Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin, Berlin, Germany

The Dolese Brothers limestone quarry near Richards Spur, Oklahoma is well known for the preservation of the richest assemblage of dissorophoid amphibians, including the diminutive *Doleserpeton annectens* and *Pasawioops mayi,* the moderately sized *Cacops morrisi,* and the spectacularly large *Acheloma dunni.* There is evidence of additional dissorophoid taxa being present in the fissure fills because of the presence of dermal armor that is attributable to *Dissorophus* and *Aspidosaurus.* Here we report on the discovery of yet another dissorophid on the basis of a well-preserved skull that is similar in morphology to *C. morrisi*. The new dissorophid is characterized by the relatively low profile of the skull, dorsally located orbits, a sculpturing pattern consisting of radiating ridges and grooves, and an L-shaped, narrow opening in the tympanic embayment. It differs from *C. morrisi* in the absence of a lateral exposure of the ectopterygoid (LEE) in juveniles, the lack of a sutural contact between the prefrontal and the lateral exposure of the palatine (LEP), the lack of a sutural contact between the LEP (or LEE) and the jugal. It also differs from *C. morrisi* in having a small posterior process of the postorbital that contacts the supratemporal, the presence of an ectopterygoid fang, and in the shape of the basal plate of the parasphenoid, which is anteroposteriorly elongated and laterally flaring. Phylogenetic analysis of 14 dissorophoid taxa and 54 cranial characters resulted a single most parsimonious tree, and yielded a sister-taxon relationship between this new dissorophid and *Cacops morrisi.* The new dissorophoid thus falls within a clade of species of *Cacops*, allowing us identify it as a new species of the genus. The new Richards Spur *Cacops* species highlights the morphological diversity of species within this enigmatic genus, with variation surrounding a distinct cranial morphology.

Poster Session IV (Saturday, November 5)

GEOGRAPHIC EXTENT OF THE BARSTOW FORMATION, CENTRAL MOJAVE DESERT

REYNOLDS, Robert, consulting paleontologist, Redlands, CA, USA; MILLER, David, U.S. Geological Survey, Menlo Park, CA, USA; WOODBURNE, Michael, Professor emeritus, UC Riverside, Riverside, CA, USA; ALBRIGHT III, L., University of North Florida, Jacksonville, FL, USA

A sequence of marker beds is recognized in the lower Barstow Formation in the central Mojave Desert. The consistent lacustrine sequence includes (upward) beds of stromatolitic limestone, brown platy limestones, and a horizon rich in strontium sulfate and borate minerals. Where it has been dated, the marker bed sequence represents approximately 0.8 million years of deposition. The sequence can be followed from outcrops east of Barstow in the southern Cady Mountains, at Harvard Hill, westerly through Daggett Ridge, Stoddard Valley, Calico Mountains, Lenwood, and into the type section of the Barstow Formation at the Mud Hills. Recent identification of the Peach Spring Tuff (PST, 18.8 Ma) in several Barstow Formation stratigraphic sections relative to the marker sequence shows that the time of deposition of the marker sequence varies considerably, generally younging from east to west. These data allow preliminary interpretation of the extent and time of deposition within the early Miocene Barstow basin and the age of the fossil faunas from the Barstow Formation. Previously described Hemingfordian NALMA faunas and transitional He/Ba faunas in the Toomey Hills and along Daggett Ridge can now be correlated with the lithostratigraphy of the Miocene Barstow Basin. The term "Barstow Formation" has been applied to areas where the marker sequence has not been located, such as the Alvord Mountains and the Gravel Hills. It is not yet clear whether this is caused by facies changes or represents limits of the Barstow depositional basin

Poster Session II (Thursday, November 3)

THE MAKING OF THE AGE OF MAMMALS: A BEHIND THE SCENES LOOK AT EXHIBIT PREPARATION AND DISPLAY

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The new Age of Mammals exhibit at the Natural History Museum of Los Angeles County showcases Cenozoic fossils in a new light. Over 120 vertebrate fossil specimens are used to tell the stories of how continents move, climates change, and mammals evolve. The expertise of museum curators, fossil preparators, and design professionals brings to life mounted skeletons, isolated elements, fossil replicas, and touch specimens in a dynamic and interactive setting. Laboratory work spanned over three years to prepare, repair, mount, and cast fossil specimens. The preparation and mounting process of our juvenile sperm whale, *Aulophyseter morricei*, and the new desmostylian, Paleoparadoxiidae, highlight some of the challenges and achievements of the exhibit. In addition to selecting specimens and providing the intellectual framework, museum curators and consultants were responsible for label copy, design, illustration, multimedia, fabrication, mounting, and installation. The exhibit, Age of Mammals, received outstanding reviews from a wide variety of media outlets.

Poster Session I (Wednesday, November 2)

PLESIOSAUR BODY SHAPE AND ITS IMPACT ON STABILITY

RICHARDS, Courtney, Marshall University, Huntington, WV, USA; O'KEEFE, F., Robin, Marshall University, Huntington, WV, USA; HENDERSON, Donald, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Despite the variability of cross-sectional body shape within Plesiosauria, its impact on plesiosaur stability has never been investigated. This study focused on *Tatenectes*, *Cryptoclidus*, and *Muraenosaurus* due to their variable body morphologies. The objective was to create accurate body shape reconstructions for the three plesiosaur genera and use these reconstructions to understand how plesiosaur cross-sectional body shape impacted stability. The reconstructions were created based on measurements and photographs taken from fossil remains. The vertebral columns were articulated using photographs of the vertebrae and the angles at which the ribs, gastralia, pectoral girdles, and pelvic girdles articulate with the spine were measured to ensure that the body depth and width were correctly reconstructed. In addition to creating reconstructions, measurements were taken from each vertebra to see if there is a correlation between centrum shape and spinal curvature. The most rhomboidal vertebrae are associated with the areas of the greatest degree of spinal curvature, while less rhomboidal vertebrae are associated with flatter areas of the vertebral column and areas where the curvature is gradual. In contrast to the condition seen in Primates, plesiosaur spinal curvature was not shown to be associated with wedging of the vertebrae. Computer models based upon the skeletal reconstructions were run through a software program that tests the ability of animals to passively return to equilibrium following a lateral roll. For the computer models, *Muraenosaurus* was replaced with *Thalassomedon*, which had a similar morphology. *Tatenectes* and *Cryptoclidus* recovered from a lateral roll quickly, with 10 and 12 cycles respectively, while *Thalassomedon* required 25 cycles to recover. The findings suggest that the more stable, dorsoventrally compressed plesiosaurs such as *Tatenectes* and *Cryptoclidus* would have been shallow-water, bottom feeders and the less stable, laterally compressed genera, such as *Thalassomedon* and *Muraenosaurus* would have been deep-water, pelagic feeders.

Poster Session II (Thursday, November 3)

A MID-CARBONIFEROUS CHONDRICHTHYAN BRAINCASE FROM THE PEAK DISTRICT OF DERBYSHIRE, UK

RICHARDS, Kelly, University of Cambridge, Cambridge, United Kingdom; CLACK, Jennifer, University of Cambridge, Cambridge, United Kingdom

A micro-CT scanned chondrichthyan braincase from the Peak District of Derbyshire, UK, is described. The braincase consists of multilayered prismatic calcified cartilage and resembles that of *Cobelodus* in the short otico-occipital region and the prominence of the posterior dorsal fontanelle, however several features preclude this diagnosis including, a raised lateral dorsal aortal path, the presence of paired buccal-hypophyseal fenestrae and relatively large postorbital processes. The braincase has undergone slight lateral distortion as well as late taphonomic disarticulation due to matrix fracture, therefore the braincase is reconstructed *in silico*. Spatially associated with the specimen are two spines and a number of teeth unidentified from scanning

The specimen was collected from the Shaw Engine Mine spoil locality, and represents the first documented skeletal chondrichthyan remains from Derbyshire, or indeed, England. The black limestone matrix is Viséan in age, and is broadly contemporaneous with the Bearsden deposits of Scotland and the Bear Gulch deposits of Montana. The unit stratigraphy is inaccessible due to the loss of historical records, but the matrix is rich in vertebrate, invertebrate and plant remains including: chondrichthyan dermal denticles and teeth, acanthodian scales, actinopterygian scales and teeth, conodont elements, ammonoid buccal elements, brachiopods, ostracods and microconchid tube worms.

Palaeozoic chondrichthyan braincases are extremely rare and difficult to prepare manually, *in silico* visualisation and description of this specimen adds weight to previous arguments of character polarity and challenges possible juvenile characters.

Poster Session I (Wednesday, November 2)

THE DERMAL SCALES OF *TIKTAALIK ROSEAE*

RICHTER, Martha, Natural History Museum, London, United Kingdom; DAESCHLER, Ted, Academy of Sciences, Philadelphia, PA, USA; SAMSON, Ivan, University of Birmingham, Birmingham, United Kingdom; SHUBIN, Neil, University of Chicago, Chicago, IL, USA

The origin of tetrapods and the 'fish-tetrapod' transition remains an area of active research. Transitional forms exhibit a mosaic of anatomical features that relate to respiration, locomotion, feeding and sensory systems. Previous studies of the squamation of various sarcopterygian fishes have demonstrated a high degree of homoplasy, hindering the codification of dermal scales characters within phylogenetic studies. *Tiktaalik roseae* is a 375 million year old finned sarcopterygian that is currently considered the sister group to limbed forms based on a suite of characters related to many of the palaeobiological traits referred to above. Here we examine the dermal scales of *T. roseae* and compare their morphology and histology with that of other Late Devonian sarcopterygians from the Fram Formation in Arctic Canada and the Catskill Formation in Pennsylvania, USA, as well as with osteoderms (epidermal scales) of extinct stem tetrapods and living amphibians. A sample of the squamation in the holotype of *T. roseae* was utilized for micro-CT scan studies and some scales were thin-sectioned for histological description. The scales of *Tiktaalik* are rhombic, thick and ornamented with regular round tubercles, and the base is undulating. They articulate with each other through

an overlapping surface. The scales are entirely made of cellular bone, presenting a basal layer of lamellar bone, trabecular bone in the middle of the scale and a compact bone layer forming the ornamental tubercles. Primary osteons and resorption lines are abundant in the trabecular layer with relatively large canals crossing the scales both basely and superficially.

Technical Session I (Wednesday, November 2, 11:00 am)

A BASAL THYREOPHORAN (DINOSAURIA, ORNITHISCHIA) FROM AFRICA CLARIFIES THE EARLY EVOLUTION OF ARMORED DINOSAURS

RIDGWELL, Nicole, University of Chicago, Chicago, IL, USA

Basal thyreophoran phylogeny has been limited to three genera, *Scutellosaurus*, *Emausaurus*, and *Scelidosaurus*. This phylogenetic transition - from bipedal basal ornithischians to quadrupedal and elaborately armored eurypodans - is clarified by a new taxon from the Tiourarén Formation of Niger. Cladistic analysis places the African thyreophoran between *Scutellosaurus* and *Scelidosaurus*. At present there is not enough data to resolve the relationship of the taxon with *Emausaurus*. One feature unites the African thyreophoran with *Scelidosaurus* and eurypodans. Although the preacetabular process is narrow in *Scutellosaurus*, in the new taxon, it twists into a horizontal plane and expands transversely towards its distal end. More derived thyreophorans are characterized by an overall transverse widening of the ilium. The widening seen in the new taxon is the beginning of this trend. The dermal armor on the new taxon are proportionately larger than in *Scutellosaurus*, and more similar to that in *Scelidosaurus*; the largest pieces are approximately three to four times the length of the vertebrae. The armor is also more complex and includes a wider variety of forms, including rhomboidal scutes, long and narrow scutes without an expanded base that posses a slight lateral curve, and a least one scute that has a sutured edge for contact with another scute. Other features suggest that this taxon is more basal than *Scelidosaurus*. As in *Emausaurus* and basal ornithischians, the antorbital fossa is large. In *Scelidosaurus* and other more derived thyreophorans, the transverse processes of the dorsal vertebrae extend dorsolaterally, but in our taxon and in other more basal taxa, they extend horizontally. The dorsal margin of the ilium, although widened anteriorly, is elsewhere narrow compared with the condition in *Scelidosaurus*. The taxon is probably an obligate quadruped, the earliest positive evidence of this posture among thyreophorans. The humerus, femur, and tibia are approximately the same length. Obligate quadrupedality, thus, appears to have evolved first among early thyreophorans of small body size and is not a consequence of body size increase.

Technical Session IV (Wednesday, November 2, 3:15 pm)

INTERNAL AIRWAY MORPHOLOGY AND SOUND PRODUCTION IN PLEISTOCENE GIANT BEAVERS

RINALDI, Caroline, University of Missouri-Kansas City School of Medicine, Kansas City, MO, USA; MARTIN, Larry, University of Kansas Natural History Museum and Department of Ecology and Evolutionary Biology, Lawrence, KS, USA; TIMM, Robert, University of Kansas Natural History Museum and Department of Ecology and Evolutionary Biology, Lawrence, KS, USA; COLE III, Theodore, University of Missouri-Kansas City School of Medicine, Kansas City, MO, USA; KUMAR, Vandana, University of Missouri-Kansas City School of Dentistry, Kansas City, MO, USA

The skull of an adult Late Pleistocene giant beaver, *Castoroides ohioensis*, from eastern Kansas was studied using high resolution cone-beam computed tomography (CT). CT scans and 3D reconstructions reveal unique internal airway morphology, not known in any other mammal. The internal nares are divided into dorsal and ventral passageways. Posteriorly, the dorsal passageway is continuous with the mesopterygoid fossa, a ladle-shaped depression in the basisphenoid. Anteriorly, the dorsal passageway is continuous with the nasal cavity and the external nares. The ventral passageway is continuous with the nasopharynx, but terminates anteriorly superior to the incisive foramina. The dorsal and ventral passageways are connected by a narrow cleft that runs most of the length of the superior aspect of the ventral passageway. The cleft measures 2.8 mm wide at the anterior end, 2.0 mm wide at the midpoint, and narrows posteriorly until it closes just anterior to the posterior opening of the ventral passageway. Based on its expanded pterygoid fossae, the pterygoid muscles were greatly enlarged in the giant beaver, relative to the Recent beaver, *Castor canadensis*. It is likely that this expansion of the pterygoids played a role in the origin of the airway subdivisions. The expansion of the internal pterygoid fossae resulted in the palatine bones meeting at the midline and the creation of dorsal and ventral subdivisions of the internal nares. In *Castoroides ohioensis*, this subdivision continued into the elongated dorsal and ventral passageways. The ventral passageway became available for a function different from respiration. When air was forced through the narrow cleft into the dorsal passageway and nasal cavity, there would have been a significant change in velocity, called the Venturi effect, possibly creating sound. Production of vocalizations might have allowed giant beavers to communicate with conspecifics up and down Pleistocene rivers, as has been described in the modern hippo.

Poster Session III (Friday, November 4)

FIRST OCURRENCE OF ANTHRACOTHERES (ARTIODACTYLA, ANTHRACOTHERIIDAE) FROM THE EARLY MIOCENE OF CENTRAL AMERICA.

RINCON, Aldo, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; JARAMILLO, Carlos, Smithsonian Tropical Research Institute, Panama, Panama

Anthracotheres are medium to large-sized piglike mammals known from the early Eocene through late Pliocene of Eurasia, Africa, and North America. The last North American anthracothere, early Miocene *Arrethoterium*, is thought to have been derived from Eurasian *Elomeryx*. While anthracotheres are well known from the tropics of Africa and Asia, they have been absent from the tropical record of the New World. Here we describe an anthracothere specimen from the Early Miocene Las Cascadas Formation from Panama including a juvenile left dentary with Dp1-m2, associated i2-3, an astragalus, and an isolated partial upper canine. A second individual is represented by a partially preserved posterior part of the skull and a badly crushed left M3. The Panamanian anthracothere is similar to the bothriodontine *Arrethoterium acridens* from the Early Miocene Toledo Bend Local Fauna in having: 1) extremely high, triangular pointed cusps on m1-m2; 2) upper canine transversally compressed and pinched into a carina; 3) preprotocristid reaching the lingual margin of the lower molars; and 4) a reduced dp2-dp3 diastema. It differs from *A. acridens* in having isolated crescents on the lower molars and from *Arrethoterium fricki* from the Hemingfordian of South Dakota in having a deeper and more robust dentary, no mesostylid on the lower molar, and larger body size. In fact, the Panamanian anthrocothere is most similar to Oligocene *Elomeryx* based on the presence of laterally compressed lingual cusps on the lower molars. The second individual is tentatively referred to *cf. Arretotherium* based on the dimensions and restricted morphology present on the LM3. If our identification of the *Elomeryx*-like taxon is correct, this would suggest that primitive bothriodontines entered Central America in the late Oligocone where the would have persisted into the early Miocene even after they disappeared at higher latitudes. Discovery of more complete fossils from the Panama Canal, including upper dentitions, would be critical for further evaluating this hypothesis.

Poster Session IV (Saturday, November 5)

A NEW CAMPANIAN VERTEBRATE LOCALITY FROM NORTHWESTERN COAHUILA, MEXICO

RIVERA-SYLVA, Hector, Museo del Desierto, Saltillo, Mexico; HEDRICK, Brandon, University of Pennsylvania, Philadelphia, PA, USA; GUZMAN-GUTIERREZ, Ruben, Secretaria del Medio Ambiente, Aguascalientes, Mexico; GONZLEZ, Artemiza, UANL, Linares, Mexico; DODSON, Peter, University of Pennsylvania, Philadephia, PA, USA

We present a new vertebrate assemblage in the Campanian Aguja Formation of northwestern Coahuila, Mexico. The assemblage comprises both freshwater aquatic and terrestrial elements analogous to other coeval localities further north. Centrosaurine ceratopsians and hadrosaurines make up the known dinosaurian terrestrial biota of the assemblage. The centrosaurine appears to be diagnostic based on numerous cranial and postcranial elements, thus marking the first diagnosable centrosaurine from Mexico. The giant hadrosaurines, are known here from disarticulated, but complete long bones, including a tibia more than 1.2m in length. The hadrosaurine elements occur both above and below the centrosaurine bed in the section suggesting several depositional events. In addition, there is evidence of trionychid turtles as well as crocodilians referred to *Deinosuchus*, both of which are present as surface material. The presence of trionychids gives evidence supporting a large, coherent freshwater system with low energy river sections. Trionychids are known to prey on fishes and other vertebrates as well as a variety of invertebrates, the presence of which will be explored in future investigations using screen-scanning techniques. *Deinosuchus* sp. is suggested to have been part of the system based on large crocodilian teeth. Interestingly, there is a distinct lack of microfossils at the site, with several crocodilian teeth and one possible tyrannosaurid tooth making up the entirety of the tooth microfauna.

Lithology, sedimentology, and geomorphology confirm the presence of a series of depositional events of alternating sandstone and sandy mudstone facies with a diverse fauna including dinosaurs, cryptodirans, and crocodilians occurring at multiple horizons. The freshwater system was situated on a coastal plain, which drained as a delta into the paleo Gulf of Mexico. Future surveys will yield more material for a detailed reconstruction of the local habitat types of the system as well as the entire extent of the system geographically and temporally.

Poster Session II (Thursday, November 3)

THE COOPER CENTER: A NOVEL PARTNERSHIP FOR THE MANAGEMENT OF PALEONTOLOGICAL RESOURCES

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Paleontological mitigation in Orange County, California, over the past 35 years has resulted in an enormous collection of fossils spanning the Jurassic through Recent time, including particularly significant collections of Miocene marine mammals. The John D. Cooper Center has been established as a curational facility through partnership of the County of Orange and California State University, Fullerton. This novel relationship will allow for the establishment of a consistent and effective management and research program that will benefit students of Cal State Fullerton, the citizens of Orange County, and the paleontologi-

cal community. The goals for the Cooper Center are to begin processing the large backlog of unprepared fossil material, to bring the collection up to modern curation standards, and to reduce overcrowding that prevents the accessioning of any new collection material. The bulk of this effort will require the support of students and volunteers, through community involvement and the development of a vertebrate paleontology program at Cal State Fullerton. This unique partnership may serve as a template for the management of other collections in the future.

Preparators' Session (Thursday, November 3, 10:15 am)

THE PREPARATION OF YPM 57103, A CASE STUDY

ROACH, Brian, Yale Peabody Museum, New Haven, CT, USA; FOX, Marilyn, Yale Peabody Museum, New Haven, CT, USA; BHULLAR, Bhart-Anjan, Harvard University, Cambridge, MA, USA

In 2005, a Yale Peabody Museum team working in the Triassic Chinle Formation of Utah's Grand Staircase - Escalante National Monument excavated the complete, articulated skeleton of an as yet undescribed 1.5 meter long crocodylomorph. This case study will describe the preparation of this specimen; the materials and methods used in its preparation and its molding and casting, and why these were chosen. It will also describe the challenges presented by abundant calcium-carbonate concretions, the need to work the matrix block from two sides, and repairs necessitated by damage from a water leak while in the preparation lab. Because the specimen is both fragile and complex, it was impossible to remove it from its matrix block; however, it was necessary to reduce the block dramatically to optimize the specimen for CT scanning. Before molding, cracks were filled with a polyethylene glycol 1000/3350 mixture. The specimen was molded with silicone rubber. Support jackets of specialized high strength plaster and fiberglass cloth were made to support the smaller block while allowing preparation and research on both sides. Since water damage was confined to the matrix, repairs were made using a paste of ground matrix and methyl methacrylate, over a layer of fiberglass cloth adhered with methyl methacrylate, to reinforce thin areas. CT scanning required beam adjustment to maximize grayscale values in the range of the bone because of challenging aspects of matrix composition, in particular the abundance of concretions in close proximity to the bone. Size limits necessitated the use of both micron CT and medical CT. Even after scanning parameters were optimized, scans showed considerably less morphology than was visible by examining the fossil itself because of excellent color separation between bone and matrix. Thus, in this case, scans proved to be no substitute for good manual preparation, which ultimately provided the primary data for analyzing the specimen's morphology. This specimen experienced many usual and unusual aspects of the complete preparation process from excavation to research.

Symposium 3 (Thursday, November 3, 8:30 am)

BASIN-SCALE CONTROLS ON CONTINENTAL VERTEBRATE TAPHONOMY: INSIGHTS FROM THE CAMPANIAN OF LARAMIDIA

ROBERTS, Eric, James Cook University, Townsville, Australia; TAPANILA, Leif, Idaho State University, Pocatello, ID, USA; ROGERS, Raymond, Macalester College, Saint Paul, MN, USA; FOREMAN, Brady, University of Wyoming, Laramie, WY, USA

The Campanian of Laramidia represents one of the most widespread and voluminous records of continental vertebrate fossil preservation in the world. Ongoing geologic investigations are focused on the development of a high-resolution chronostratigraphic framework for Campanian strata across the Western Interior Basin. The addition of new radiometric ages from Alberta to Texas, and recalculation of legacy ages using updated standards, permits previously inaccessible levels of precision for correlating coeval fossil-bearing units and facilitates investigation of basin-scale controls on continental vertebrate taphonomy. An immediate observation is that many of the most fossiliferous continental stratigraphic successions from Canada to Mexico fall into very narrowly constrained temporal intervals. For instance, the window between 77 and 74 Ma appears to be a period of exceptional and widespread vertebrate preservation that includes the most fossiliferous intervals of the Dinosaur Park, Two Medicine, Judith River, Kaiparowits, Fruitland-Kirtland, and Aguja formations. Comparisons between these formations reveal significant differences in the style and modes of preservation, yet few obvious trends linking the increased preservation in each of these units to trends in tectonics (subsidence, accommodation space, sedimentation rate), paleoenvironments or paleoclimate. So why is exceptional vertebrate fossil preservation across wide areas of Laramidia, and indeed elsewhere, so strongly linked to short duration intervals? The answer may actually be the same reason that these formations are so well dated—a high abundance of altered volcanic ash beds (bentonites) in each unit. The positive correlation between abundant bentonites and elevated potential for fossil preservation is probably aided by rapid burial events (> unstable sediments) and favourable pore fluids resulting from diagenesis of volcanic ash; however, we hypothesize that the key factor in this process is the break-down of volcanic ash into bentonite (swelling clays). Bentonites decrease formation permeability, thereby limiting the damaging effects of post-depositional groundwater movement through a formation.

Poster Session II (Thursday, November 3)

NEW CRANIODENTAL REMAINS OF THE FALSE SABERTOOTH *SANSANOSMILUS JOURDANI* FROM THE MIOCENE OF THE VALLÈS-PENEDÈS BASIN (NE IBERIAN PENINSULA) AND THE PHYLOGENY OF THE BARBOUROFELIDAE (CARNIVORA)

ROBLES, Josep, FOSSILIA Serveis Paleontològics i Geològics, S.L., Sant Celoni, Spain; ALBA, David, Institut Català de Paleontologia, UAB, Barcelona, Spain; FORTUNY, Josep, Institut Català de Paleontologia, UAB, Barcelona, Spain; ROTGERS, Cheyenn, FOSSILIA Serveis Paleontològics i Geològics, S.L., Sant Celoni, Spain; MOYÀ-SOLÀ, Salvador, ICREA at Institut Català de Paleontologia & Unitat d'Antropologia Biològica (Dept. BABVE), UAB, Barcelona, Spain

We report new craniodental remains of the false sabertooth *Sansanosmilus jourdani* (Carnivora: Barbourofelidae) from the Middle/Late Miocene of the Vallès-Penedès Basin (Catalonia, Spain). The new material—including a cranium, a calvarium, several mandibles and isolated dental remains, from the Abocador de Can Mata series, Creu Conill 20 and Hostalets Superior—allow us to provide a more detailed description of this species than previously available, with *Sansanosmilus jourdani vallesiensis* being considered its junior subjective synonym. A cladistic analysis, combining previously-published data with those provided by the new remains from the Vallès-Penedès, strongly supports the monophyly of barbourofelids, which appear more closely related to felids than to nimravids. The analysis further indicates that the tribe Afrosmilini is paraphyletic, with some *Afrosmilus* species being more closely related to the Barbourofelini than other afrosmilins are. On the contrary, the analysis supports the monophyly of the Barbourofelini, with *Sansanosmilus palmidens* being its basalmost member, and *Sansanosmilus jourdani* being the sister-taxon of the *Barbourofelis* clade. This indicates that, as currently conceived, the genus *Sansanosmilus* is paraphyletic, with *S. jourdani* sharing several derived features with *Barbourofelis* spp. This might justify resurrecting the genus *Albanosmilus*, currently considered a junior subjective synonym of *Sansanosmilus*, for *S. jourdani*. From a palaeobiogeographic viewpoint, our results suggest that (1) barbourofelins originated in Eurasia during the early Middle Miocene, following at least two dispersal events of African afrosmilins into that continent; (2) *Barbourofelis* originated during the late Middle Miocene, following the dispersal of Eurasian *Sansanosmilus* into North America; (3) the presence of *Barbourofelis* in Turkey during the Late Miocene is most likely interpreted as a later independent dispersal event from North America back into Eurasia.

Technical Session VI (Thursday, November 3, 4:00 pm)

PHYLOGENETIC RELATIONSHIPS OF THE PTERANODONTOID PTEROSAURS FROM THE LOWER CRETACEOUS OF BRAZIL

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Pterosaurs from the Lower Cretaceous Araripe Basin of Brazil were first described some 30 years ago and, thanks to their exquisite preservation, have been extensively studied since. The most speciose group of flying reptiles from this unit concerns the anhanguerids and putatively related taxa, which some authors refer as ornithocheirids. Anhanguerids and ornithocheirids (as presently defined) concern two of the most important groups of Cretaceous pterosaurs, but still their relationships were never tested in a cladistic context. Therefore, we performed the first analysis of the phylogenetic affinities between anhanguerids, non-anhanguerid Brazilian pteranodontoid pterosaurs, and *Ornithocheirus simus* from the Cretaceous of England. The species were included in a slightly modified version of a previously published data matrix, which was analyzed in TNT with the traditional search algorithm. As the strict consensus tree was largely unresolved, the wildcard taxa were detected and pruned with the aid of the agreement subtree command. Subsequently, the least incomplete taxa from the groups being investigated were not pruned from the tree buffer. Results confirmed the monophyly of the Anhangueridae, including the genera *Anhanguera* and *Tropeognathus*. *Caulkicephalus trimicrodon* and *Cearadactylus atrox* were recovered in a polytomy, as the sister-groups of the Anhangueridae; this lack of resolution is due to the missing data regarding the mandible of the former. Their sister-group was the clade '*Cearadactylus*' *ligabuei* + *Ludodactylus sibbicki*. '*Anhanguera cuvieri* was found as their sister-group. These results suggest that '*Cearadactylus*' *ligabuei* and '*Anhanguera*' *cuvieri* must be relocated to new genera. *Ornithocheirus simus* was one of the wildcard taxa and had a dubious position. Therefore, we propose that the Ornithocheiridae should be restrained to its type-genus.

Poster Session IV (Saturday, November 5)

THE POSTCRANIAL MORPHOLOGY OF *ANCHOMOMYS FRONTANYENSIS* AND ITS IMPLICATIONS FOR UNDERSTANDING THE LOCOMOTION OF THE EARLIEST PRIMATES

ROIG SECALL, Imma, Institut Catala de Paleontologia, Barcelona, Spain; MOYÀ-SOLÀ, Salvador, Institut Catala de Paleontologia, Barcelona, Spain

Here, we analyze for the first time the morphology of the talus and calcaneus of *Anchomomys frontanyensis*, a small adapid from the Robiacian (Eocene) locality of Sant Jaume de Frontanyà 3C (SJF3C) (MP14-15; Bellmunt Formation, NE Spain) with the main aim to reconstruct its locomotor profile. We have quantified bone shape and analyzed proportions by employing measures of the tali and calcanei, and have calculated several ratios to compare its tarsal shape with other fossil and living primates. We have found that the slender and gracile tarsal bones of *A. frontanyensis* are more omomyid –like than adapid-like mainly due to the allometric effect of its small size and not related to any specific locomotor adaptation, in particular leaping. However, *A. frontanyensis* has some tarsal features that are frequently

associated with leaping in prosimians (high talar body, elongation of the talar trochlea, trochlear rims with the same degree of height, and presence of a posterior trochlear shelf), as well as others that are common in climbing primates (slightly grooved trochlea, flat talar body, presence of a 'squatting facet', and a medial malleolar cup that is moderately deep and distally extended onto the talar neck). On the basis of these observations, *A. frontanyensis* is reconstructed as a generalist arboreal form, since it was certainly capable of both climbing and leaping. Additional traits observed in *Anchomomys* reinforce its generalist locomotor behaviour (as opposed to specialized), and reflect its proficiency in the use of vertical supports more than horizontal ones. Among living taxa, members of the genus *Cheirogaleus* may be good analogues for *Anchomomys frontanyensis* in terms of locomotion.

Poster Session II (Thursday, November 3)

NEW EARLY TRIASSIC FISH FAUNAS FROM THE WESTERN UNITED STATES AND THE RECOVERY OF FISHES AFTER THE END-PERMIAN MASS EXTINCTION

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The end-Permian mass extinction is the largest known crisis in the history of life, with more than 90% of marine species not surviving into the Mesozoic. While some organisms had a slow rate of recovery during the subsequent Early Triassic, others reached high diversity very soon after the main extinction event. Here, we present the results of an updated analysis on the diversity dynamics of Early Triassic chondrichthyan and osteichthyan fishes. Most localities yielding marine Early Triassic fishes are from the Tethys Realm (e.g. Madagascar) or the Boreal Sea (e.g. Greenland, Spitsbergen). Early Triassic fish occurrences in the United States are rare. Until recently, only one locality was known: Bear Lake in southeastern Idaho. However, an additional site yielding Early Triassic fishes was discovered near Candelaria (Mineral County, Nevada). We herein report new Early Triassic fish faunas from the Bear Lake and Candelaria areas. The new marine fish fauna from Bear Lake is derived from late Smithian (early Olenekian) deposits of the Thaynes Formation. This is the first time that fishes are reported from the late Smithian of this region. The age of the new ichthyofauna from Candelaria can be restricted to the Dienerian (late Induan) based on ammonoids. The Early Triassic ichthyofaunas from Bear Lake and Candelaria contain mainly lower actinopterygians but also actinistians. Knowledge regarding Early Triassic fish faunas from the United States is crucial in order to understand the recovery of fishes of the eastern Panthalassa Ocean in the wake of the end-Permian mass extinction. The study of Early Triassic fishes from Bear Lake and Candelaria is especially important as these sites were located close to the southern Panthalassan Realm during the Early Triassic – a part of this superocean for which we so far have no record of Early Triassic fishes.

Symposium 4 (Friday, November 4, 12:00 pm)

CONTRASTING PATTERNS OF ROCK AND BIOTIC DIVERSITY IN THE MARINE AND TERRESTRIAL FOSSIL RECORDS OF NORTH AMERICA

ROOK, Deborah, University of Wisconsin-Madison, Madison, WI, USA; HEIM, Noel, University of Wisconsin-Madison, Madison, WI, USA; MARCOT, Jonathan, University of Illinois at Urbana-Champaign, Urbana, IL, USA; PETERS, Shanan, University of Wisconsin-Madison, Madison, WI, USA

Macrostratigraphy examines the relationship between sedimentary dynamics and biotic diversity in the marine realm. Using packages of continuous sedimentation bound by hiatuses of non-deposition, erosion, or alternations between marine and non-marine sediments, we are able to quantify large scale patterns of sedimentation through the rock record. We linked macrostratigraphic data in the Macrostrat database to fossil collection data in the Paleobiology Database (PaleoDB), which connects fossils to the rocks in which they were originally found. Using the information from these two linked databases, we have shown that the geologic completeness of paleontological sampling, a measure of the available rock with at least one recognized fossil occurrence, is similar for the marine and the non-marine. Here, we test the hypothesis that the temporal distribution of lithologies (in the form of evenness) has a relationship to genus-level taxonomic diversity in both the marine and non-marine realms. Our evenness metric is calculated similarly to ecological community evenness, but with number of units (as abundance) with a lithology type (as species) within each time interval (as the community) therefore, dominance of one or a few lithologies within a time period would constitute unevenness. Uneven sampling of lithologies and their corresponding depositional environments can bias our perception of taxonomic diversity if taxa in poorly sampled environments are underrepresented in the fossil record. Our preliminary results show a positive correlation between and lithologic evenness and non-marine generic richness – more even sampling of lithologies corresponds to a higher observed taxonomic richness. There is no strong relationship between lithologic evenness and marine diversity. This demonstrates a distinct difference in the relationship between biologic and sedimentary processes at work in the marine and non-marine realms, and possibly differences in the magnitude of the bias imposed by the rock record on the underlying biologic patterns.

Technical Session XVII (Saturday, November 5, 1:45 pm)

RATES AND PATTERNS OF NORTH AMERICAN CAMELID LIMB EVOLUTION IN THE CONTEXT OF CENOZOIC ENVIRONMENTAL CHANGE

ROSS, Darcy, University of Illinois, Champaign, IL, USA; MARCOT, Jonathan, University of Illinois, Champaign, IL, USA

The pattern of environmental change throughout the Cenozoic is characterized by a trend toward increasing ecological dominance of open habitats (e.g., grasslands) at the expense of closed habitats (e.g., forests). Numerous lines of evidence constrain the spatial and temporal pattern of this transition. Traditionally, the radiation of hypsodont horses in North America has been assumed to signal the spread of open, grass-dominated environments. However, recent study of grass phytoliths show a rise in the numerical abundance of open-habitat grasses at least 4My earlier. A possible reason for this discrepancy is that dental evolution is slow to respond to environmental change. Limb evolution might show a more immediate response to the spread of open environments. Many studies of extant taxa demonstrate a link between morphology of the limb skeleton and habitat, which are corroborated by biomechanical studies of locomotion. Studies of fossil taxa have leveraged these relationships to establish patterns of limb evolution within clades of ungulates (e.g., camels and horses), and more generally in guilds of mammals (e.g., carnivorans and ungulates) in the context of Cenozoic environmental changes. In this study, we analyze the evolution of limb evolution in the family Camelidae. We take a geometric morphometric approach to quantify the morphology of six limb elements. We ordinate the shape data, and reconstruct these ordinations on dated estimates of camelid phylogeny. We use these reconstructions to estimate per-lineage evolutionary rate in 1.5My bins between 40 and 20 My, spanning the first half of camel evolution in North America. Our results show a generally low rate of evolution between 35 and 25Ma, followed by a rapid increase in evolutionary rate that persists across the Oligocene/Miocene boundary. This rapid increase is coincident with estimates of grassland expansion based on phytoliths, and precedes the radiation of hypsodont horses. These results also corroborate previous studies of camel and ungulate limb evolution and suggest that limb evolution might be more sensitive to environmental change than dental evolution.

Technical Session XVII (Saturday, November 5, 2:30 pm)

EXTENDING KNOWLEDGE ON THE EVOLUTIONARY HISTORY OF TRAGULIDAE (MAMMALIA, CETARTIODACTYLA)—NEW DISCOVERIES FROM EUROPE AND AFRICA

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Modern tragulids are a group of small-sized cetartiodactyls including the smallest living hoofed mammal (*Tragulus javanicus*). They live in disjunct distribution in tropical rainforests in Africa and Asia. Since they possess ruminant synapomorphies in common with strikingly differing traits from all other (pecoran) ruminants they are graded as most primitive living ruminants. The fossil record and molecular evidence indicate a Late Eocene origin followed by an Oligocene gap and a sudden Early Miocene diversified appearance with wide dispersal in the Old World throughout the Miocene.

Miocene Tragulidae of Europe were described even before extant representatives. Several species were established in the mid 19th Century and all assigned to the genus *Dorcatherium*. Since their type materials have very restricted specimen numbers they caused immense difficulties in tragulid taxonomy and consequently in phylogeny and biostratigraphy. New materials of the type species *D. naui* as well as of further species give a much more complete picture of morphological characters and allow for a revision above the species level resulting in three different genera. A new genus and species from the Early Miocene of Turkey updates tragulid paleobiogeography and predates the immigration to Europe from Neogene Mammal-Zone MN4 to MN3. *Dorcatherium* was the only genus in the African Miocene as well, but the recently established genus *Afrotragulus* resulted from systematic revision of selenodont cheek teeth and increased the number of African genera to three with the Extant *Hyemoschus.* This is a first step to trace evolutionary lineages of tragulids in Africa according to morphology and not size. The investigation of a *Hyemoschus* skeleton revealed the yet undescribed feature of an unfused Os malleolare, which was previously thought to be a synapomorphy in tragulids when fused to the distal end of the tibia.

With these extended character sets the knowledge on systematics, biostratigraphy, and biogeography of tragulids is largely advanced, documents a striking diversity at the beginning of the Miocene in Eurasia and Africa and points to a radiation before.

Technical Session XV (Saturday, November 5, 11:15 am)

AN ENIGMATIC LARGE-SIZED PARTIAL SKELETON OF AN EUCYNODONT FROM THE ANTLERS FORMATION, TRINITY GROUP, EARLY CRETACEOUS OF TEXAS

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The first remains of Early Cretaceous mammals in the Antlers Formation, Trinity Group, Texas, were described as a new genus and species of triconodont, *Astroconodon denisoni*. Mammals from the Antlers Formation, both in Texas and Oklahoma, include, in addition to *Astroconodon*, basal multituberculates, a spalcotheroid, a variety of small tribosphenic mammals basal to Theria, and arguably primitive members of both Metatheria and Eutheria. A small semi-articulated skeleton was also found at Mart Frye's Farm, about 4.5 miles from the center of Decatur, TX, in the sandstones of the Antler Formation, Trinity Group. Mart Frye's farm is about 2 miles from Greenwood Canyon, the type locality of *Astroconodon*.

The skeleton includes ten dorsal vertebrae (some of them articulated to ribs), partial right pelvis, epipubic bone and partial right leg including femur and proximal fragments of tibia and fibula. No dental elements were found. All of the bones are deficiently preserved and the articular surfaces appear not to be completely ossified suggesting a sub-adult individual. The ilium, pubis and ischium are relatively gracile, while the femur, which has suffered much compression, is short and stout, with poorly differentiated laminar trocanters and neck. The incomplete femoral head would be oval and only slightly medially inflected. In these features, the femur resembles those of recently described triconodonts from the Jurassic and Cretaceous of China and tritylodonts. The pelvis (ilium plus ischium) is approximately 40mm long and the femur slightly longer. This is a large specimen for a Mesozoic mammal and does not agree in size with any of the dentally known mammals from the Antlers Fm. The similarly aged Cloverly Fm. from central USA, has yielded a tricondont similar to *Astroconodon* and, among other forms, the larger gobiconodontid *Gobiconodon ostromi*. The femur and tibia of the skeleton presented here are unlike that of *Gobiconodon*. We regard this partial skeleton as representing either a yet unknown mammal, probably a triconodont, or more likely a tritylodont.

Technical Session XV (Saturday, November 5, 10:45 am)

OLDEST FOSSIL EVIDENCE ON ORIGIN OF THE MAMMALIAN BRAIN

ROWE, Timothy, University of Texas at Austin, Austin, TX, USA; MACRINI, Thomas, St. Mary's University, San Antonio, TX, USA; LUO, Zhe-Xi, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Origin of the mammalian brain is of general scientific interest and thanks to comparative anatomy and embryology of living species, many different hypotheses have been postulated as driving mechanisms in its early evolution. X-ray computed tomography of the Early Jurassic mammaliaforms Morganucodon and Hadrocodium affords a test of these various hypotheses using new information from the fossil record, and it sheds light on a nuanced historical sequence of evolutionary events. Basal cynodonts had uniformly small brains, with encephalization quotients far below mammalian levels. In two measurable evolutionary pulses, relative brain size expanded to mammalian levels with enlarged olfactory bulbs, neocortex, pyriform cortex, and cerebellum. Encephalization was likely driven by increased resolution in olfaction and tactile sensitivity from body hair, and improved neuromuscular coordination. The origin of crown Mammalia saw a third pulse of olfactory enhancement, with ossified ethmoid turbinals supporting an expansive olfactory epithelium, allowing full expression of a huge odorant receptor genome. Odorant receptor gene duplication events are implicated in all three evolutionary pulses. At its origin, the brain in the ancestral mammal differed from even its closest extinct relatives specifically in its degree of high-resolution olfaction, as it exploited a world of information dominated to an unprecedented degree by odors and scents.

Poster Session III (Friday, November 4)

THE WILKIN-QUARRY RANCHOLABREAN BIOTA OF LINCOLN COUNTY, NEVADA

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A sand-and-gravel quarry located near Panaca, Nevada (elev. 4,800 feet) has produced a *Bison latifrons* horn core and associated skull fragments, tusk material (probably *Mammuthus*), freshwater gastropods, pollen, and impressions of broad leaves. *Bison latifrons* is rare in Nevada, having been described from only one other site (Tule Springs). The quarry is owned and operated by Jim Wilkin, who has graciously cooperated in this research.

Most of the sediment consists of coarse sandy gravel, however there are isolated patches of silt. The *Bison* and proboscidean material was collected from the coarse gravels, whereas the pollen. leaf impressions and gastropods were recovered from the finer-grained sediment.

A highly diverse assemblage of pollen types has been recovered, including approximately 30% high-spine Asteraceae (sunflower family) and about 20% cheno-am pollen (mostly salt-tolerant species such as saltbush). *Artemesia* (sagebrush) pollen is abundant, reflecting a cold desert setting, however *Larrea* (creosote), a hot-desert genus, is also anomalously present. Also present is pollen from oak, alder, pine, juniper, sedges, and roses among other taxa.

Three species of freshwater gastropods occur in the assemblage: *Gyraulus circumstriatus*, *Gyraulus parvus*, and *Physella virgata*, all of which are still extant. *P. virgata* lives in ephemeral bodies of water and is capable of migrating between shallow pools. The most abundant species are *G. circumstriatus* and *G. parvus*, both of which inhabit ephemeral pools and marshes.

The gravelly sediment occurs in 1-to-2-m-thick, fining-upward cycles. Cross-bedding and clast imbrication show a predominantly southwestward paleocurrent direction, which matches the flow direction of Pleistocene White River. That river drained into the Colorado River via Meadow Valley Wash.

We interpret this biota and associated sediments to represent a floodplain ecosystem with a shallow, gravel-bed river. The finer-grained deposits represent abandoned channels; these became marshy pools teeming with tiny gastropods. Alder was a conspicuous riparian species, with a woodland of oak, juniper, and pines occurring in nearby drier habitats. Xeric habitats apparently also existed in the vicinity.

Technical Session XV (Saturday, November 5, 9:45 am)

MIDDLE PERMIAN BIODIVERSITY CHANGES AND THE GUADALUPIAN EXTINCTION ON LAND; UNRAVELING EVIDENCE FROM THE BEAUFORT GROUP, SOUTH AFRICA

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The Beaufort Group of South Africa chronicles a near continuous record of fluvial sedimentation from the Middle Permian to the Mid Triassic. The lowermost formation in the group, the Abrahamskraal Formation, has the potential to record the end-Guadalupian extinction, if indeed it occurred on land. This formation, which is up to 2 500 m thick and has a rich diversity of fossil tetrapods, corresponds with the *Eodicynodon* and *Tapinocephalus* biozones. Despite its potential significance, it has received relatively little research attention because fieldwork has been hampered by the intensely folded nature of the rocks. Extensive fieldwork over many years combined with the application of the newly developed GIS-based database for Beaufort fossils has begun to remedy this problem, and allowed important new insights into faunal change in the Abrahamskaal Formation. In particular, taxonomic refinements for dinocephalians and dicynodonts have enabled a more detailed delineation of stratigraphic ranges and biogeographic distributions of the various elements of the tetrapod fauna. The recent recognition of several new dicynodont genera from the *Tapinocephalus* Zone has brought the diversity of this clade up to levels that are similar to those of the Late Permian. In addition, dicynodonts display a stable pattern of turnover throughout the stratigraphic range of the Abrahamskraal Formation, with no apparent extinction event. In fact, the appearance of the common genus *Diictodon* predates the disappearance of dinocephalians, and it retains its high abundance into succeeding biozones. Apart from providing a greater understanding of biodiversity changes throughout the stratigraphic succession, these new data make it possible to biostratigraphically subdivide the *Tapinocephalus* Assemblage Zone and to refine stratigraphic correlation with other Middle Permian continental deposits.

Poster Session I (Wednesday, November 2)

A HUMERUS OF A GIANT LATE EOCENE PSEUDO-TOOTHED BIRD FROM ANTARCTICA

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We report a nearly complete right humerus (SGO.PV 22001) of a huge pseudo-toothed bird (Odontopterygiformes) from the Late Eocene of La Meseta Formation, Seymour Island, west Antarctica, collected during the XLVII Chilean Antarctic Scientific Expedition (2011). The fossil was found in glacial moraine deposits belonging to the stratigraphical unit "Telm 7", approximately 1.5 km to the west from the Marambio base. Its preserved length is 85 cm and only the distal end is missing. The fragmentary material from Seymour Island is not identifiable at genus- and species-levels. It is notable, however, that by its morphological features, the fossil more closely resembles Neogene than Paleogene Odontopterygiformes. Features in which it agrees with *Pelagornis* but differs from *Dasornis* include the greater cranial prominence of the caput humeri, which also has a more abrupt and straighter distal border. Although the tuberculum dorsale is badly preserved, it is wide and protrudes proximally to the level of the caput. The diaphysis is flat and also distinguishes the fossil from *Dasornis*. Judging from the size of the humerus, the fossil appears to have been larger than the largest known pelagornithid, *Pelagornis chilensis*. Together with another large-sized humerus from the middle Eocene of Belgium, which was tentatively assigned to *Dasornis emuinus*, the *Pelagornis*-like morphology of the fossils supports a single origin of giant pseudo-toothed birds as has been previously suggested.

Poster Session II (Thursday, November 3)

PRAIRIE PALEOECOLOGY: ICE AGE MAMMALS AND TEMPERATURES IN THE U.S. MIDWEST

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One traditional strength of Quaternary paleoecology is the ability to reference modern biota. Taking advantage of that, I established correlations, using ecoregion maps and published distribution data, between taxonomic diversity of modern mammals and climatic variables. The predictive equations from the significant correlations can then be used to produce estimates of paleoclimate. These methods can provide more than gestalt interpretations; quantitative predictive equations may be generated from these data. Based on previous uses of these predictive equations, temperature estimates appear to be more reliable than those for precipitation; therefore, only temperature values were generated in this study.

I examined published lists of fossil mammals for more than 200 Pleistocene and Holocene localities in Illinois. Some of these are superimposed sites (many archaeological); some are isolated specimens. Because the correlations based on modern biodiversity have better resolving power with more diverse paleoassemblages, analyses were done separate for sites with progressively higher minimum numbers of species. Taken collectively, the more speciose localities produced estimated temperature trends expected for faunas before, during, and after the last glacial maximum. However, a broader geographic perspective would better show any patterns. Therefore, this ongoing project is extending the scope to include the entire Midwest, and eventually the continent's entire fluctuating ice margins.

Poster Session III (Friday, November 4)

CT ANALYSIS OF THE ETHMOIDAL REGION IN CAINOTHERIIDAE (ARTIODACTYLA, MAMMALIA)

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Internal cranial structures such as the turbinal skeleton inside the ethmoidal region are still poorly known within Cainotheriidae. These complex structures provide important morphological information for phylogenetic and paleobiological questions. The ethmoidal region of several Oligocene cainotheriids as *Caenomeryx filholi* from Gaimersheim (Germany) and *Cainotherium commune* from the Quercy phosphorites (France) were studied by high resolution computed tomography (µCT). *Caenomeryx* and *Cainotherium* both show a very similar arrangement and number of turbinals, though we detected differences in proportion. The studied cainotheriids possess a reduced nasoturbinal, which is restricted to a pneumatized crest of the nasal bone, and a bilamellar maxilloturbinal. The crista semicircularis is a prominent structure with a distinct processus uncinatus. The frontoturbinal recess houses two frontoturbinals, the ethmoidal recess contains three ethmoturbinals. Between ethmoturbinal I and ethmoturbinal II one interturbinal is present. Furthermore, the ethmoidal region of *Caenomeryx* and *Cainotherium* is characterized by large pneumatized spaces as the very prominent sinus maxillaris, which correlates with the strong crista semicircularis, the sinus praesphenoidalis, and an irregular sinus frontalis. A bilamellar maxilloturbinal is also observed in extant artiodactyls like Suidae, Camelidae, Tragulidae, Cervidae, and Bovidae and represents the grundplan condition of the order. However, the shape and number of the fronto-, ethmo-, and interturbinals in the studied cainotheriids is quite distinct from that observed in living artiodactyls. All investigated species of the latter have an increased number of turbinals, which often show a complex plication. In contrast, the number and general morphology of the turbinal skeleton of the cainotheriids resembles that of other extant and extinct small mammals (e. g., *Mesocricetus*, *Tupaia*, *Carcinella*). Thus, this pattern is probably correlated with body size. As the turbinal skeleton of Cainotheriidae has a simple structure it cannot be ruled out that it represents the ancestral morphotype for Artiodactyla.

Poster Session IV (Saturday, November 5)

TAPHONOMY OF THE "DRAGON'S TOMB" *SAUROLOPHUS* (DINOSAURIA:HADROSAURIDAE) BONEBED, NEMEGT FORMATION (LATE CRETACEOUS), MONGOLIA

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One of the richest Late Cretaceous dinosaur faunas is found in the Nemegt Formation of Mongolia. Dinosaur fossils are typically encountered as articulated skeletons, with bonebeds being relatively scarce. A notable exception is the famous "Dragon's Tomb" bonebed at Altan Ula II that preserves multiple complete skeletons of *Saurolophus* with skin impressions. In the 1940's, a Russian-lead expedition collected five virtually complete skeletons and a juvenile skull from the locality. Although some of the specimens have been prepared and studied, the taphonomy and sedimentology of the bonebed has never been documented in detail. Partially in response to recent illicit poaching, a multi-national team began an on-going project in 2009 to document this historic locality. The surface of the bonebed was cleaned and *in situ* sections totaling 13m2 were mapped in detail. Every fossil, including those displaced by poaching, was identified, measured, and taphonomic data collected. The approximate placement of the original five skeletons was determined and portions of at least five additional articulated *Saurolophus* specimens were identified, as well as previously unreported occurrences of multiple disarticulated bones. At least three size classes (young juvenile to mature adult) of *Saurolophus* were identified. The exposed portion of the bonebed, including areas previously excavated, is estimated to be ~170m2, suggesting that over 100 *Saurolophus* carcasses may have contributed to the original assemblage, although the cause of death cannot be determined. The locality is reinterpreted as a point bar deposition (not a channel deposit), the toe of which is unexposed and therefore has the potential to contain significant new specimens. The survey also documented the first *Tarbosaurus* skeleton from the site. Within the Nemegt Formation, isolated occurrences of the top predator *Tarbosaurus* outnumber those of hadrosaurids by over 4:1, which is unusual for a Mesozoic terrestrial ecosystem. The Dragon's Tomb has a more typical 1:10 carnivore-herbivore ratio, and provides new data for understanding the paleoecology, and regional taphonomic and depositional environments of the Nemegt Formation.

Poster Session II (Thursday, November 3)

PATTERNS OF BODY MASS AND DIET OF LARGE UNGULATES FROM MIDDLE AND LATE PLEISTOCENE OF UK AND GERMANY AND THEIR CONNECTIONS WITH ENVIRONMENT

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Ecomorphology of ungulates reflects the environments they live in. The average diets of ungulates vary following differences in vegetation, and their body size is affected by a complex set of ecological and physiological connections. In this study we analyze Middle and Late Pleistocene British and German ungulate palaeocommunities in order to test whether there are significant correlations of diet and body size of the ungulates with climate and vegetation openness. This can be robustly done for well sampled Pleistocene sites because of the great amount of fossil material, possibility to combine local mammal and pollen fossil records, and the drastic fluctuations of Pleistocene climate and environmental conditions. We used mesowear analysis for dietary analyses and regression equations for estimating body mass from dental and skeletal measures. The results show a good average correlation between ungulate mesowear and non-arboreal pollen percentages of the localities, but there are differences in the patterns of different species. Body size is on average larger in open than in closed environments and in glacial than in interglacial ungulate communities with the important exception of horses (*Equus ferus*), which show a significantly strong opposite pattern compared with the other ungulates. The results indicate that the connection of body size and environment is not as straightforward as the connection of diet and vegetation. This is likely to reflect varying effects of population density and ecological adaptations together with environmental conditions on body size in different species.

Symposium 2 (Wednesday, November 2, 10:30 am)

MICROVERTEBRATE FAUNA AND PALEOECOLOGY OF THE TULE SPRINGS LOCAL FAUNA, CLARK COUNTY, NEVADA

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The Upper Las Vegas Wash north of Las Vegas, Nevada, yields the Tule Springs local fauna (TSLF), the largest open-site late Pleistocene vertebrate fossil assemblage known from the Mojave Desert and southern Great Basin. The TSLF includes diverse megafauna along with newly documented microvertebrates that occur within the extensive groundwater discharge deposits of the Las Vegas Formation. Megafaunal remains have been reported, but systematic sampling for microvertebrates across all members of the Las Vegas Formation has not previously been conducted.

Groundwater discharge deposits form during times of relatively cool temperatures and enhanced effective precipitation. This complex depositional environment records the interplay between hydrophilic plants, trapped eolian sediments, and invertebrate and vertebrate faunas. Groundwater discharge deposits are themselves effective climate proxies containing important data relating to the timing and the magnitude of past climate change.

High-resolution stratigraphic control is attained for vertebrate sites by using a detailed sedimentologic and chronostratigraphic scaffold that allows snapshot reconstruction of microvertebrate microhabitats. This scaffold enables documentation of long-term trends in taxonomic representation and relative abundance through multiple glacial and interglacial cycles, effectively tracking the responses of organisms to changing climatic conditions through geologic time.

Microfauna include *Lithobates*, *Anniella*, *Masticophis*, cf. *Arizona*, *Marmota flaviventris*, *Neotoma* cf. *N. lepida*, *Reithrodontomys*, and cf. *Onychomys*. The microfauna presents a mixed environmental signal in multiple members of the formation. This juxtaposition of differing paleoenvironmental indicators accords fully with the complex spring discharge habitat mosaic envisioned for the region by previous studies. Where sample sizes are sufficient, the relative abundance of represented taxa is coupled with sedimentologic data to yield precise reconstructions of microvertebrate responses to changing climate.

Poster Session II (Thursday, November 3)

TAXON REPLACEMENT: INVASION OR SPECIATION? FIRST RESULTS FROM A SUPERTREE OF NEOGENE MAMMALS

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The NOW (Neogene of the Old World) database contains extensive information about Eurasian Miocene to Pleistocene land mammal taxa and localities. For the last 20 years the NOW database has been used to study varied aspects of the evolution and changing diversity patterns of Eurasian mammals and the effects of climate change on their population dynamics and occupancy patterns, but the scope has been restricted by the lack of a comprehensive phylogenetic framework, which has prevented analyses that require knowledge of relatedness. In order to allow resolution of taxon extinction and replacement in the fossil record with respect to phylogeny-related factors such as speciation and invasion, we are constructing phylogenetic supertrees for a number of major mammalian clades. We have initially constructed supertrees of the carnivoran families Felidae and Canidae, and the order Proboscidea. A wide variety of supertree construction methods were used, along with strict protocols for synonomy and phylogenetic tree inclusion or exclusion. The carnivoran and proboscidean supertrees aim to include all valid species and existing genera, with special focus on taxa present in the NOW database: at present, over 100 felid and 200 proboscidean species, and nearly 100 canid species, have locality records in NOW. This information, together with the supertrees, allows testing of numerous phylogeographical hypotheses, and examination of a wide array of questions related to taxon replacement. Results with the European felid record indicate that after the Vallesian crisis (9.5 Ma), local speciation within the subfamily Machairodontinae filled the ecological niches of the expanding Pikermian biome mainly with large-sized felids. At the end-Miocene (5.3 Ma) Pikermian collapse, the returning woodland niches were mainly occupied by medium- to large-sized machairodonts originating in Africa and Asia and several small- to medium-sized Felinae lineages originating in Africa and North America. The results highlight the importance of using well-defined geographical areas and species with good ecometric information in studies of taxon replacement dynamics in the fossil record.

Technical Session III (Wednesday, November 2, 2:30 pm)

MORPHOLOGICAL DISPARITY, ALLOMETRY AND PHYLOGENETIC SIGNALS IN THE SKULLS OF EXTANT AND FOSSIL CATS (FELIDAE, CARNIVORA)

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While modern felid species occupy various niches in terrestrial ecosystems, they are remarkably uniform in terms of diet (hypercarnivory) but also skull morphology; it is often difficult to distinguish species from cranial specimens alone. However, some felid species exhibit subtle but distinct within-species morphological variation. This morphological variation was quantified in 33 extant and 8 extinct species of cats, through multivariate ordination (principal components analysis, PCA) of 29 linear variables of the skull. The resulting two-dimensional or three-dimensional morphospace shows considerable overlap in morphospace occupation in the various small-sized cat species. Spatial statistics indicates a single peak in spatial landscape corresponding to this high-density distribution of the small-sized cats. However, nonparametric multivariate analysis of variance shows significant differences between the major groups of cats (eight genetic lineages + Machairodontinae), and revealing significant differences in most post-hoc pair wise comparisons. The first principal component axis strongly correlates with body size, with large-sized cats converging on to a similar region in morphospace. To quantify the "hyper-volume" and spread in morphospace of each group, disparity metrics were computed at various taxonomic levels. At the species-level, the ocelot and puma have exceptionally high disparity. Similarly, at the lineage level, the Puma Lineage has particularly high disparity, followed by the Leopard Cat, Ocelot and Panthera Lineages. The two subfamilies, Felinae and Machairodontinae show similar levels of disparity, indicating that while machairodonts are superficially vastly disparate (from the feline-like metailurins to the sabre-tooths) they are not more disparate than modern felines. However, increase of sample size for machairodonts may yet reveal more disparity than presented here. Finally, morphospace occupation is highly correlated with phylogeny, but most of that phylogenetically structured variance is shared with variance attributed to size; morphology is phylogenetically constrained but due to phylogenetically structured allometry.

Poster Session I (Wednesday, November 2)

THE DEVELOPMENT OF CARPAL ELEMENTS IN CHILEAN TINAMOU AND CHICKEN CLARIFIES CONTROVERSIES ABOUT THE PRESENCE OF THE ULNARE IN THE WRIST OF MODERN BIRDS

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In basal theropods (like *Herrerasaurus* and *Eodromaeus*) the elements preserved in the carpus have been identified as the ulnare (Ue), radiale, centrale and least four distal carpals. Of these, the Ue is conserved in the neotheropod lineage, distal to the ulna, with a concave proximal articular surface. The Ue is observed in therizinosaurids, oviraptorosaurids, troodontids and basal avialians. The ulterior fate of the Ue leading to modern birds is debatable. Some authors have identified the Ue in the adult wing of modern birds as a free element beside the ulna and between the ulna and carpometacarpus. However, a well-cited study of the embryology of carpal elements in the chicken argued that the Ue is absent from the wrist of adult modern birds, describing the loss of the cartilaginous Ue at day 8 of incubation, followed by the immediate appearance of a new unidentified "element X" at the same position (distal to ulna). We have re-examined the development of the neoavian carpus in the chicken as well as a paleognath bird, the Chilean Tinamou *Nothoprocta perdicaria*, following cartilage-stained skeletal elements at close intervals throughout the development of the wrist. We found that "element X" in the chicken is in fact the Ue. We suggest it was erroneously considered a different element because by comparison to the Ue at day 7, the Ue at day 8 becomes proportionally much smaller, and further acquires a very distinctive boomerang-like shape. In the Chilean Tinamou, the presence of the Ue is unmistakable: Unlike the chicken, the Ue does not become proportionally smaller, nor does it acquire a boomerang-like shape. Although the Ue does not disappear from the avian wrist, it does not become the free element beside the ulna and between the ulna and carpometacarpus of modern birds that is often identified as the Ue. This element does not derive from the embryological Ue, but from a different cartilaginous precursor often identified by embryologists as the pisiform. The Ue remains a distinct element in the avian wrist until late stages, when it becomes incorporated to the carpometacarpal complex (Day 9-10 in chicken, day 20 in chilean Tinamou).

Technical Session IV (Wednesday, November 2, 2:00 pm)

NEW GENERA OF HYSTRICOGNATHI (RODENTIA, MAMMALIA) FROM THE LATE EOCENE OF THE FAYUM DEPRESSION, NORTHERN EGYPT

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Hystricognathous rodents from the Paleogene of Egypt continue to play a crucial role in debates surrounding the origin and early evolution of the group. Here we present evidence for two new genera and species of primitive phiomorph rodents, represented by mandibles and partial maxillae from the terminal late Eocene (~34 Ma) Locality 41 (L-41) in the Fayum Depression of northern Egypt. One genus is the smallest known Paleogene hystricognath, being about the same size as contemporaneous "*Phiomys*" *lavocati*, has very simple molars, and like derived Oligocene-to-Recent phiomorphs (but unlike contemporaneous taxa) apparently retains dp4 very late into life. The other genus is very similar in dental morphology, but has lower molars that are about 3.5 times larger. Parsimony analysis of craniodental features scored across 53 stem and crown hystricognaths places these genera in a very advanced position as sister taxa of *Thryonomys* (African cane rat) to the exclusion of other Fayum phiomorphs and even Miocene taxa such as *Paraulacodus*, implying extensive ghost lineages for numerous living and extinct phiomorphs. Phylogenetic analysis of the same matrix with a chronobiogeographic character added instead places the new genera in an intermediate position between derived living and extinct phiomorphs such as *Paraulacodus*, *Paraphiomys*, *Metaphiomys*, and *Thryonomys*, and other primitive Fayum phiomorphs such as *Phiomys* and other primitive taxa from Quarry L-41. The new genera further augment the already remarkable morphological diversity observable among hystricognaths in the latest Eocene of northern Africa, and indicate that the group underwent a major adaptive radiation in the late Eocene.

Technical Session XVI (Saturday, November 5, 10:15 am)

WHEN IS AN EEL NOT AN EEL? AXIAL REGIONALIZATION AND SPECIALIZATION IN AN EARLY ACTINOPTERYGIAN FISH, *TARRASIUS PROBLEMATICUS*

SALLAN, Lauren, University of Chicago, Chicago, IL, USA

Superficial similarities can obscure interrelationships, ecological convergence, and biodiversity. *Tarrasius problematicus* is an early ray-finned fish (Actinopterygii) from the Carboniferous Glencartholm locality in Scotland, and is notable for its eel-like shape, lobate pectoral fins, continuous median-caudal fin, and lack of trunk scales. Re-examination of *Tarrasius* has revealed a number of novel specializations, including distinct regionalization of the vertebral column. *Tarrasius* possesses three clearly defined trunk regions exhibiting ossified centra, modified arches, and articular processes. In contrast, the caudal vertebrae are marked by thin neural and hemal arches connected by an ossified band around the notochord. Although detailed axial morphology is only known for a handful of early fishes, Paleozoic actinopterygians were thought to lack regional specialization based on partial elements and modern forms. Similar vertebral modifications in early tetrapods have been linked to the transition to land. However, *Tarrasius* was not terrestrial or even necessarily benthic: pectoral fins originate laterally and pelvic fins are absent. Just as in tetrapods, specialized trunk regions in *Tarrasius* likely worked to limit torsion and lateral undulation. Therefore, vertebral specialization might have driven by a need for greater stability and control during caudal fin-driven locomotion. Interestingly, the similarly eel-like *Paratarrasius* from Bear Gulch, previously united with *Tarrasius* on the basis of general appearance and homoplastic characters, did not share *Tarrasius'* axial morphology, probable locomotor mode, or general ecology.

Technical Session I (Wednesday, November 2, 9:15 am)

DNA, DINOSAURS, AND METAGENOMICS: A NEW TOOL FOR MASS IDENTIFICATION OF DNA FROM FOSSIL BONE

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The idea that endogenous soft tissues are preserved in Mesozoic fossil bone remains contentious after 6 years of research. Here, full characterization of DNA is reported using 'Metagenomics' techniques from a section of *Brachylophosaurus canadensis* fossil, JRF 56, from the Judith river formation near Malta, Montana. Soft tissue structures similar to those reported as dinosaurian blood vessels and bone cells are observed in JRF 56, providing the platform for analyzing the molecular content of this fossil further. Previous studies have focused on long-lasting proteins since it is generally accepted that DNA can not survive such time scales. Here metagenomics data is presented that identifies ALL the DNA in the sample giving proportionate rank of endogenous molecular species. The sample was processed to isolate organic remnants from the intravascular cavities of the fossil's cortical bone, excluding possible contamination from sediments on the bone surface. DNA from various species of bacteria, plants, fungi, and chordates was detected in the bone and therefore longer lasting proteins from these species can be expected. Critically, avian molecules identified as modern bird DNA were found in the organic isolates. The presence of modern bird and other chordate DNA provide a large analytical obstacle to identifying possible endogenous molecules. Bacteria DNA provides support for the production of biofilms within the fossil. The specific types of bacteria suggest biotic-mineral interplay over the geologic life span of the fossil, as suggested in previous work. Metagenomics provides a new and significant method for examining the extent of modern biomolecular infusion into ancient fossils. Metagenomics should thus be incorporated as part of the standard "toolbox" in the investigation of molecular paleontology.

Poster Session I (Wednesday, November 2)

LARGE SUBFOSSIL FROG FROM NORTHWESTERN MADAGASCAR

SAMONDS, Karen, University of Queensland, Brisbane, Australia; CONWAY, Sarah, McGill University, Montreal, QB, Canada

Despite decades of research on Madagascar's extant fauna, one of the most unique and endemic on the planet, the origin and evolution of the Malagasy amphibian fauna remains relatively poorly understood. Dispersal and vicariance scenarios have been suggested to explain the occurrence of most groups on Madagascar, while the presence of a few groups has been attributed to human introduction within the last 2500 years. As Madagascar has been isolated for more than 88 million years, any dispersal scenarios require crossing a formidable marine barrier (~400 kilometers). Whereas amphibians tend to have low tolerance for marine environments, salinity tolerance is variable in some groups, and there can be no question that amphibians have crossed marine barriers successfully, given their presence on geologically young, volcanic oceanic islands.

The subfossil record of Malagasy anurans is limited to one report of microhylid limb elements collected from Ampasambazimba, central Madagascar. We describe here the first nearly-complete subfossil frog skeleton from Madagascar's Cenozoic; a large associated specimen collected from Anjohibe Cave, northwestern Madagascar. This individual is represented by both skull (frontoparietal, ethmoid, prootic, maxilla, and dentary) and postcranial elements (3rd, 4th, and 8th vertebrae, humerus, radius, ulna, pubis, ischium, tibiofibula, calcaneus, astragalus, and tarsals). The snout-vent length is ~ 170 mm, which exceeds the size of the largest extant Malagasy frog, the ranid *Hoplobatrachus tigerinus.* While the region surrounding the cave is currently dry and human-modified grassland, this material corroborates what is implied by other subfossil groups: that the natural vegetation of this region was considerably more forested and humid in the past.

This new glimpse into the fossil record of Malagasy anurans has great potential to help reconstruct the historical changes in species richness and diversity during the Late Pleistocene and Holocene. Additionally, as biogeographic scenarios of Malagasy vertebrates still remain largely unknown due to the near-lack of a Cenozoic fossil record, this specimen can provide direct evidence of arrivals, extinctions, and the area of origin for the ancestors of the modern forms.

Symposium 3 (Thursday, November 3, 12:00 pm)

LAURASIAN FAUNAL INTERCHANGE IN THE LATE CRETACEOUS: THE OUT OF LARAMIDIA HYPOTHESIS

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Subaerial connections of previously isolated landmasses constitute some of the most significant events in the history of non-marine life, involving large-scale exchanges of floras and faunas, as well as episodes of origination and extinction. In the best-documented examples (e.g., the Great American Interchange), the emigration of taxa tends to be predominantly unidirectional, favoring the larger of the two landmasses. Beginning about 95 Ma, North America was subdivided into eastern and western landmasses by incursion of the Cretaceous Western Interior Seaway. Current evidence indicates that the western landmass, Laramidia—less than 20% the area of present day North America—was isolated for ~25 million years. Upper Cretaceous formations in Asia and Laramidia share a number of dinosaur clades, and it has previously been argued that the bulk of these clades originated on Asia and dispersed to western North America. Yet comparative resolution has been hampered by the lack of radioisotopic dates for the relevant eastern Asian formations (e.g., Djadochta, Iren Dabasu, Nemegt). Recently discovered fossil evidence recovered from the Campanian-aged Wahweap and Kaiparowits formations of southern Utah, including a pair of taxa that represent the earliest representatives of ceratopsid and tyrannosaurid dinosaurs, provides new insights into the origins and phylogenetic relationships of key clades, bolstering an emerging picture of Laramidia as the landmass of origin for many taxa. Integration of stratigraphic, phylogenetic, and biogeographic evidence using dispersal-extinction cladogenesis (DEC) analysis indicates that multiple theropod and ornithischian clades originated on Laramidia and dispersed to Asia during the latest Campanian or early Maastrichtian. Given that Asia was many times larger than Laramidia, this biogeographic finding stands in stark contrast to the standard picture of similar faunal exchanges during the Cenozoic.

Technical Session III (Wednesday, November 2, 1:45 pm)

CARNIVORE DIVERSITY THROUGH THE CENOZOIC OF OREGON

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The John Day Basin of Oregon includes a rich fossil record, with a nearly complete sequence of beds spanning the late Eocene through the latest Miocene (~50 – 5 million years ago). Carnivore guilds are well represented from the Arikareean, Hemingfordian, Barstovian, and Hemphillian of Oregon, allowing us to closely track changes in species richness, body size, and feeding types. Craniodental measurements including skull length and dental dimensions were measured for each species and used to estimate body mass and relative tooth sizes, carnassial blade length, and molar grinding area. A multidimensional morphospace was used to analyze divergence among sympatric species and examine morphospace occupation through time. Absolute species richness was highest in the mid Oligocene, and declined through the mid Miocene. This is a consequence of a spectacular diversity of small canids in the Oligocene and the decline of hesperocyonines and hypocarnivorous borophagines in the early Miocene. Unlike overall species richness, the diversity of hypercarnivores, characterized by a trenchant heeled talonid, was relatively stable through time despite the fact that there was a repeated turnover of large hypercarnivores. Morphospace comparisons reveal that nimravids were replaced by hesperocyonine canids followed by amphicyonids and then felids. Similarly, the small canids of the Oligocene and early Miocene occupy the same area of morphospace as mustelids and procyonids later in the Miocene. These results are consistent with previous studies, suggesting that selection for adaptive divergence and hypercarnivory drives evolution within carnivore guilds, despite differences in taxonomic composition and time.

Symposium 1 (Wednesday, November 2, 11:15 am)

CIRCUMVENTING CONSTRAINTS IN LIMB EVOLUTION: THE MOLE'S "THUMB" AND LATE GROWTH IN LIVING AND FOSSIL FORMS

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Some fossil taxa possessed more than the usual number of five fingers characteristic of crown tetrapods, providing relevant evidence to address rare structures of living species. Among the latter are the Panda's 'thumb' and the remarkable digit-like 'os falciforme' of moles, used in concert with the true fingers during digging. These cases may involve the evolutionary remodelling of wrist bones or mechanisms so far unexplained. Preaxial elements have evolved numerous times in tetrapod evolution and the use of the term prepollex and prehallux concern a purely positional matter and should not imply phylogenetic homology of the adult structures. We examine the molecular early limb development of moles and shrews and discovered that novel developmental peculiarities facilitated the inclusion of the mole's 'thumb' into the evolutionary older digit series. The expression pattern of *Sox9*, *Msx2* in embryonic specimens revealed that the os falciforme develops in an originally proximal position and extends distally into the digit area after *Sox9* expression in the true digits has faded. The os falciforme develops in domain of *Msx2*-expressing tissue at the anterior border of the mole digital plate, but the apical ridge (identified by *Fgf8* expression patterns) overlying this domain regresses before a digit-like skeletal pattern can be specified. The discovery of the modularity of the developmental program of the region of the first digit, suggests that the plasticity around the pentadactyl pattern should originate at late stages in that region of the autopod, whereas changes to digits 2-5 seem interdependent, changes to digit 1 are independent.

The circumventing of a constraint, in the number of digits in the mole's case, is one of many examples of the plasticity of developmental programs.These can be reconstructed with some confidence and to some extent for fossils based on their adult phenotypes. Several aspects of late growth are relevant in this context, including developmental sequences, limb bone microstructure and the sequence of epiphyseal fusion.

Technical Session XI (Friday, November 4, 2:45 pm)

HIGH MAXIMUM GROWTH RATE IN CF. *MAMENCHISAURUS* ARGUES AGAINST LOW BASAL METABOLIC RATE AS THE EXPLANATION FOR SAUROPOD DINOSAUR GIGANTISM

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Compared to other lizards, Varanidae have a relatively high basal metabolic rate (BMR), but varanid BMR is only one fifth of mammalian BMR. Such a low basal metabolic rate, leading to a field energy expenditure (FEE) one fifth that of large mammals, was recently hypothesized to explain the unique gigantism of the sauropod dinosaurs. We test the varanid BMR hypothesis of sauropod gigantism by deriving the first well constrained growth curve and maximum growth rate (MGR) estimate for a sauropod dinosaur. The test is based on the relationship between BMR and MGR expressed in Case curves. MGR can be obtained from the cyclical growth record in the histology of dinosaur bones. We use Case curves to constrain BMR of a giant individual of cf. *Mamenchisaurus* from the Late Jurassic part of the Shishugou Formation (Junggar Basin, NW China). Its large ulna (preserved length: 96 cm) and associated humerus show an external fundamental system (EFS), indicating that the individual was fully grown. Based on the 3-D mathematical slicing method, we estimate the mass of the individual at death at 25,075 kg. Assuming isometry in body mass vs. shaft circumference, we calculate mass gain per annual growth cycle from the percentage of increase in cortical thickness. Preserved cycle 13 records a MGR of 1667 kg/year (4567 g/day). We also calculate MGR from growth models fitted to the growth record. A logistic growth model indicates a MGR of 3006.33 g/day, and a von Bertalanffy growth model indicates a MGR of 2837.94 g/day. These values compare with values for mammals and precocial birds scaled to sauropod size but are inconsistent with those for a varanid lizard scaled up to 25 metric tons body mass (1761 g/day), thus we reject the varanid BMR hypothesis of sauropod gigantism.

Poster Session IV (Saturday, November 5)

NEW FOSSIL PROBOSCIDEANS FROM MID-PLIOCENE WORANSO-MILLE, ETHIOPIA: IMPLICATIONS FOR ELUCIDATING THE DIVERSIFICATION AND EVOLUTION OF BASAL TAXA OF CROWN ELEPHANT LINEAGES

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Recent fieldwork in the Woranso-Mille area of the central Afar depression, Ethiopia has produced an abundant, diverse mid-Pliocene mammalian fauna that contains a significant early hominin fossil sample. Proboscideans are also well represented at Woranso-Mille localities, primarily by teeth, mandibles, and partial crania. Most of these specimens are dated to 3.82-3.72 Ma. They document a number of taxa, including rare fossils of advanced anancine gomphotheres, and more common remains of several elephant species. The mid-Pliocene is an interesting interval of proboscidean evolution, as the first, archaic elephants were completely replaced by basal constituents of crown elephant lineages, taxonomic diversity was high (with multiple genera of elephants, stegodonts, anancine gomphotheres, and deinotheres co-occurring in Africa), and substantial changes in the craniodental apparatus are observed in elephants from this time, presumably in response to more open habitats and greater competition for grazing resources. The Woranso-Mille sample is important because there are few African sites of this age, and more needs to be known about the adaptive diversification of early crown elephants. Comparative morphometric study of dentition indicates that as many as four elephant species are present in the sample: *Elephas recki brumpti*, cf. *E. ekorensis*, cf. *Loxodonta adaurora*, and cf. *Mammuthus* sp. ("Hadar" type). Differences in hypsodonty among these taxa presage the later success of *E. recki* and replacement of other elephants by this species in East Africa during the early Pleistocene, and contrasts between *E. recki* from Woranso-Mille and late Pliocene Hadar, Ethiopia provide evidence for rapid evolutionary change in the lineage. The Woranso-Mille sample also yields information critical for understanding the pattern and mode of African elephant evolution, which in *E. recki* appears to have been anagenetic and strongly directional for enhanced grazing effectiveness.

Poster Session II (Thursday, November 3)

SEXUAL DIMORPHISM IN ELASMOTHERIINA (MAMMALIA, RHINOCEROTIDAE) WITH REMARKS ON *HISPANOTHERIUM MATRITENSE*

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Rhinoceros remains from middle Aragonian (middle Miocene) locality of Intercambiador Principe Pío (Madrid Basin, Spain) are reported. They pertain to the elasmotheriine *Hispanotherium matritense*, a slender rhinoceros species typical from the central basins of the Iberian Peninsula. Previously proposed horn dimorphism in *H. matritense* seems improbable on the basis of the new material and no postcranial differences have been found. Newly recovered remains include one i2 of a male and a complete female lower incisor set with both i1 and i2. Tusk-like i2 of males are considerably larger and sharper than females confirms previous observations. A review of sexual dimorphic characters in the Subfamily Elasmotheriina reveals a wide range of differences such as lower incisors development, horn presence or thickness variations of the zygomatic arches.

Poster Session I (Wednesday, November 2)

CHANGES IN METACARPAL CURVATURE DURING WILD CHIMPANZEE DEVELOPMENT

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Chimpanzees display several locomotor transitions during development, including a shift from walking on their palms to walking on their knuckles. During knuckle-walking in the African apes, the middle phalanges bear most of the weight. This method of locomotion puts the metacarpals nearly perpendicular to the middle phalanges, such that the metacarpals serve as load-bearing conduits subject to significant bending loads. Diaphyseal curvature of long bone shafts has been found to respond to the loading environment. This curvature increases the predictability of the load environment in mammalian long bones where bending is the main loading force. It is therefore predicted that adult chimpanzees should have greater metacarpal curvature than younger chimpanzees, who engage in less frequent knuckle-walking. Digital photographs of wild caught chimpanzee third metacarpals were analyzed to evaluate the degree of longitudinal shaft curvature in different aged individuals using the included angle method. Specimens were aged based on tooth eruption and divided into age categories that corresponded to locomotor shifts. One-way ANOVA revealed significant variation in the included angle between each age category ($p < 0.05$). Post hoc analyses found that longitudinal curvature of the third metacarpal was significantly less curved in infant chimpanzees less than three years old, compared to older subadult and adult chimpanzees ($p < 0.05$), the latter of whom engage in much higher rates of quadrupedal locomotion compared to young infants. These results provide support for the idea that curvature in the metacarpal shaft may reduce variability in bending stresses experienced by the shaft and thereby increase stability during knuckle-walking. The skeletal correlates of knuckle-walking from this study are important in reconstructing locomotor behavior in the ape fossil record.

Poster Session III (Friday, November 4)

VARIATION IN THE MOLAR MORPHOLOGY OF *DIDELPHIS VIRGINIANA* AND ITS IMPLICATIONS FOR THE FOSSIL RECORD

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In the fossil record, mammalian taxa are routinely identified on the basis of molar morphology. The presence, absence, 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.

Using a light microscope, I examined the molars of extant *Didelphis virginiana* from the collections of the Smithsonian Institution, National Museum of Natural History, Division of Mammals. For each specimen (n=105), the four upper and four lower molars on the both the right and left sides were examined. 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. Variation in the presence/absence, size and shape of several stylar shelf cusps, as well as variation in postprotocrista was found in the upper molars. Variation in the postcristid was found in the lower molars. Some variations only appeared once in the sample, others appeared repeatedly. With respect to the latter, these variations occurred across the collection localities and four subspecies.

Poster Session II (Thursday, November 3)

THE CHINESE COLOSSUS: AN ANALYSIS OF THE PHYLOGENY OF *RUYANGOSAURUS GIGANTEUS* AND ITS IMPLICATIONS FOR TITANOSAUR EVOLUTION

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For many years the taxonomic history of Titanosauria has been a puzzle, and even today the phylogenetic positions and even the general morphological and evolutionary affinities of many titanosaurs and titanosauriforms are not well-understood, particularly the gigantic new Asian forms. One of the largest examples is the massive Chinese titanosaur *Ruyangosaurus giganteus* – though comprised of only six bones, the holotype preserves enough diagnostic features to offer several clues to its phylogenetic affinities. A preliminary review of literature on *Ruyangosaurus* shows that its initial classification as a member of Andesauridae is based on three weak characters that do not make for a definite diagnosis. *Ruyangosaurus* differs from the three taxa traditionally included in Andesauridae in multiple diagnostic characters of the vertebrae, femur, and tibia. Several plesiomorphies of *Ruyangosaurus* are rare or non-existent in titanosauria outside the clade Lognkosauria and its close relatives. The vertebra initially described as a posterior cervical is most likely an anterior dorsal, and shows a strong resemblance in its extremely wide, flattened proportions to the anterior dorsal of *Puertasaurus*. The recovered posterior dorsal vertebra of *Ruyangosaurus* shares a number of synamorphies with *Mendozasaurus* and *Pitekunsaurus*. External pneumatization of the vertebrae is moderate, and fine internal camellae are present, indicating a transitional position between the largely external pneumatic diverticulae in basal titanosaurs like *Andesaurus* and the heavily internalized pneumaticity of derived lithostrotians. The slender and proximally rugose femur is unusual in shape among titanosauria, having the fourth trochanter and lateral bulge located unusually high on the shaft, similar to *Malawisaurus*, *Traukutitan*, and *Pitekunsaurus* as well as a referred specimen of *Titanosaurus indicus* and two unnamed South American taxa. *Ruyangosaurus* is phylogenetically recovered as a probable lognkosaurian, with significant implications for the geographic distribution and evolution of that group and the paleobiology of Late Cretaceous China.

Poster Session IV (Saturday, November 5)

A REVIEW OF THE CRETACEOUS MARINE REPTILES FROM JAPAN

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A large number of specimens of marine reptiles are known from the Japanese Cretaceous, and we reviewed their taxonomy and stratigraphic distribution based on publications and personal observation of museum collections. Occurrences of the Chelonioidea, Mosasauridae, and Plesiosauria have been documented from north to south in the Upper Cretaceous rocks outcropped in the prefectures of Hokkaido, Iwate, Fukushima, Osaka, Wakayama, Hyogo, Kagawa, and Kagoshima, and the oldest report dates back to the 1920s. Possible plesiosaurian teeth are known from the Lower Cretaceous, but they are too fragmentary for confident identification. Holotypes of the following taxa are known from the Japanese Upper Cretaceous: dermochelyid *Mesodermochelys undulatus*, mosasauine *Mosasaurus hobetsuensis* and *M. prismaticus*, tylosaurine *Taniwhasaurus mikasaensis*, and elasmosaurid *Futabasaurus suzukii*. Remains of dermochelyids, mosasaurines, and elasmosaurids are fairly common, but less diagnostic materials of protostegiid turtles, plioplatecarpine mosasaurs, polycotylid and pliosauroid plesiosaurs were also collected. The Japanese chelonioid fauna is distinctly dominated by *Mesodermochelys*, and comparison with the chelonioid faunas of Europe and North America suggests a restricted geographical distribution of chelonioid species during the Late Cretaceous compared to their global distribution today. Relative abundance of the mosasaurine remains in Campanian-Maastrichtian records supports the global trend of increasingly mosasaurine-dominated mosasaurid faunas in post-Santonian time. Fragmentary elasmosaurid fossils are fairly common and known from all stages of the Upper Cretaceous, and serve as evidence of their continuous presence in the northwestern Pacific. Polycotylid specimens are fewer and their confirmed horizons are limited to the Cenomanian to Turonian. Pliosauroid specimens are very few and fragmentary, but they may extend the known stratigraphic range of the group significantly.

Poster Session I (Wednesday, November 2)

A NEW THEROPOD DINOSAUR FROM THE ROMUALDO *LAGERSTÄTTE* (APTIAN-ALBIAN), ARARIPE BASIN, BRAZIL

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Despite being one of the foremost fossiliferous deposits from Brazil, the dinosaur fauna from the Early Cretaceous Romualdo Formation is still poorly known. Up to now all records belong to theropods, representing spinosaurids and non-avian coelurosaurs. The specimens were collected in the carbonate concretions that are restricted to the upper portion of this stratigraphic unit and that gave it the status of a *fossillagerstätte*. Here we present the first evidence of a theropod dinosaur from the dark shales present at the base of the Romualdo Formation, close to the contact with the Ipubi deposits. The specimen, housed at the Museu de Paleontologia de Santana do Cariri (MPSC R-2089), is composed of an incomplete hind limb and *pes*. The distal end of the femur (width 72mm) is preserved in close connection to the tibia. Only proximal portion of the tibia is preserved including part of the shaft (preserved length 200mm; width at proximal end 75mm). The cnemial crest is well developed, followed by a deep ridge, and is not as high as in the Abelisauridae or *Ceratosaurus*. The robust fibula corresponds to less than half the width of the tibia (46mm). Metatarsals are short and unpinched, a plesiomorphic feature which exclude MPSC R-2089 from pertaining to more derived theropod clades with arctometatarsalian *pes*, such as Troodontidae, Tyrannosauroidea, and Ornithomimosauria. This specimen also does not belong to the Maniraptoriformes, due to the absence of thin elongated metatarsals. The *pes* is functionally tridactyl with digit one very reduced. The pedal phalanx II condylar eminence is less than half the total length of phalanx. It preserves only two short unguals correspondent to digits 3 and 4 (length: 35 and 31mm). MPSC R-2089 probably represents a basal Tetanurae, and is possibly related to the Spinosauridae, a clade previously reported from the Romualdo Formation. Comparisons with *Angaturama* and *Irritator* are limited, since those are based on cranial material. Since MPSC R-2089 represents the first dinosaur from the lower layers of the Romualdo Formation, and based on its size, it probably belongs to a new taxon.

Poster Session IV (Saturday, November 5)

INDIVIDUAL VARIATION IN *TRICERATOPS* FROM THE HELL CREEK FORMATION, MONTANA: IMPLICATIONS FOR DINOSAUR TAXONOMY

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In the absence of large monospecific bonebeds, it is difficult to assess the degree of individual morphological variation present within non-avian dinosaurs. Phylogenetic signals may be obscured not only by stratigraphic variation, but ontogenetic, sexual, and other intraspecific variation. New resolution of ontogenetic and stratigraphic trends in *Triceratops* (Ornithischia: Ceratopsidae) allows these variables to be accounted for. Here we present an assessment of individual cranial variation within the large (n>100) *Triceratops* sample from the Hell Creek Formation (HCF), Montana. The HCF sample demonstrates that two specimens from the same stratigraphic interval and ontogenetic stage may exhibit significant variation, particularly in size, degree of apparent cranial fusion, and the morphology of cranial ornamentation. Several subadult specimens far exceed the size of more mature individuals. Some very large specimens (skull length ≥2 meters) with heavily remodeled (mature) bone microstructure exhibit open cranial sutures and unfused epi-ossifications. Histological evidence reveals that many large, mature specimens were still undergoing restructuring of cranial morphology at the time of death. These findings indicate that relative size and apparent cranial fusion are unreliable as primary indicators of ontogenetic stage. Principal components analysis of landmark based measurements highlight variation in cranial ornamentation within ontogenetic stages, particularly in the postorbital horn cores which vary in length and robustness. Variation is also noted in the number of epi-ossifications, curvature of the epinasal, and morphology of the parietal fenestrae. Presently, there is no morphometric evidence for sexual dimorphism within *Triceratops*. Sexual variation in this genus may have been fairly subtle or expressed through coloration. Individuals followed the same general ontogenetic trajectory but varied in the rate at which features developed. These findings emphasize that alternate sources of variation should be explored before morphological characters in non-avian dinosaurs are considered taxonomically significant.

Technical Session XVIII (Saturday, November 5, 3:30 pm)

DEVELOPMENT OF THE LUNG IN *ALLIGATOR MISSISSIPPIENSIS* (ARCHOSAURIA: CROCODYLOMORPHA) AND THE EVOLUTION OF THE ARCHOSAURIAN RESPIRATORY SYSTEM

SCHACHNER, Emma, University of Utah, Salt Lake City, UT, USA; METZGER, Ross, University of California San Francisco, San Francisco, CA, USA; FARMER, C.G., University of Utah, Salt Lake City, UT, USA

The origin of the avian-style respiratory system is one of the fundamental questions of vertebrate evolution. Previously several potential homologies in the lungs of birds and crocodiles have been identified, suggesting that these features provide insight into the ancestral archosaur lungs; however, few recent studies have pursued this possibility. Here we describe the development of the bronchi in *Alligator mississippiensis* and compare it with that of the chicken (*Gallus gallus domesticus*), with the aim of identifying homologies and novelties in this respiratory system. Furthermore, we investigate the effects on morphogenesis of oxygen tension during development. Alligator eggs were obtained from the Rockefeller Wildlife Refuge in Louisiana and incubated under varying levels of oxygen. Lungs were dissected, fixed at relevant intervals, and immunohistochemistry was used to visualize the airway epithelium and pulmonary smooth muscle. Preliminary analysis indicates that bronchial chambers form by branching morphogenesis, and that the branching pattern appears to be stereotyped allowing for the identification of both homologies and novelties. In the earliest stages of development, the similarity in the formation of the primary bronchus and the most proximal secondary bronchi in both alligators and birds is striking. Furthermore, the second secondary bronchus to form in the alligator appears to be homologous with the first ventrobronchus in the chicken. The lungs differ in that chickens have four ventrobronchi while only one was clearly present in the alligator. Both dorsobronchi and lateral bronchi are present in both taxa. These pilot data suggest that similar molecular and genetic programs may underpin the morphogenesis of these lungs.

E&O Poster Session

QUALITATIVE CLASSROOM DATA ON THE DEVELOPMENT OF STUDENTS' UNDERSTANDING OF COMPLEX SYSTEMS IN VERTEBRATE PALEONTOLOGY AT A 2 YEAR COMMUNITY COLLEGE

SCHENCK, Robert, Kingsborough Community College, Brooklyn, NY, USA

Many students do not develop the ability to recognize a complex system when they are confronted with one and do not have the ability to understand one. Instead students try to apply simple linear models with single causes and direct effects to them. Student responses in a Community College introductory Oceanography class were studied to determine if a complex systems approach to course material could develop and if this approach could carryover to issues in vertebrate paleontology. A complex systems method of thinking involves: recognizing interactions among components, distinguishing levels of analysis, recognizing the influence of feedback mechanisms, and understanding emergent properties. Drafts and Final submissions of student term papers were examined for instances of linear and complex systems responses and compared. This allowed tracking of changes in the individual. Students were also given a small set of pre-test questions to which they provided written answers including diagrams and sketches. These questions contained a mix of material covered in class and material relevant to vertebrate paleontology. Linear and complex systems responses were noted. At the end of the course, a post-test was administered, evaluated similarly and compared. Degree of correlation between development of a complex systems approach on course and outside of course materials was determined.

Poster Session II (Thursday, November 3)

COMPARATIVE PALEAEOHISTOLOGY OF TRIASSIC RAUISUCHIAN AND AETOSAURIAN OSTEODERMS (ARCHOSAURIA: PSEUDOSUCHIA)

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Osteoderm material of eight rauisuchian taxa (*Batrachotomus kupferzellensis* from Germany, *Prestosuchus chiniquensis*, *P. loricatus* and *Rauisuchus tiradentes* from Brazil, *Ticinosuchus ferox* and a possible juvenile rauisuchian from Switzerland, *Tikisuchus romeri* and the putative *Yarasuchus deccanensis* from India), ten aetosaurian taxa (incl. *Aetosaurus ferratus* and *Paratypothorax andressorum* from Germany, *Stagonolepis olenkae* from Poland, and *Adamanasuchus eisenhardtae*, *Calyptosuchus wellesi*, *Desmatosuchus* spp., *Paratypothorax* sp., Stagonolepididae, *Tecovasuchus chatterjeei* and *Typothorax coccinarum* from North America), and the Upper Triassic pseudosuchian *Revueltosaurus callenderi* from Petrified Forest National Park, Arizona, as an outgroup were sampled histologically to elucidate the morphogenesis and structure of dermal armour in these diverse and widespread lineages of pseudosuchian archosaurs. Whereas the rauisuchian samples were found to be rather compact bones, usually lacking significant bone remodelling or large areas of cancellous bone, thus presenting good growth records, the aetosaurian samples showed well developed diploe structures in which the cancellous part can be quite extensive. This is in contrast to previously sampled Aetosaurinae osteoderms from South America (including *Aetosauroides scagliai*), which generally lacked a larger area of interior cancellous bone. In the rauisuchians, highly vascularised woven- or fibrolamellar bone tissue deposited in the core areas indicates higher growth rates early in development, whereas a more compact parallel-fibered bone matrix indicates reduced growth rates later in development. In the aetosaurian samples, woven- or fibrolamellar bone tissue, previously described also in Aetosaurinae osteoderms from South America, was found in *T. coccinarum*, whereas the other aetosaur osteoderms were predominantly composed of parallel-fibred or lamellar-zonal bone. In the *R. callenderi* osteoderm, the interior core consisted of dense cancellous bone, with dense trabecular bone being present only in the thick central region. Otherwise the specimen was composed of (often densely remodelled) parallel-fibred bone tissue.

Romer Prize/Technical Session 5 (Thursday, November 3, 12:00 pm)

TEMPO-SPATIAL PATTERNS IN THE EVOLUTION OF EXTANT AFRICAN BOVIDAE BASED ON MOLECULAR, FOSSIL AND CLIMATE NICHE DATA

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The Bovidae are the dominating large mammal group within fossil assemblages of African Neogene fossil sites. Due to a wide range of habitat adaptations, the presence of certain species within fossil assemblages provides detailed information about prevailing environmental conditions. However, this information is locally and / or temporally restricted due to a biased distribution and availability of fossil sites. Furthermore, taphonomic biases particulary affected species with low body size and / or adaptation to humid and forested environments.

Molecular analyses and climate niche models can help to overcome these difficulties. We produced a fossil calibrated phylogeny of 76 extant Afro-Arabian bovid species (95% of full sample). 11 fossil records served as calibration points, giving the first appearance dates of tribes and higher taxa. Analyses of divergence times show temporal patterns within the evolution of lineages adapted to humid and arid environments. Evidently major speciation processes occurred between 8-5 and 5-2.5 Ma. These events are in accordance with turnover pulses in fossil assemblages.

Additionally, we used the climate niche modelling approach usually applied for future distribution predictions. For the extant bovids this resulted in five major polyphyletic climate groups depending on 7 climatic variables: hot-wet, hot-dry, chilled-wet, chilled-dry and intermediate. A projection of the group´s preferences on climate scenarios for the two significant periods in bovid evolution shows a potential distribution during the Late Miocene and Pleistocene. The resulting hypothetical distribution maps connect fossil sites spatially and bridges gaps in the fossil records. Our approach combines paleontological and molecular methods and improves our understanding of macro evolutionary processes.

Symposium 3 (Thursday, November 3, 8:15 am)

VOLCANO-TECTONIC PARTITIONING OF LARAMIDIA: INFLUENCE ON CAMPANIAN TERRESTRIAL ENVIRONMENTS AND ECOSYSTEMS

SCHMITT, James, Montana State University, Bozeman, MT, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA

Campanian (83.5-70.6 Ma) Laramidia comprises a north-south trending paleogeographic province separated from the mainland of the North American continent (Appalachia) by the Western Interior seaway. Terrestrial vertebrate faunas of Laramidia, particularly those of late Campanian age (76.0-70.6 Ma), exhibit evidence of endemism hypothesized to represent either latitudinally discrete regional faunas or gradation between northern and southern faunal extremes and attributed to latitudinal climatic gradients.

We suggest that tectonically controlled elements along the north-south trending Sevier orogenic belt/foreland basin active during Campanian time also served as important physical and ecological barriers, partitioning the Laramidia landmass into latitudinally distinct provinces and influencing associated terrestrial depositional systems. These tectonic features include: 1) Elkhorn Mountains volcanic field (Helena salient of western Montana), 2) three major cross-strike structural discontinuities (CSD) within the Sevier orogen and related long-lived fluvial megafan systems (SW Montana/NW Wyoming, NE Utah, central Utah), and 3) zones of impingement between Laramide foreland uplifts and Sevier thrusting (SW Montana, NW Wyoming, NE Utah).

The 80-70 Ma explosive Elkhorn Mountains volcanic center impacted adjacent fluvial systems through input of volcaniclastic sediment, affecting channel morphology and floodplain ecosystem dynamics. Large, integrated drainage basins developed in the orogenic wedge at CSD locations (thrust belt recesses), providing large volumes of coarse sediment to large, braided fluvial megafan systems. Zones of impingement of Sevier thrust and Laramide reverse faults likely had lesser effects on depositional systems, as these Laramide uplifts (Blacktail/Snowcrest, ancestral Teton/Gros Ventre, Uinta) were nascient during Campanian time, providing primarily fine-grained detritus to fluvial systems. Each of these differing fluvial system styles partitioned the Laramidian alluvial plain into distinct ecosystems capable of engendering latitudinal faunal divergence that should be testable with more detailed sampling of the vertebrate fossil record.

Symposium 1 (Wednesday, November 2, 8:30 am)

AUTOPODIAL EXPRESSION IN MOUSE LIMBS DRIVEN BY A HOXD ENHANCER OF FINNED VERTEBRATES

SCHNEIDER, Igor, The University of Chicago, Chicago, IL, USA; ANEAS, Ivy, The University of Chicago, Chicago, IL, USA; NOBREGA, Marcelo, The University of Chicago, Chicago, IL, USA; SHUBIN, Neil, The University of Chicago, Chicago, IL, USA

The evolutionary transition of the fins of fish into tetrapod limbs involved genetic changes to developmental systems that resulted in a novel skeletal configuration. Approaches to understanding this problem have entailed the search for antecedents of limb structure in fossils, genes, and embryos. Previous studies have revealed that the expression of posterior Hox genes of the A and D paralogue groups in distal fins appears similar to that of tetrapod digits. These analyses of expression have stood in contrast to studies of Hox gene regulation, which suggested that Hox expression in distal appendages of tetrapods is regulated by novel enhancers not present in fish. Here, using a phylogenetic approach to transgenesis, we reveal that orthologous enhancer sequences of zebrafish and skates can drive expression in mouse digits and zebrafish fins. Our results reveal that the Hox enhancer, previously associated with the origin of digits, was present in the common ancestor of gnathostomes and that the capacity to drive expression in the autopod arose in fish.

Poster Session II (Thursday, November 3)

DIVERSITY OF AETOSAURS (ARCHOSAURIA:STAGONOLEPIDIDAE) IN THE UPPER TRIASSIC PEKIN FORMATION (DEEP RIVER BASIN), NORTH CAROLINA

SCHNEIDER, Vince, North Carolina Museum of Natural Sciences, Raleigh, NC, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA; FRASER, Nicholas, National Museums Scotland, Edinburgh, United Kingdom

Aetosaurs are an extinct clade of quadrupedal, heavily armored archosaurs that had a Pangean distribution during the Late Triassic. Aetosaur fossils from the Upper Triassic Pekin Formation in the Deep River Basin of North Carolina consist primarily of isolated osteoderms and, rarely, more associated material. Because aetosaur osteoderms are extremely distinctive, they are often used in taxonomic identifications. However, this has also lead to some confusion with the Pekin aetosaurs in the American Museum of Natural History (AMNH) collections being assigned, by various authors, to *Desmatosuchus*, *Longosuchus*, or *Lucasuchus.* Our reevaluation of the AMNH specimens confirms that they possess characteristics of *Lucasuchus*. We previously identified the diminutive aetosaur *Coahomasuchus* from an incomplete, articulated skeleton, but assignment of disarticulated material from the Pekin Formation remains problematic. An associated new partial carapace from the same quarry, North Carolina Museum of Natural Sciences (NCSM) 21723, includes 10 nearly complete paramedian and nine lateral osteoderms from the first 10 rows of osteoderms. An important feature of NCSM 21723 is that an articulated fifth row of cervical osteoderms almost encloses the neck, with prominent spines on both the dorsal and lateral osteoderms. This is a novel configuration among aetosaurs, but otherwise NCSM 21723 preserves a mosaic of character states found in *Longosuchus*, *Lucasuchus*, or both taxa while simultaneously preserving several more primitive character states. Consequently, we can interpret it as either a new taxon or conclude that variation in osteoderm characters is more extensive than previously documented. Either possibility affects the current practice of identifying aetosaur taxa to the genus level from osteoderms. Using current taxonomic practices, there are at least three genera in the Pekin Formation (*Lucasuchus*, *Coahomasuchus*, and NCSM 21723). The co-occurrence of *Lucasuchus* and *Coahomasuchus* strengthens correlation of the Pekin Formation to lowermost strata in the Dockum (Colorado City Formation) in West Texas.

Poster Session IV (Saturday, November 5)

NEW INFORMATION ON PACHYCEPHALOSAUR DINOSAUR DIVERSITY IN THE FOREMOST FORMATION (CAMPANIAN) OF ALBERTA

SCHOTT, Ryan, Univeristy of Toronto, Toronto, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

The diversity and interrelationships of pachycephalosaurian dinosaurs (Ornithischia: Marginocephalia) remain poorly resolved, due in part to the incomplete nature of their remains. Many taxa, including the enigmatic *Colepiocephale lambei* from the Foremost Formation (FF) of Alberta, are known only from partial frontoparietal domes. New fieldwork in the FF has recovered a number of new pachycephalosaur specimens including the first complete parietal and partial squamosal. The squamosal, which was found in the same sandy interval and in close proximity to a new frontoparietal dome of *C. lambei*, has two corner nodes and a secondary node row on the dorsal surface. An identical pattern of ornamentation is found in two squamosals collected from the lower Judith River Formation of Kennedy Coulee, Montana, and we conclude that these squamosals are from the same taxon, most likely *C. lambei*. A complete evaluation of pachycephalosaur material from the FF identified several frontoparietal domes that do not conform to the diagnostic morphology of *C. lambei*. Here we test the hypothesis that these specimens are distinct from *C. lambei* with both qualitative morphological comparisons and linear and geometric morphometric analyses of frontoparietal shape. Results suggest that these specimens are distinct from *C. lambei*, but we are unable to sufficiently distinguish the specimens from other taxa, notably *S. validum*, due to the limited nature of the material. This result doubles known pachycephalosaur diversity in the FF. We incorporate the new morphological information into a series of phylogenetic analyses of Pachycephalosauria, which include the FF squamosal as a distinct taxon and as *C. lambei*, to test the systematic position of FF taxa. When the squamosal is considered as a distinct taxon, it falls in a polytomy with *Goyocephale* and a clade containing all other pachycephalosaurs exclusive of *Wannanosaurus, Stegoceras, Colepiocephale*, and *Hanssuesia*. Inclusion of squamosal morphology in the scoring for *C. lambei* has no effect on the tree topology. These results are an important step towards an increased understanding of pachycephalosaur evolution and diversity during the Late Cretaceous.

Poster Session II (Thursday, November 3)

THE HISTOLOGY OF A MASSIVE TITANOSAUR FROM ARGENTINA AND IMPLICATIONS FOR MAXIMUM SIZE

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A massive titanosaur (MPM PV1156) was excavated in the Pari Aike Formation (Maastrichtian) of Santa Cruz Province, Argentina. Not only is this nov. gen et sp. similar in size to immense sauropods such as *Futalognkosaurus*, *Paralititan*, and *Puertasaurus*, but it also possesses over 80% of its skeletal elements, therefore representing one of the most complete extremely massive titanosaur skeletons. Transverse ground thin sections of the humerus of MPM PV1156 reveal cortical bone that has been subject to heavy secondary remodeling; the inner cortex is almost entirely composed of overlapping, well-defined secondary osteons with little remaining primary bone. However, though Haversian bone constitutes the majority of the cortex, a thick layer of unaltered, well-vascularized fibrolamellar bone extends between the remodeled inner cortex and the periphery of periosteal surface. Neither lines of arrested growth (LAGs) or an external fundamental system (EFS) are present at the periosteal margin. Recent work on the histology of titanosaurs such as *Lirainosaurus*, *Alamosaurus*, and *Magyarosaurus* has suggested that members of this group may develop extensively remodeled tissues—including a cortex completely replaced by Haversian bone all the way to the periosteal surface—after reaching sexual maturity but *prior* to attaining maximum size for their species. Thus, the presence of unremodeled fibrolamellar bone in the outer cortex of MPM PV1156 may indicate that despite its enormous proportions, this specimen had not reached senescence and was still growing at the time of its death.

Poster Session II (Thursday, November 3)

LATE NEOGENE *ALLIGATOR* EVOLUTION AND A DESCRIPTION OF SPECIMENS FROM THE GRAY FOSSIL SITE, SOUTHERN APPALACHIANS, USA

SCHUBERT, Blaine, Geosciences, East Tennessee State University, Johnson City, TN, USA; MEAD, Jim, Geosciences, East Tennessee State University, Johnson City, TN, USA; STOUT, Jeremy, Geosciences, East Tennessee State University, Johnson City, TN, USA

The Gray Fossil Site (GFS) is an extensive late Miocene-early Pliocene sinkhole deposit in northeastern Tennessee that preserves both flora and fauna. The site is reconstructed as a permanent lake with a surrounding oak-hickory forest, and the most abundant vertebrate fossils are from aquatic or semi-aquatic organisms, including tapirs, fish, salamanders, frogs, turtles, snakes, and alligators. The focus of this presentation is the *Alligator* material from the GFS, and a comparison of this taxon with previously described species in the genus. *Alligator* first appears in the late Eocene-Oligocene fossil record of North America and is of biogeographic interest because the genus dispersed into China during the Neogene. There are only two living alligators, *A. sinensis* of east-Asia and *A. mississippiensis* of North America. Most extinct *Alligator* species are from North America and date from Oligocene to Miocene. From oldest to youngest these are *A. prenasalis*, *A. mcgrewi*, *A. olseni*, *A. thompsoni*, and *A. mefferdi*. Most *Alligator* specimens from the GFS are osteoderms and fragmentary cranial and postcranial skeletal elements. In addition, there are four noteworthy specimens: a reasonably complete yet highly fractured juvenile skeleton, one pathological adult skull, and two partial skeletons without skulls. Osteological characters that separate late Neogene *Alligator* species are few, and some previously used characters may have polymorphic states. Analysis of the available GFS *Alligator* material indicates that it exhibits at least one morphological state thought to be generically unique to *A. olseni*, but in other characters it is similar to *A. mefferdi* or *A. mississippiensis*. Thus, the GFS *Alligator* possesses a unique mixture of characteristics found in other *Alligator* species, but no autapomorphies have been confirmed. Based on these results, it seems that the east-Asian *A. sinensis* had diverged from an unnamed clade that included *A. olseni* + *A. mefferdi* + *A. mississippiensis* prior to the deposition at the GFS, however, the relationships of these alligators remains unclear.

Preparators' Session (Thursday, November 3, 10:45 am)

USING NEUTRON RADIOGRAPHY TO QUANTIFY CONSOLIDANT PENETRATION IN FOSSIL BONE

SCHULP, Anne, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands; SCHOUTEN, Remmert, University of Bristol, Bristol, United Kingdom; METTEN, Lango, Institute for Energy, JRC EU, Petten, Netherlands; VAN DE SANDE, Alan, Institute for Energy, JRC EU, Petten, Netherlands; BONTENBAL, Aad, retired, Petten, Netherlands

When applying solvent-based consolidant systems in vertebrate paleontological conservation, it is important to understand the factors determining the distribution of the consolidant in the fossil. Of particular interest is the question under which conditions the consolidant may be dragged back to the bone surface by the evaporating solvent. This may result in the unwanted buildup of a thick layer of consolidant on the surface of the fossil, while generally a deep and isotropic penetration is preferred instead.

Physical sectioning of a fossil provides a quick, affordable and destructive assessment of the penetration characteristics of a solvent-based consolidant system. Neutron imaging instead, apart from being non-destructive, has the advantage of providing a much more quantitative, spatial impression of the actual distribution of the consolidant. Because of its non-destructive nature, it could potentially also provide better insight into the effect of multiple applications of consolidant.

Therefore, as a proof-of-concept, bone material from the type Maastrichtian (SE Netherlands) was partially consolidated and imaged using the High Flux Reactor facility (HFR) in Petten. As neutrons are particularly well absorbed by hydrogen bonds, many consolidants become clearly visible in otherwise neutron-radiolucent materials such as the fossils considered here. The fossil material was stored in a climate-controlled museum collection at 50-60% RH prior to making the radiographs. Air RH at the HFR facility was controlled at 55%. Neutron radiographs were made using sub-thermal neutrons, flux 7.88·109m-2s-1 with a reactor power of 45MW; exposure time 50 minutes, using a gadolinium backscreen. Field of view was 230 mm.

Neutron imaging of an acetone/methylmethacrylate system applied on type Maastrichtian mosasaur material showed that in this case, the consolidant distribution was rather even, and that the penetration of the consolidant, poorly visible and hard to assess on a physical section, turned out to be effective.

Technical Session XIII (Friday, November 4, 2:00 pm)

STRUCTURE AND FUNCTION OF DRYOLESTID MOLARS (MAMMALIA, CLADOTHERIA)

SCHULTZ, Julia, Universität Bonn, Bonn, Germany; MARTIN, Thomas, Universität Bonn, Bonn, Germany

The mesio-distally compressed and linguo-buccally widened pretribosphenic dryolestid molars are characterized by embrasure shearing. During occlusion the trigonids of the lower molars fit into the triangular spaces between the "primary trigon basins" of the upper molars. Striation analysis and virtual simulation of the chewing process using the newly developed "Occlusal Fingerprint Analyser"-software (OFA) were applied to study the function of the occlusal surface of the molars. The main cusps have mainly a puncture-crushing function, whereas the sharp pairs of leading edges paracrista/protocristid and metacrista/paracristid act as cutting devices probably for slicing hard exoskeletons of insects. In addition dryolestids evolved accessory shearing surfaces, mesial to the "primary trigon" and distal to the trigonid for further processing softer parts of food items. The unicuspid talonid of the lower molars with its buccally sloping hypoflexid groove has a guiding and shearing function, when the paracone slides along the groove in buccal direction during mastication. This groove is homologous to the hypoflexid of the tribosphenic molar, although in tribosphenic molars it is variably inclined and less involved in the occlusal contacts. The parastylar wing mesial to the "primary trigon" of the upper dryolestid molars has additional guiding function during the mastication process. The striations on the shearing surface at the distal side of the protoconid are more steeply inclined than the guiding groove of the hypoflexid. This indicates that the lower molar moves in two phases into occlusion during the chewing cycle: an initial puncture-crushing phase and a subsequent shearing phase before full centric occlusion. A grinding phase after centric occlusion as typical for tribosphenic molars does not occur in dryolestid molars. During the evolution of the talonid basin, the shearing area of the hypoflexid was displaced buccally and rotated in mesial direction. In combination with the formation of the talonid basin a functional shift in the chewing cycle from shearing to grinding occurred and the hypoflexid lost its function as a main shearing area.

Poster Session IV (Saturday, November 5)

WHERE DO ALL THE PITS COME FROM? THE EFFECT OF ABRASIVE SILICA PARTICLES ON TOOTH WEAR AND ITS IMPLICATION FOR PALEODIETARY INTERPRETATIONS

SCHULZ, Ellen, Biocenter Grindel and Zoological Museum, University of Hamburg, Hamburg, Germany; PIOTROWSKI, Vanessa, Biocenter Grindel and Zoological Museum, University of Hamburg, Hamburg, Germany; CLAUSS, Marcus, Clinic for Zoo Animals, Exotic Pets and Wildlife, University of Zurich, Zurich, Switzerland; GILDAS, Merceron, 3UMR 5276 (CNRS, ENS, University Lyon 1), research center of geology: earth, planets, environment, Villeurbanne Cedex, France; KAISER, Thomas, Biocenter Grindel and Zoological Museum, University of Hamburg, Hamburg, Germany

The dental microwear and 3D areal surface texture analyses are useful in reconstructing the diets of extinct and extant carnivores, ungulates and rodents. Both methods are based on comparing extinct with extant species. Based on microwear, a predominance of scratches had initially been interpreted as to indicate highly abrasive grazing diets, while a predominance of pits had been referred to a less abrasive browsing diet. But it is still debated if the phytoliths and / or the grit components scratch or pit the teeth. To evaluate the effects of abrasive silica particles and better understand the relationship between surface textures and paleodiet, controlled feeding experiments were conducted on a captive population of 32 rabbits (*Oryctolagus cuniculus*) over a period of 25 weeks using four blended animal feeds with known composition. The feeds consisted of grass meal (GG), grass meal with crushed oat (GH), alfalfa with crushed oat (LH) and alfalfa (LL). These represent a spectrum between C3 graze and leafy browse. Each type of animal feed was controlled for concentration of silica. The highest amounts of silica were observed in the GG feed the lowest in the LL feed. Moulds were made of the rabbit's lower molars after extended exposure to each diet and analyzed with dental microwear and 3D areal surface texture analysis. Based on both methods, the GG group has a high proportion of scratches and thus indicates the most abrasion-dominated wear signature. The LL group in turn has a high pit ratio and indicates the most attrition-dominated signature. Silica content was thus identified as the agent scratching dental surfaces. But high pit ratios were observed in the GG group as well. This is related to the higher chewing pressure needed to comminute grass components. We therefore conclude that pitting is not only a measure of browsing.

Poster Session IV (Saturday, November 5)

GEOLOGY AND MAMMALIAN PALEONTOLOGY OF THE CVANCARA LOCALITY (PALEOCENE), TONGUE RIVER MEMBER, FORT UNION FORMATION, GRANT COUNTY, NORTH DAKOTA

SCHUMAKER, Karew, University of North Dakota, Grand Forks, ND, USA; KIHM, Allen, Minot State University, Minot, ND, USA; WEILER, Matthew, University of North Dakota, Grand Forks, ND, USA; HARTMAN, Joseph, University of North Dakota, Grand Forks, ND, USA

The Cvancara Locality is a vertebrate-bearing channel-lag deposit of the Tongue River Member. The locality was discovered in 1962 because of the presence of marine bivalve fossils from the Cannonball Member, although the presence of vertebrate fossils was noted. Fossils are found within an ironstone concretion conglomerate approximately 40-60 cm above the inferred Cannonball-Tongue River contact. Vertebrate fossils were the primary focus of collecting efforts in 2000 and 2010. The conglomerate unit has produced abundant fish, turtle, champsosaur, and mammal fossils. The mammalian taxa present include multituberculates, primates, and condylarths. The multituberculates include *Mesodma* sp. and *Neoplagiaulax* sp. cf. *N. hazeni*. Two primate taxa are present: *Pronothodectes* sp. and *Picrodus silberlingi*, with the latter being a useful biostratigraphic indicator. The identification of *Pronothodectes* is problematic in that it falls between the size ranges of the two known species of the genus, *Pr. matthewi* and *Pr. jepi*. A lower molar of *Tetraclaenodon puercensis* was also recovered from the locality. The preliminary NALMA interpretation of the Cvancara locality is late Torrejonian (To3). This age interpretation is based on the presence of *Picrodus silberlingi*, an index taxon for the To3. If the multituberculate material, tentatively assigned to *Neoplagiaulax hazeni,* does in fact represent *N. hazeni,* then the age assessment will become more complicated as *N. hazeni* is only known from Tiffanian. Additional material may allow for a more confident age assessment. The geological setting of the Cvancara Locality is very similar to the Lloyd and Hares II locality, which has also been interpreted to be either late Torrejonian (To3) or early Tiffanian (Ti1). The age interpretation for the Cvancara locality helps to delimit the timing of the retreat of the Cannonball Sea and the subsequent development of fluvial systems of the Tongue River Member.

Technical Session IV (Wednesday, November 2, 2:15 pm)

SHOW ME YOUR EAR: LOCOMOTORY ADAPTATIONS IN THE INNER EAR OF SCIUROMORPHA (RODENTIA, MAMMALIA)

SCHWARZ, Cathrin, Universität Bonn, Bonn, Germany; RUF, Irina, Universität Bonn, Bonn, Germany; MARTIN, Thomas, Universität Bonn, Bonn, Germany

Spatial orientation and body movements in three-dimensional space are detected by the vestibular system of the inner ear inside the bony labyrinth of the petrosal bone. Sciuromorph rodents are particularly suited to study functional morphological adaptations of this sense organ as they represent different modes of locomotion (arboreal, gliding, fossorial, generalistic). Petrosals of four Late Oligocene (MP28) and Early Miocene (MN2) sciuromorph taxa as well as thirty extant taxa were studied by high-resolution computed tomography (μCT). For comparison, gliding and actively flying species of other groups (Marsupialia, Chiroptera) were included, and *Tupaia* sp. was taken as outgroup. The width, height, length, and diameter of the semicircular canals were used to study adaptations of locomotion and posture. A regression analysis and Principal Component Analysis (PCA) revealed a highly significant positive correlation between the diameter of the semicircular canals and the locomotory adaptation. The diameters of the semicircular canals in arboreal (Sciurini) and gliding (Pteromyini) Sciuromorpha are significantly smaller than in fossorial taxa (Xerini). This morphology is caused by different sensitivities of the inner ear, depending on the locomotor habits of the respective taxa. For a better locomotor coordination in the three-dimensional space, flying and gliding species possess a larger sensitivity of the inner ears, which is caused by thin semicircular canals. Due to close anatomical correspondence, the bony labyrinth provides information on the soft parts and the accordant physiological parameters in fossil specimens. The morphological analysis of the semicircular canals within the petrosal can provide important information on the locomotory adaptations of fossil taxa, even if no postcranial evidence is available.

Poster Session IV (Saturday, November 5)

PARTIAL SKELETON OF AN OLIGOCENE MOLE FROM THE FOSSIL LAGERSTÄTTE ENSPEL (GERMANY)

SCHWERMANN, Achim, Steinmann-Insitute for Geology, Mineralogy and Paleontology, Bonn, Germany; MARTIN, Thomas, Steinmann-Insitute for Geology, Mineralogy and Paleontology, Bonn, Germany

A partial skeleton of a young adult *Geotrypus antiquus* (de Blainville, 1840) from the Late Oligocene (MP 28) fossillagerstätte Enspel in Germany comprises the skull with both mandibles and complete dentition as well as parts of the axial skeleton, shoulder girdle, arms, hands, and one femur. For the first time, the dentition and humeri of an individual are preserved in association and confirm the earlier putative attribution of these diagnostically important skeletal elements.

During preparation, the fossil has been transferred to an artificial plastic matrix and was subsequently μCT scanned for a 3D analysis. Reconstruction of the skeleton of the forelimb revealed a highly fossorial adaptation for this basal representative of the genus *Geotrypus* similar to modern *Talpa europaea*. The scapula is very narrow and elongated with elliptic articular facets, the clavicula is short and stout, and the humerus is very robust with large proximal and distal processes. Like in *Talpa*, the metacarpals and phalanges are broad and shortened, and additional sesamoid bones have been detected in the hand. For the first time the prepollex (os falciforme) could be identified in a fossil mole. It is about of the same size as in modern *Talpa*. Minor differences to modern fossorial moles were found in the proportion of clavicula and humerus. In *Geotrypus* the clavicula is longer than wider whereas it is slightly wider than longer in the modern Scalopini and Talpini. Although the humerus of *Geotrypus* exhibits strong fossorial adaptations, it is a bit more slender than that of modern fossorial moles. The ratio from length to proximal width is 1.46, whereas it is 1.34 in *T. europaea*. In the scapula of *Geotrypus* a metacromion is still present, which is reduced in modern Scalopini and Talpini. A cladistic analysis based on a data matrix including 17 Recent taxa placed *Geotrypus* at a basal position within the Eurasian clade Talpini.

Poster Session I (Wednesday, November 2)

A NEW PLESIOSAURIDAE FROM THE PLIENSBACHIAN OF GERMANY AND ITS EVOLUTIONARY IMPLICATIONS

SCHWERMANN, Leonie, Steinmann Institute, University of Bonn, Bonn, Germany; SANDER, P. Martin, Steinmann Institute, University of Bonn, Bonn, Germany

In June 2007, a partly articulated skeleton of a plesiosaurid was discovered in a clay pit in North Rhine-Westphalia, Germany. Previously, plesiosaurid specimens had only been found in the Lower Lias (Hettangian and Sinemurian of England) and Upper Lias (Toarcian of southern Germany, England, and France) of Europe. The stratigraphic horizon of the new specimen is Pliensbachian in age, filling this stratigraphic gap in the plesiosaur fossil record. The skull and anterior part of the neck as well as the distal elements of the limbs are missing, but most of the axial skeleton is preserved. Altogether, there are 76 vertebrae (23 cervicals, one or two pectorals, 20-22 dorsals, 3 sacrals, and 28 caudals). Comparison with related taxa suggests that there were at least 10 more cervical vertebrae. The limb girdles and the proximal parts of the fore- and hindlimbs are also well preserved. Carpals, tarsals, and phalanges are scattered over the slab on which the specimen is preserved. A comparison of the new taxon with Lower Jurassic plesiosaurs in the collections of the Natural History Museum in London and the Museum of Natural History in Stuttgart and descriptions in the literature showed it to distinctly differ from known taxa. To corroborate the hypothesis of the specimen being a new taxon, it was added to an existing phylogenetic data matrix, and the analysis was performed using the same settings as in the original matrix. As a result, the specimen was described as a new taxon, *Westphaliasaurus simonsensii*, based on seven unambiguous synapomorphies. The new taxon was found to fit within the monophyletic Plesiosauridae, together with *Plesiosaurus dolichodeirus*, *Seeleyosaurus guelmiimperatoris*, *Microcleidus homalospondylus*, *Occitanosaurus tournemirensis*, and *Hydrorion brachypterygius*. Both, phylogeny and geographical distribution of the Plesiosauridae suggest that the radiation of the Plesiosauridae was a Europe-wide event.

Technical Session XVI (Saturday, November 5, 8:15 am)

NEW OSTEOSTRACAN TAXA FROM THE LOWER DEVONIAN (LOCHKOVIAN) MAN ON THE HILL LOCALITY IN CANADA, INCLUDING A NEW NON-CORNUATE OSTEOSTRACAN

SCOTT, Bradley, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada

The Osteostraci are armored jawless vertebrates considered to be the sister group to the Gnathostomata. Osteostracans are known from the Early Silurian to the Late Devonian. Osteostracans include both primitive, non–cornuate osteostracans (those lacking cornual processes, but retaining pectoral fins and with a headshield composed of small tesserae), and the more derived cornuate osteostracans. The geographic distribution of the Osteostraci was limited to the Laurentia, Avalonia, Baltica, and Kara terranes, and the Altaids. Non–cornuate osteostracans are distributed across Laurentia and Avalonia, with members of the Ateleaspidae from the Østlandet basin of the Baltica terrane. The ancestral distribution of the cornuate osteostracans has been resolved by previous work as being Spitsbergen, with dispersal by each of the three major clades of cornuates from this region. The new species from the Lower Devonian (Lochkovian) Man On The Hill (MOTH) locality, Mackenzie Mountains, NWT, Canada, include one in the genus *Machairaspis* along with a new species of *Waengsjoeaspis*. Two species form a clade with *Superciliaspis*, previously known from MOTH. A fifth is placed in Zenaspida as it shares characters with some members, but it does not share any of the previously proposed synapomorphies of the group. A sixth is the only known non–cornuate osteostracan from the Lower Devonian. It has clearly differentiated pectoral fins and trunk scales that share a number of features with early chondrichthyans. Based on a maximum-parsimony reconstruction of osteostracan biogeography following earlier work, the ancestral distribution of the clade containing the new non–cornuate osteostracan is resolved as Østlandet, whereas that of *Waengsjoeaspis* is unchanged in being resolved as Spitsbergen. The remaining MOTH osteostracans belong to the Zenaspida and several of them are in a clade unique to MOTH. For the Zenaspida as a whole, addition of the new taxa from MOTH reduces resolution of the group; however, the earlier proposed ancestral distribution of Spitsbergen for this clade cannot be rejected. The additional taxa quadruple the known species-level diversity of osteostracans at MOTH.

Poster Session IV (Saturday, November 5)

NEW SPECIES OF *UNUCHINIA* (MAMMALIA, APATOTHERIA) FROM THE PALEOCENE OF ALBERTA, CANADA: PHYLOGENETIC AND BIOSTRATIGRAPHIC IMPLICATIONS

SCOTT, Craig, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; BOYER, Doug, Brooklyn College, City University of New York, Brooklyn, NY, USA

Apatotherians are an unusual group of extinct mammals known primarily from the late Paleocene through Oligocene of North America and Europe. They are characterized by having enlarged upper and lower incisors, peculiar bladelike lower second premolars, and, where preserved, postcranial adaptations indicative of arboreality, including elongate manual digits that may have been used in ways analogous to those of the extant Aye-Aye. The higher level relationships of the group are uncertain, although recent analyses suggest a possible link to Euarchontoglires. Whereas members of one of the included subfamilies, the Euramerican Apatemyinae, are generally well known and represented by cranial and postcranial material, those of the second subfamily, the North American Unuchiniinae, are poorly understood, owing to rarity of specimens. We report here on a new species of *Unuchinia* from the Paleocene Paskapoo Formation of Alberta, Canada. The new species, represented by several dentigerous jaws and isolated teeth, provides important information on unuchiniines, including the first documented upper post-incisor dentition. The characteristic "can opener" shaped I1 and enlarged bladelike p2 confirm referral of *Unuchinia* to Apatotheria. *Unuchinia* differs from apatemyines in having two enlarged lower incisors, a two-rooted P2, a well-developed and two-rooted P3, a large three-rooted P4, transverse upper molars, relatively large p3 and p4, and lower molars with tall trigonids that lack a strong anterolabial projection of the paracristid. *Unuchinia* has previously been considered the most basal apatotherian on the basis of lower incisor number and lower molar structure; the suite of newly identified characters, including most importantly the large P3/p3 and transverse upper molars, supports this hypothesis. Fragmentary specimens of *Unuchinia* from the middle Torrejonian (To2) Who Nose? locality and the late Tiffanian (?Ti5) Gao Mine locality indicate that the fossil record of unuchiniines spanned most of the Torrejonian and Tiffanian in Alberta, and that *Unuchinia* and, more rarely *Jepsenella*, are the only apatotherians presently known from the Paleocene of western Canada.

Symposium 2 (Wednesday, November 2, 12:00 pm)

PLIO-PLEISTOCENE *EQUUS* IN WESTERN NORTH AMERICA: MORPHOLOGY, MOLECULES, AND CHANGES IN DIVERSITY THROUGH TIME AND SPACE

SCOTT, Eric, San Bernardino County Museum, Redlands, CA, USA

Recent investigations have highlighted discrepancies between anatomy-based and molecular studies assessing the diversity of Plio-Pleistocene North American *Equus*. Metrically, three basic groupings can be discerned: large and small stout-limbed horses, and "stilt-legged" horses. Within each of these groups, subsets can be distinguished on the basis of dental morphology. Based on these data, as many as ten species of *Equus* can be recognized in Plio-Pleistocene North America, although nowhere did all these species co-occur. In contrast, molecular studies of fossil and modern *Equus* have proposed that both stout-limbed and stilt-legged lineages may each have comprised single, wide-ranging, morphologically-plastic species.

The present study employs morphologic and metric data from large *Equus* at Plio-Pleistocene localities throughout the American west, documenting changes in representation and distribution of equid morphospecies through geologic time. Results are not in accord with interpretations advanced from molecular studies. The highly-successful large horse species *Equus scotti* is present in multiple early and middle Pleistocene faunas from throughout the region, exhibiting a relatively consistent size and morphology at different latitudes and showing little morphologic change through multiple glacial-interglacial transitions. This stability conflicts with inferences of high morphologic plasticity for *Equus* proposed from molecular studies.

In the late Pleistocene, following the immigration of *Bison* into midlatitude North America ≤240 ka, the species *Equus "occidentalis"* replaces *E. scotti* as the common large horse in the southwest. *Equus scotti* remains the common large species north and east of this range. The co-occurrence in geologic time of these two distinct morphologies, through multiple climatic oscillations, and the retention of their metric and morphologic distinctiveness for tens of thousands of years despite close geographic proximity and possible overlap of the two forms, indicates reproductive isolation and separation at the species level. This rebuts arguments that only one species of stout-limbed *Equus* was present in late Pleistocene North America.

Poster Session I (Wednesday, November 2)

DENTAL MICROWEAR TEXTURE ANALYSIS OF EXTANT AFRICAN BOVIDAE

SCOTT, Jessica, University of Arkansas, Fayetteville, AR, USA

Bovids are often used as paleoenvironmental proxies because they are among the most ubiquitous taxa at fossil sites and because modern ruminants fall into discrete dietary categories that reflect habitat preferences. Traditionally, bovids have been classified on a grazer-mixed feeder-browser continuum based on the percentages of monocots and dicots in their diet. However, actual bovid diets are more complex than these categories suggest and many intermediate classifications have been proposed, including variable grazers, browser-grazer intermediates, frugivores, and generalists. Studies of fossil bovids typically apply the principle of taxonomic uniformitarianism, and while rarely questioned for recent faunas, its utility for reconstructing the paleoecology of extinct species is uncertain. It is critical that ecological similarities of extant and fossil taxa be tested using an epigenetic signal in order to have confidence in these assumed relationships. Here I present a new database of dental microwear texture data for 25 species of extant African bovids, representing 6 dietary categories and various levels of mixed feeding. Point clouds were generated from M2 and M2 enamel bands using a white-light confocal profiler, and data were collected at a lateral sampling interval of 0.18 µm (resolution= 0.005 µm) over an area of 276 x 204 µm. Scale-sensitive fractal analysis attributes used to separate extant taxa with differing diets were calculated. The results show significant variation among the dietary classifications and confirm that grazing taxa have less complex, more anisotropic surfaces with smaller features than browsing taxa. The results also indicate that microwear texture analysis can successfully distinguish beyond the classic grazer-browser continuum and accurately classify various levels of mixed feeding. Some significant differences within dietary categories were also present, suggesting that texture analysis may have the potential to reveal seasonal and geographic differences in diet. These data have important implications for faunal-based paleoenvironmental reconstructions and can be applied to fossil taxa from sites and time periods across Africa.

Symposium 1 (Wednesday, November 2, 11:45 am)

EVOLUTION OF THE "OTHER" PART OF THE LIMB: FOSSIL AND DEVELOPMENTAL PERSPECTIVES ON MAMMALIAN SHOULDER GIRDLE EVOLUTION

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The shoulder girdle (SG) is comprised of the bones that attach the forelimbs to the axial skeleton. In the ancestors of mammals, these bones included the scapula and large, well-developed coracoids. In modern mammals, the SG consists of a single main bone, the scapula, and the coracoid has been reduced to a small scapular process. The reduction of the mammalian SG was associated with the evolution of an upright stance, and thereby many classic mammalian traits (e.g., endothermy, increased foraging, etc.). Evolutionary modifications in SG structure are also associated with the diversity of locomotor strategies employed by modern mammals. By incorporating data from paleontological, embryologic, genetic and molecular sources we have begun to investigate the intrinsic mechanisms by which (a) the modern mammalian SG evolved, and (b) was subsequently modified in mammals with diverse locomotor strategies.

The modern mammalian scapula is an amalgam of several elements with independent developmental and/or evolutionary origins (i.e., coracoid, scapular blade, scapular head, acromion). Our morphometric investigations of the integration of these elements in extant mammals, and their correlated evolution in fossil groups, suggest that these elements tend to vary independently among and within species. In line with this, the development of each SG element appears to be controlled by largely independent genes. For example, *Hoxc6*, *Pax1*, and *Emx2* have been linked to the development of the coracoid, acromion, and scapular blade, respectively. Using *in situ* hybridization to assay expression pattern and qPCR to

assay expression level, we have found that relatively subtle modifications in the timing and level of the expression of these genes coincide with the evolution of species-specific scapular morphologies in pig, mouse, bat and opossum, and likely drove the evolution of the modern mammalian SG as well. Taken together, our analyses suggest that the elements of the scapula develop and evolve in a highly modular manner, which may have contributed to the evolution of an upright stance and scapula, and thereby locomotor, diversity in modern mammals.

Technical Session X (Friday, November 4, 9:15 am)

FOREST STRUCTURE, CLIMATE, AND TIMING OF MAMMALIAN IMMIGRATIONS DURING THE PALEOCENE-EOCENE THERMAL MAXIMUM IN NORTH AMERICA

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Global warming of 5-10 °C opened high-latitude dispersal routes between Asia, North America, and Europe during the Paleocene-Eocene Thermal Maximum (PETM), which began ~56 Ma and lasted ~175 kyr. The carbon isotope excursion (CIE) associated with the PETM is well defined in the Cabin Fork Area of the southern Bighorn Basin, Wyoming, based on δ13C values in mammalian tooth enamel and soils. It spans 34m of strata. A large, stratigraphically well-resolved fossil collection from Cabin Fork shows that the first PETM immigrants to arrive in this part of North America were cursorial perissodactyls and artiodactyls, first appearing near the onset of the CIE. In contrast, arboreal euprimates first appear ~8-10m stratigraphically higher in the CIE, implying a substantially later arrival. We use δ13C values from mammalian tooth enamel to test the idea that differences in forest structure, specifically forest canopy, were associated with changing climate and the timing of mammal immigrations. A forest canopy can be recognized by mammals with exceptionally negative δ13C values, relative to the rest of the fauna, that reflect consumption of leaves from the understory. Because canopy development is precipitation dependent (~≥170 cm for closed canopy), we also calculate a humidity proxy by comparing δ18O values from the pantodont *Coryphodon* (aridity insensitive) with those from the equid *Sifrhippus* (aridity sensitive). Carbon isotope results are not consistent with the presence of a canopy, lacking negative δ13C outliers during the CIE. However, this could be explained by the absence of understory browsers in the fauna. The humidity proxy suggests a pattern of dry/wet/dry cycles in the PETM. The cursorial immigrants first appear in the lower dry interval at the beginning of the CIE, whereas the first euprimates appear in the succeeding wet interval. These results are consistent with the idea that drier conditions during the PETM resulted in more open forests favoring the dispersal of cursorial mammals, whereas later wetter conditions resulted in denser vegetation, although perhaps lacking a fully developed closed canopy, favoring the dispersal of arboreal euprimates.

Poster Session I (Wednesday, November 2)

INJURY IN A THEROPOD DINOSAUR FROM THE EARLY CRETACEOUS OF SPAIN

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The Ana locality is one of several dinosaur bone sites located in the Arcillas de Morella Formation (Aptian, Lower Cretaceous; eastern Iberian Chain, Spain). Over 700 fossils have been collected, including vertebrate and invertebrate species. Dinosaur bones (Theropoda, Ornithopoda and Sauropoda) are abundant.

Here, we report a pathological chevron of a theropod, which shows a big callus that deforms most of the upper part of the bone. Pathology in dinosaur bones has been reported for many groups, but it seems to be common in theropod dinosaurs.

The specimen corresponds to a proximal chevron (26.8 cm in length) belonging to an unidentified theropod. A bulbous and rugose callus is located on the left side of the chevron. This callus measures 12 cm dorso-ventrally, 6.5 cm cranio-caudally, and 3.5 cm laterally. The new osteological tissue exhibits low alienation with respect to the previous bone elements. The base of the broken left joint has shifted to the outside and has displaced the new left joint near the central axis of the chevron and forward. This displacement also implies a deformation and a partial obstruction of the chevron canal, reducing its dimensions by approximately 50% of its initial size.

The big size and rugose texture of the callus implies that the bone had not enough time to remodel the bony callus. In birds and mammals, bony callus appears at three to 16 weeks after injury, while the re-absorption of callus occurs after six month. This would suggest that the theropod from the Ana site died a few weeks after the traumatic event because the callus had not completely re-absorbed.

Poster Session IV (Saturday, November 5)

DIETARY RECONSTRUCTION OF CHINESE SHOVEL-TUSKED GOMPHOTHERES (MAMMALIA: PROBOSCIDEA): EVIDENCE FROM DENTAL MICROWEAR OF MOLAR TEETH AND TUSKS

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The shovel-tusked gomphotheres have long captured the attention and imagination of paleontologists due to their magnificent dorso-ventrally flattened mandibular tusks which resemble the head of a shovel. These uniquely shaped tusks have led to much speculation regarding the life history patterns in these forms as many theories have been put forth to attempt to explain the functional significance of these strange mandibular tusks (e.g., scooping up aquatic plants). Dental microwear has been used extensively to reconstruct mammalian dietary niche utilization and has proven itself to be a useful proxy for determining direct dietary behavior of both extant and extinct forms. Molar teeth and mandibular tusks of the middle Miocene gomphothere *Platybelodon* sp. from the Linxia Basin of China (Hujialiang Formation, Gansu Province) were examined using stereomicroscopy to reconstruct paleodiet and to test the hypothesis that *Platybelodon* used its mandibular tusks as shovels. Molar microwear scars are typical of extant mammals that browse on leaves and twigs. There is a distinctive ontogenetic trend toward coarser browse in older individuals. In addition, the orientation and nature of microwear scars on mandibular tusks is inconsistent with mandibular shoveling and more consistent with cutting or stripping of vegetation.

Technical Session XI (Friday, November 4, 2:00 pm)

MASS DISTRIBUTION AND FOOTPRINT AREA IN ELEPHANTS: FUNCTIONAL RAMIFICATIONS FOR LARGE-BODIED EXTANT AND EXTINCT TERRESTRIAL VERTEBRATES

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Body mass and its distribution across supporting limbs and functionally relevant flesh dimensions, such as footprint area, are very poorly known in large extant terrestrial vertebrates. Here we show that African and Indian elephants carry approximately 57% and 43% of their body mass on fore- and hind limbs, respectively, at rest in a quadrupedal stance. Fore- and hind limb footprint area is proportionate to mass loading at rest, resulting in an even distribution of mass across each footpad of approximately 100 KPa (14.6 psi). How this variable scales among other mammals with footpads and hooves or whether it remains constant in elephants or other large terrestrial mammals during growth or dwarfing is currently under study. We show how these data can be used to calculate the center of mass for a quadruped, a calculation that may be applicable to dinosaurian trackways. The predominance of dinosaurian trackways with equal-depth impressions for fore- and hind limb footprints suggests that there may exist previously unrecognized constraints in the design of large land quadrupeds such that foot area scales in proportion to mass loading at rest.

Poster Session II (Thursday, November 3)

USING GEOMETRIC MORPHOMETRICS TO EXPLORE THE MASTICATORY SYSTEM OF AILURIDS

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A morphometric study of jaw shape and lower teeth has been performed within Caniformia, focused on the family Ailuridae. Results show that, compared with other caniforms, the red panda (*Ailurus fulgens*) has a short and deep jaw, with a tall and forwardly oriented coronoid; an angular process which is positioned low; a second molar positioned close to the jaw joint; relatively developed cheek teeth (p4, m1 and m2), and a trigonid slightly longer than the talonid in m1. Compared with *A. fulgens,* the Late Miocene *Simocyon* has a less robust jaw with a less developed angular process (thus a shorter masseter), a backwardly oriented coronoid, molar teeth more distantly positioned from the jaw joint, a reduced second molar, and a higher ratio between trigonid and talonid lengths. The development of the masseter and the shape of the coronoid in the Mio-Pliocene *Pristinailurus bristoli* are intermediate between *Simocyon* and *Ailurus*. Moreover, the robustness of the jaw and the height of the coronoid (which estimates the temporalis moment arm) are similar to *Simocyon*. In contrast, the distance from the last molar to the jaw joint is closer to *Ailurus*. Finally, the Pliocene *Parailurus baikalikus* has a mandibular corpus and cheek teeth that are similar to those of *A. fulgens*, except for a longer trigonid.

The evolution of the chewing system of Ailuridae followed two directions during the Neogene: (1) simocyonines retained the mandibular shape of presumably omnivorous ancestor of ailurids, but their dentition changed towards a more carnivorous diet, increasing the dimensions of the trigonid; (2) ailurines modified their jaws and teeth for a more folivorous diet: sloping forward the coronoid; displacing the molar tooth row below the jaw joint; and increasing the moment arm of the masseter, the size of m2 and the dimensions of the talonid basin of the lower carnassial. Together, these features suggest that the degree of integration between the jaw and the lower dentition was greater in ailurids, which express adaptations

towards herbivory compared to the evolution of the chewing system towards flesh-eating in simocyonines, thus presenting a remarkable example of mosaic evolution.

Technical Session XVIII (Saturday, November 5, 12:15 pm)

NEW REMAINS OF *MIADANASUCHUS OBLITA* FROM THE LATE CRETACEOUS OF MADAGASCAR AND A REEVALUATION OF TREMATOCHAMPSIDAE

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Significant new material of the enigmatic crocodyliform *Miadanasuchus oblita* from the Upper Cretaceous Maevarano Formation of northwestern Madagascar permits a detailed diagnosis of the species and facilitates comparisons with other Cretaceous trematochampsids from South America and Africa. Originally identified several decades ago on the basis of fragmentary specimens, new remains including a well preserved partial skull and numerous isolated cranial and postcranial elements permit a comprehensive assessment of its morphology. *Miadanasuchus* is notable among crocodyliforms generally, and trematochampids in particular, for its wide, short rostrum; fused nasals; prominent, ventrolaterally expanded anterior maxilla bounded posteriorly by a deep notch for reception of a hypertrophied 10th dentary tooth; robust and relatively short mandibular symphysis with a relatively short splenial contribution; and prominent, ornamented ventrolateral flange of the angular. *Miadanasuchus* compares closely with other trematochampsid crocodyliforms including *Montealtosuchus arrudacamposi*, *Trematochampsa taqueti*, and *Hamasasuchus rebouli* in having a well-developed perinarial fossa, a prominent series of enlarged anterior maxillary teeth, and a laterally concave series of reduced mid-dentary alveoli. Reevaulation of taxa assigned to Trematochampsidae (and 'Peirosauridae') reveals a total of 12 valid members. A phylogenetic analysis of crocodyliform relationships incorporating many of these taxa recovers a monophyletic clade of Trematochampsidae incorporating members of the traditional 'Peirosauridae' in a close relationship with Mahajangasuchidae and *Araripesuchus* spp. Within Trematochampidae, a monophyletic clade including *Peirosaurus*, *Montealtosuchus*, and *Lomasuchus* suggests a Late Cretaceous radiation within South America. The presence of the trematochampsid *Miadanasuchus* in the Late Cretaceous of Madagascar is likely related to vicariance of a geographically widespread Trematochampsidae during Gondwanan fragmentation.

Technical Session III (Wednesday, November 2, 3:30 pm)

THE CLAWLESS OTTERS OF AFRICA (*AONYX*): MORPHOLOGY, ECOLOGY, AND FOSSIL RECORD

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The African clawless otters (*Aonyx*) occur today throughout sub-Saharan Africa in the vicinity of perennial water sources. These otters are relatively large-bodied (12–20 kg) and large-brained (~100 cm3), and they forage by hand for animal prey at the land-water ecotone. *Aonyx* includes two major forms: a craniodentally robust and megadont form that relies heavily on decapod crustaceans in both freshwater and marine environments, and a microdont form whose morphology and unique ecology are described here in detail for the first time. This study is based on an analysis of over 500 museum specimens (both fossil and modern) as well as field observations in the Democratic Republic of Congo. The microdont and megadont forms of *Aonyx* are allopatric, with the microdonts closely associated with the Guineo-Congolian forest zone and the megadonts broadly distributed across the rest of the subcontinent (excluding deserts). Within the megadont group, a geographic gradient in tooth size is apparent in both the Pleistocene and modern records, with the most robust specimens recorded from the coast of South Africa, somewhat less robust specimens from the southern African interior and West Africa, and the least robust of the megadonts from eastern Africa. Although the African clawless otters are usually grouped in a single species (*Aonyx capensis*), the microdont otters of the equatorial forest zone differ strikingly in morphology, behavior, and ecology, and they warrant specific recognition (*Aonyx congicus*). The fossil taxon, *Aonyx robustus*, is available for the massive Pleistocene specimens from South African archaeological sites, however these fossil otters clearly fit within the range of variation of extant populations from the same regions. The clawless otters of Africa provide a fascinating example of the interplay of morphology and ecology in mammal evolution.

Poster Session I (Wednesday, November 2)

THE SEXUAL DIMORPHISM OF *SHASTASAURUS TANGAE* (REPTILIA: ICHTHYOSAURIA) FROM GUANLING BIOTA, CHINA

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The taxonomy is highly controversial for ichthyosaurs of Guanling Biota (early Carnian, Guizhou, SW China), especially long-snouted large ichthyosaurs. Recently, all published 12 specimens, which had been named as different genus and species, were referred to one species, *Shastasaurus tangae*. Three additional ichthyosaur specimens have been prepared and are available for this study. These specimens can be confidently referred to *S. tangae* based on the cranial features; however, they are differentiated from the holotype of *S. tangae* by the limb morphology. In published specimens, the hindfin is thin and long and the metatarsal and proximal phalanges of digit II smaller or missing (Type A). In new specimens, the hindfin is relatively wider with well-developed preaxial accessory digit, and the metatarsal and proximal phalanges of digit II is similar in size as in digits III and IV (Type B). Furthermore, the postaxial accessory digit is distinct on the forefin of new specimens but not of published specimens. The specimens also show some variation on the relative width of skull and the angle of the bifurcated parietal sagittal crest. Measuring the size of each specimen these differences are not ontogenetic variation, but could be attributed to sexual dimorphism.

Poster Session II (Thursday, November 3)

ELUCIDATING SEMI-ARBOREAL LOCOMOTION OF SMALL GROUND SLOTHS (SUPERORDER XENARTHRA, ORDER PILOSA) THROUGH INDEX ANALYSES

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Order Pilosa (anteaters, ground, and tree sloths) are an ancient group of mammals, isolated on South America for 90 million years. Approximately 9 million years ago, ground sloths arrived in North America probably island hopping across the Caribbean. After the Isthmus of Panama arose, sloths disbursed as far north as Alaska. Their modes of traveling include the unique traviportal locomotion or bearing weight across the 5th carpal, metacarpal, and distal phalange bones of the manus and the 5th tarsal, metatarsal, and distal phalange bones of the pes. The extant two families of tree sloths are penduloportal (moving by hanging on the underside of branches). The two families of tree sloths are not closely related, and there lacks much evidence of an extinct ground sloth of closely shared ancestry. These distinct adaptations to the fore and hind limbs of a traviportal ancestor should provide a clear marker in evaluating the move from traviportal through semi-arboreal to penduloportal locomotion. By reducing the limbs into levers, measuring the length of the lever, load, lift, and fulcrum and formulating a series of indices of arboreal and semi-arboreal locomotion based on those measurements of both the fore and hind limbs for anteaters, ground and tree sloths, tree squirrels, pangolins, primates, and an opossum. The results were graphed in 2D and 3D scatterplots, placing smaller ground sloths from Caribbean islands within the 95% confidence ellipsoid with the semi-arboreal xenarthran species, supporting the small ground sloths' transition towards trees.

Poster Session I (Wednesday, November 2)

VALIDATING *DIMETRODON* SPECIES FROM THE BRIAR CREEK BONE BED (LOWER PERMIAN, ARCHER COUNTY, TEXAS) USING BONE HISTOLOGY AND MORPHOMETRICS OF FEMORA AND HUMERI

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The Briar Creek Bone Bed (BCBB) (Artinskian, Nocona Formation) in western Archer County is one of the richest sources of *Dimetrodon* bones in the Lower Permian of Texas, USA. Based on size, a small (*D. natalis*), an intermediate (*D. booneorum*), and a large species (*D. limbatus*) have been described from here and other localities of the same age. Alternatively, it has been proposed that these traditionally recognized species represent an ontogenetic series of only one species. This hypothesis was based on a regression analysis of the distal epyphisis width as a function of length in humeri. The ontogenetic series hypothesis, coupled with environmental interpretations of the sites, led to the suggestion that adults and juveniles of *Dimetrodon* preferred different habitats. However, the ontogenetic series hypothesis is inconsistent with the late ontogenetic state of the small bones as suggested by their morphology.

Histologic analysis of newly excavated material from the BCBB, procured over two field seasons, has resolved the discretion between these two competing hypothesis. The histologic data is complemented by regression analysis of the minimal femora and humeri diaphysis circumference as a function of length from the various *Dimetrodon* species. The histology of the cross-section of the diaphysis of the new specimens indicates that *D. natalis* is not the juvenile of a larger species and thus likely a valid taxon. Histology of the long bones consists of prominent lamellar zonal periosteal bone and a medullary region infilled with cancellous bone. Analysis of the juvenile femora revealed no visible growth cycles in the cortex, bones of intermediate size contain two growth marks, and the largerst specimens show up to four growth cycles, ending in a well developed external fundamental system. Radial canals and osteocytes seem to be more dense in the juvenile specimens. Large erosional cavities in the periosteum and secondary cancellous bone are abundant in the intermediate humeri. Validation of *D. boonerum* and *D. limbatus* is still unresolved.

Poster Session I (Wednesday, November 2)

A NEW SPECIES OF *TSAIDAMOTHERIUM* (BOVIDAE, MAMMALIAN): SECOND DISCOVERY OF THE UNICORNOUS ANTELOPE RESTRICTED TO CHINA IN THE LATE MIOCENE

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When *Tsaidamotherium hedini* was first discovered on the bank of Tossun Lake in the Thaidam Basin, it impressed the researchers by having only one robust plate-like horn core right above the cranium. There was no further occurrence of this mysterious antelope for over 70 years, until recently a new species, *Tsaidamotherium proboscis,* was found in the Late Miocene Liushu Formation of the Linxia Basin (equivalent to the European Vallesian), which is more than 700 kilometers away from the original locality. Both of the species belong to the *Hipparion* fauna in north China, and the fauna that the type species belongs to is relatively more primitive. The new species resembles the type species in a lot of aspects,

including the large size, a round horn plate of inflated parietal, a pair of stunted real horn cores above the orbit, obviously thickened basicranium, and round condyles without ridges. However, the undeveloped horn cores of *T. proboscis* are smaller and have a better fusion with the horn plate, representing a more specialized form. For the first time, the anterior part of the skull of *Tsaidamotherium* was found. The nasals and maxilla are extremely shortened and the nostrils are high and narrow, probably indicating a long nose. The premolars are also extraordinary small. Although the phylogenetic affinities of *Tsaidamotherium* are still under debate, its close relationship with other large ovibovines in north China in the late Miocene is unquestionable.

Poster Session II (Thursday, November 3)

FIRST ASSOCIATED SPECIMEN OF THE LATE CRETACEOUS SHARK, *CRETODUS* (ELASMOBRANCHII: LAMNIFORMES)

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Approximately 120 teeth and 60 vertebrae of a large lamniform shark, *Cretodus crassidens* (Dixon), were recently collected from the Blue Hill Shale Member (Middle Turonian) of the Carlile Shale near Tipton in Mitchell County, Kansas, USA. The specimen, now housed in the Sternberg Museum of Natural History, Hays, Kansas (FHSM VP-17575), is significant because it represents the first known reasonably complete, associated material of the genus *Cretodus* Sokolov. The tooth set includes both functional and replacement teeth in which the tallest fully developed tooth is about 41 mm in crown height and 52.5 mm in total tooth height. Although a strong tendency of monognathic heterodonty is exhibited, the inferred dental pattern is of the lamnoid type with at least 10 tooth rows in each jaw quadrant. Because many teeth have a tall erect main cusp with at least one pair of lateral cusplets, the dentition was suitable for grasping prey. Unlike the teeth, many vertebrae occurred in articulation within irregularly-shaped concretions from which a total vertebral count was taken based on radiographic examination using a computed tomography scanner. The vertebrae are also of the lamnoid type, and they measure up to 74 mm in diameter. If one compares the largest centrum diameter and the largest crown height in the *Cretodus* specimen to those of another Cretaceous lamniform, *Cretoxyrhina mantelli* (Agassiz), this *Cretodus* specimen is extrapolated to have measured between 4.2 and 5.1 m in total length. Because large individuals of *Cretoxyrhina mantelli* have previously been interpreted to be formidable predators, it is likely that large *Cretodus* individuals also occupied the highest trophic level within their preferred range. Whereas *Cretodus crassidens* and *Cretoxyrhina mantelli* lived contemporaneously, based on the fossil record the two taxa likely practiced resource partitioning within the North American Western Interior because the former occurs more commonly in near-shore deposits and the latter in off-shore deposits.

Poster Session IV (Saturday, November 5)

X-RAY COMPUTED TOMOGRAPHY OF TWO EXCEPTIONALLY PRESERVED NEONATE MAMMOTHS FROM SIBERIA

SHIRLEY, Ethan, University of Michigan, Ann Arbor, MI, USA; ROUNTREY, Adam, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; TIKHONOV, Alexei, Zoological Institute, Russian Academy of Sciences, Saint-Petersburg, Russia; BUIGUES, Bernard, International Mammoth Committee, Saint Mandè, France

Lyuba and Khroma, two neonate mammoths from northwest and northeast Siberia, respectively, are the best-preserved mammoth specimens yet recovered. Lyuba's age-estimate is ca. 42,000 yrBP, but Khroma's assay returned an "infinite" result (>45,000 yrBP). Because of their completeness, stringent conditions were placed on their study. Some dissection and limited sampling was allowed, but both specimens were left mostly intact. X-ray computed tomography (CT) thus offered our only access to significant parts of their anatomy. Here we report observations on skeletal morphology, intracranial volume, and diagenetic history.

Lyuba and Khroma have markedly different skull morphologies, especially in their premaxillae and mandibles, which are wider and more robust in Khroma. Khroma also has an ossified, projecting, "mustache"-like structure, absent in Lyuba, on the anterior margin of the premaxillae.

These differences led us to suspect early-onset sexual dimorphism. External genitalia indicate that Lyuba is female, and aDNA analyses confirmed this, but aDNA analyses are not yet complete for Khroma. However, analysis of soft-tissue structures of the urogenital tract, visible in CT data, suggests that Khroma may also be female.

Alternative explanations for the morphologic differences focus on disparities of time and geography, including the possibility that these specimens represent different species.

Intracranial volume in both specimens measures approximately 2.3L. Eutherian neonatal brain size varies with maternal basal metabolic rate and duration of gestation, making comparison of these values with those from modern elephants of particular interest. However, published brain sizes for neonatal elephants are based on weight and are highly variable.

Causes of death for Lyuba and Khroma may have been similar, based on sediment in the trachea, seen in CT data, but their diagenetic histories were likely different. In Lyuba, but not in Khroma, vivianite is found throughout the body, including as nodules within bones. The phosphate in Lyuba's vivianite is interpreted as derived from her bones via lactic acid exposure, a process that evidently did not figure in Khroma's diagenesis.

Poster Session IV (Saturday, November 5)

MONUMENT VALLEY PALEONTOLOGICAL SURVEY, PART III: NEW LOCALITIES FROM THE LATEST BRIDGERIAN—EARLIEST UINTAN NALMA TRANSITION IN THE ADOBE TOWN MEMBER OF THE WASHAKIE FORMATION, WASHAKIE BASIN, SOUTHWESTERN WYOMING

SHOUP, Ben, ARCADIS U.S., Inc., Buffalo, WY, USA; ADAMS, Jason, ARCADIS U.S., Inc., Boulder, CO, USA; SCHAAF, Clint, ARCADIS U.S., Inc., Buffalo, WY, USA

Paleontological resources from various NALMAs in the Washakie Basin of southwestern Wyoming have been intensively collected and studied for over 130 years. Cognizant of the paleontological significance of this region and potential future impacts, the Bureau of Land Management (BLM) recently commissioned surveys to document previous discoveries and potential new localities on specific land parcels with high paleontological sensitivity. In 2010, ARCADIS U.S., Inc. was retained by the BLM to complete Part III of the Monument Valley Paleontological Survey encompassing nearly 3,800 acres in "The Haystacks" area of the Washakie Basin. Review of previous investigations revealed hundreds of collections made in this area from the 1870's to the mid 1990's, most notably work by the Field Museum of Natural History. The survey conducted in August, 2010 resulted in the discovery of 42 new vertebrate localities from the Adobe Town Member of the Washakie Formation. Of the localities, 26 contained exclusively mammalian fauna, while others included various mammal, turtle and crocodilian specimens. Most specimens discovered were representative of large artiodactyls and perissodactyls (particularly brontotheres and equids). One locality contained a creodont. Stratigraphic position of the localities could be accurately determined due to extensive outcrops and presence of well-defined marker beds. Several localities are of particular interest because of their stratigraphic proximity to the boundary between the latest Bridgerian and earliest Uintan NALMAs. Further investigations of specimens from these localities may aid in clarifying the transition between Bridgerian and Uintan faunas in the Washakie Basin. ARCADIS prepared a detailed report on these localities which included resource management recommendations. In total, 16 of the new localities discovered during the field survey were determined to contain significant vertebrate paleontological resources in immediate danger of degradation, theft or vandalism due to the extent of exposure. The BLM is the primary agency responsible for the management of these resources under the Paleontological Resources Preservation Act. By implementing adequate protective measures, such as collection and curation of these resources, the BLM can mitigate permanently damaging impacts, maximize data recovery, and present future research opportunities for specimens from these localities.

Symposium 1 (Wednesday, November 2, 8:15 am)

FOSSILS, GENES AND THE SEARCH FOR ANTECEDENTS OF THE TETRAPOD LIMB

SHUBIN, Neil, The University of Chicago, Chicago, IL, USA; SCHNEIDER, Igor, The University of Chicago, Chicago, IL, USA

Antecedents of the tetrapod limb are now known at every level of biological organization in fins. Fossils and the comparative anatomy of extant forms reveal that the three fundamental segments of limbs-- stylopod, zeugopod, and autopod-- are present in finned vertebrates. Homologies extend across the skeleton as well, from features on the humeri to those in the proximal carpus. Indeed, the genetic processes that pattern these three segments are also primitive to limbs: the suite major patterning genes are present and their regulatory architecture and function appears conserved. Aspects of tetrapod gaits are also seen in diverse finned vertebrates, including dipnoans. Taken together, major characters of limb structure, development, and even walking, are more general in their phylogenetic distribution than digits. While functional, paleontological, and genetic work continues to push apomorphies of crown tetrapods down the tree, numerous puzzles emerge. What are the regulatory processes that are actually unique to tetrapod digits? Why do the closest relatives of limbed vertebrates possess fins with a lungfish-like metapterygial axis? The search for antecedents brings new answers to old questionsand thereby enables us to ask more precise questions going forward.

Technical Session II (Wednesday, November 2, 3:30 pm)

NEW INFORMATION ON THE TRIASSIC VERTEBRATE FAUNAS OF ANTARCTICA

SIDOR, Christian, University of Washington, Seattle, WA, USA; SMITH, Roger, Iziko: South African Museum, Cape Town, South Africa; HUTTENLOCKER, Adam, University of Washington, Seattle, WA, USA; PEECOOK, Brandon, University of Washington, Seattle, WA, USA; HAMMER, William, Augustana College, Rock Island, IL, USA

Antarctic strata of the Fremouw Formation preserve the best record of Lower and Middle Triassic vertebrate life at high paleolatitude. In the austral summer of 2010–11, we made substantial collections of tetrapods from the Beardmore Glacier region, central Transantarctic Mountains. At Graphite Peak, we collected a scattered skeleton representing the first vertebrate from the Buckley Formation (i.e., below the lowest Fremouw sand body), although adjacent paleosol morphology suggests a Triassic age for this section of the Buckley. A near-complete skeleton of a small archosauromorph (likely *Prolacerta*) was found beneath a partially articulated *Lystrosaurus* and at the same stratigraphic level as 'giant-type' vertebrate burrows, and a larger archosauriform (likely *Proterosuchus*) was recovered from

slightly higher in section. At Coalsack Bluff, a small, scattered skeleton (?therocephalian/cynodont) was found in an olive-green, rooted siltstone (i.e., Dolores paleosol) just above the last Buckley coal, possibly representing the oldest Triassic tetrapod yet recovered from Antarctica. We suggest that vertebrates found in the lower siltstones of the lower Fremouw correspond to the post-extinction recovery fauna of the Karoo Basin, South Africa. Fossils from the upper Fremouw at Fremouw Peak document the second Middle Triassic vertebrate locality from the Transantarctic Mountains. Previously known to record an indeterminate species of *Parotosuchus*, new collecting has yielded the ilium of a large dicynodont, a temnospondyl interclavicle, a large temnospondyl mandible, and possible archosauriform limb bones, among other specimens. We returned to Gordon Valley, the original Middle Triassic (Anisian) vertebrate site, and collected new material from the primary bone-bearing conglomerate, including a jaw tentatively assigned to *Cynognathus*. Importantly, we also collected the skull of what may represent a new, narrow-snouted temnospondyl from a second horizon ~4 meters lower in section. The faunas of Antarctica and South Africa evolved increasing dissimilarity from the Early to Middle Triassic, mirroring regionalization seen elsewhere in the Anisian of Gondwana.

Technical Session XV (Saturday, November 5, 8:30 am)

REASSESSMENT OF THE MORPHOLOGY AND PALEOBIOLOGY OF THE THEROCEPHALIAN *TETRACYNODON DARTI* (THERAPSIDA) BASED ON CT-SCANNING, AND THE PHYLOGENETIC RELATIONSHIPS OF BAURIOIDEA

SIGURDSEN, Trond, Université de Montréal, Montreal, QB, Canada; HUTTENLOCKER, Adam, University of Washington, Seattle, WA, USA; MODESTO, Sean, University College of Cape Breton, Sydney, NS, Canada; ROWE, Timothy, University of Texas at Austin, Austin, TX, USA; DAMIANI, Rossano, La Trobe University, Melbourne, Australia

The Lower Triassic baurioid therocephalian *Tetracynodon darti* is here redescribed, partly with the use of CT-scanning, and analyzed in the context of therocephalian relationships and biology. The previous description of this taxon is found to be inaccurate in several respects, and the anatomical descriptions are therefore expanded and corrected. The presence of a maxillary shelf similar to that of *Lycideops* is present, and *T. darti* also shares a nasal-lacrimal contact with that taxon. Several internal ridges on the nasals are present, as in many other therapsids, and these may mark the attachment of nasoturbinals. However, there is no evidence for the presence of maxilloturbinal bones. The CT-data reveals the braincase in great detail, and the fact that the dorsum sellae is formed by the prootics is confirmed. The postcranial skeleton is generally slender and similar to that of regisaurids and other small baurioids. A cladistic analysis of 34 therapsid genera and 129 craniodental and postcranial characters is performed to shed light on the relationships of *T. darti*. There is little unambiguous evidence for a sister taxon relationship between the two *Tetracynodon* species, although the validity of the genus cannot be rejected with confidence. Part of the problem is the possibility that some of the shared features of *T. tenuis* and *T. darti* may either be due to the juvenility of the specimens, or represent genuine synapomorphies. However, the analysis reveals evidence for a monophyletic Lycideopidae within Baurioidea. This clade includes *Lycideops, Choerosaurus* and *Karenites*, as well as *T. tenuis* and *T. darti*.

Poster Session II (Thursday, November 3)

COMPARATIVE STUDY OF TWO POPULATIONS OF THE SABERTOOTHED FELID *PROMEGANTEREON OGYGIA* (FELIDAE, MACHAIRODONTINAE) FROM BATALLONES-1 AND BATALLONES-3 SITES (LATE MIOCENE, MN 10,TORREJÓN DE VELASCO, MADRID, SPAIN)

SILICEO, Gema, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; SALESA, Manuel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; ANTÓN, Mauricio, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; MORALES, Jorge, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

The fossil sites of Batallones-1 and Batallones-3 are located within the Cerro de los Batallones Late Miocene paleontological complex (Madrid, Spain), which has yielded an abundant and exceptionally preserved sample of fossils of the order Carnivora, around 98% of the total sample. Both localities were formed as cavities in sepiolite levels, acting as natural traps for the carnivorans, which were trapped while trying to scavenge on animals trapped previously. Recent studies on the micromammals of Batallones-1 and Batallones-3 suggest a difference in age, with the former being older than the latter. The carnivoran sample from both sites also shows several differences, such as the presence in Batallones-3 of the ursid *Indarctos* sp., and the mustelid *Eomellivora* sp., which are absent in Batallones-1. In order to better understand these differences, we studied one of the most abundant carnivorans in both assemblages, the primitive saber-toothed felid *Promegantereon ogygia*. Several significant biometrical and morphological differences were found between the populations. The dentition of *P. ogygia* from Batallones-3 shows a relatively smaller lower canine, a reduced m1 talonid and P4 protocone, and a narrower P3, features that indicate more emphasis on cutting in the dentition. The postcranial skeleton of *P. ogygia* from Batallones-3 is characterized by a straight and narrower calcaneus, a metacarpal II with an elongated attachment area for the muscle flexor carpi radialis (flexor of the hand) and an overall slender postcranial skeleton. Some of these differences can be related to a reduction in the weight of the hind limb, which points towards an increase in the cursorial abilities of the Batallones-3 form, whereas others indicate the presence of stronger flexor muscles of the hand, related with the need for prey immobilization during hunting. In summary, the population of *P. ogygia* from Batallones-3 shows several derived characters compared with that from Batallones-1. Only future studies including the whole sample of fossils of *P. ogygia* from Batallones-3 will establish the taxonomic status of this population.

Poster Session IV (Saturday, November 5)

REMARKABLE NEW LIZARD SPECIMENS FROM THE EARLY CRETACEOUS OF BRAZIL

SIMÕES, Tiago, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The Mesozoic record of lizards can be considered rare compared to other fossil vertebrates, especially in the Gondwanic derived continents. This is due to, among other reasons, their extremely delicate skeletons, creating considerable taphonomical biases. One deposit of South America that has provided some lizard material, including two named species (*Tijubina*, *Olindalacerta*), is the Early Cretaceous (Aptian) Crato Formation of the Araripe Basin, northeast Brazil. Here we report three yet undescribed specimens (all housed at the Museu Nacional, Rio de Janeiro) from this deposit, that provide not only a rich amount of new osteological data, but also an extremely rare quality of soft tissue preservation. The technique of ultraviolet photography allowed the identification of several muscle striation marks and some other soft tissues. On the ventral side of MN 4817-V, granulated scales in the neck region, arms and trunk laterals were observed, with rhomboid scales on the trunk's medial portion. Osteodermal plates are also visible beneath the mandible, being relatively large in comparison to the adjacent scales. The musculature is partially preserved, including portions of the ventral lower jaw muscles and, under the left femur, the *M. puboischiotibialis* which allows the flexion of the crus and adduction of the thigh. Specimen MN 7234-V exhibits the whole body contour, as well as soft tissue impressions around the pelvic girdle, hind limbs and tail which were attributed to connective tissues, such as tendons. Specimen MN 7233-V has granular scale marks around the neck and anterior trunk region, as well as unidentified soft tissue close to the pelvic region. To our knowledge the new specimens are the best preserved Mesozoic lizards from South America and constitute a significant opportunity to establish a better understanding of the terrestrial squamate fauna of this continent and provide a rare insight into the soft tissue anatomy of extinct lizards.

Technical Session XIII (Friday, November 4, 1:45 pm)

DETERMINING DIET FROM THE CROSS-SECTIONAL SHAPE AND INTERCUSPID NOTCHES OF THE TEETH OF CARNIVORANS FROM RANCHO LA BREA

SIMPLER, Elizabeth, Penn State University, State College, PA, USA; HARTSTONE-ROSE, Adam, Penn State University, Altoona, PA, USA; KRISTEN, MacNeill, Penn State University, Altoona, PA, USA; JONATHAN, Perry, Midwestern University, Downers Grove, IL, USA

The quality of the Rancho La Brea (RLB) carnivore collection allows for fine-grained comparisons of dental-dietary morphology. In this study we analyze two variables in the postcanine dentition: intercuspid notches (ICN) and cusp radius-of-curvature (ROC). We compare the large RLB carnivorans to a broad sample of modern carnivorans with respect to carcass-processing ability along a hypercarnivory-durophagy continuum. ROC data demonstrated that, the RLB felids (*P. atrox* and *Smilodon*) and canids (*C. dirus*, *C. latrans* and *C. lupus*) all have relatively blunt premolars. In fact, the premolars of the RLB taxa are blunter than those of any modern felid or canid species, nearly into the range of the modern hyaenids. This finding would support the assertion that the RLB carnivores were capable of more thoroughly processing carcasses than their modern equivalents because they were less likely to be damaged when processing harder carcass components (e.g., bone). The ICN data suggest a surprisingly different conclusion: by that measure the RBL carnivores appear fairly hypercarnivorous; the RBL canids sort with the most hypercarnivorous canids and even approach some felid species. Likewise, both *P. atrox* and *Smilodon* plot at the hypercarnivorous end of the felid spectrum in their ICN scores. This strange combination of blunt cusps and highly notched premolars places the RLB carnivores outside the range of modern carnivores. In fact, this combination is found in the fascinating *Chasmaporthetes* – an extinct hyaenid that appears to have been fairly hypercarnivorous. Thus, because there are no modern analogues with this particular combination of anatomical signals, it is difficult to assess the carcass processing abilities of the RLB carnivores.

Poster Session II (Thursday, November 3)

STRUCTURE AND FUNCTION OF A PROTOSUCHIAN MANDIBULAR SYMPHYSIS USING ANATOMICAL INSIGHTS FROM *ALLIGATOR MISSISSIPPIENSIS*

SKILJAN, Rebecca, University of Missouri, Columbia, MO, USA; GANT, Cortaiga, University of Missouri, Columbia, MO, USA; HOLLIDAY, Casey, University of Missouri, Columbia, MO, USA

Mesozoic crocodyliforms evolved a variety of cranial adaptations associated with carnivory, herbivory, and a spectrum of intermediate dietary niches. Protosuchians were unlike most, more derived taxa in that they possessed fewer, blunter teeth, relatively shorter skulls, and more robust mandibular symphyses--features commonly associated with a durophagous lifestyle. As part of a broader study identifying evolutionary and functional patterns in cranial joints in crocodyliforms, we compared the structure and function of the jaws of a protosuchian crocodyliform with those of *Alligator mississippiensis* with a focus on the role of the mandibular symphysis, a previously unstudied joint with key functional insights into feeding

behavior. An ontogenetic series of alligator symphyses was CT-scanned and histologically sectioned to identify key soft- and hard-tissue components of the joint including ratios of interdigitation, ligament structure, and Meckel's cartilage. The osteological correlates of these tissues were then identified, reconstructed, and incorporated into a microCT-scan derived finite element model of the jaws of the Kayenta protosuchian, loaded with jaw muscle forces and a molariform bite point and compared to a similarly built model of *Alligator*. Whereas older *Alligator* individuals possess class III, interdigitated symphyses, the protosuchian taxon has a class I fibrous joint. However, like *Alligator*, Meckel's cartilage appears to be continuous across the midline of the joint, and moreover, the splenials suture across the midline adding additional, albeit weak reinforcement of the joint. Modeling found both taxa experience significant working- to balancing-side transmission of forces, however those in *Alligator* were of higher magnitude. This suggests the relatively larger, class I protosuchian symphysis may compensate for the lack of interdigitation and still effect a bite force capable of chewing hard foods. These results also suggest the protosuchian symphysis was likely a transitional form between the fibrous joint of stem crocodylomorphs, and more derived crocodyliforms.

Poster Session III (Friday, November 4)

THREE DIMENSIONAL DIGITAL MICROSCOPY OF SMALL- AND MICROVERTEBRATE FOSSILS

SLOAD, Eric, Appalachian State University, Boone, NC, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; SCHNEIDER, Vince, North Carolina Museum of Natural Sciences, Raleigh, NC, USA

Micro- and small vertebrates are important components of many fossil assemblages, but are difficult to image using conventional microscopy. Even when using scanning electron microscopy (SEM) problems include destructive carbon tape and coatings, limitation to greyscale images and cumbersome manipulation of specimens. We have successfully used a high resolution digital microscope to gather high definition (up to 54 mega pixel) images, as well as 3-D images that can be rotated in virtual space. Specimens analyzed include the holotypes of *Colognathus obscurus* (Case)*, Uatchitodon schneideri* Mitchell, Heckert and Sues, and *Pseudotriconodon chatterjeei* Lucas and Oakes as well as other microvertebrates. These fossils were captured in both two- and three dimensions in multiple orientations, and range in size from less than 400 micron-long *Lissodus* teeth to a 7.6 cm-long referred specimen of *Colognathus* at magnifications ranging from 10 to 200x. There are several advantages to using a digital microscope over SEM, including: but are not limited to; no need for coatings of any kind, specimens are easily manipulated, even while microscope is on, and capture of full color and three dimensional images which retain natural lighting. This method also takes less time to capture images over SEM. The model we used also has the ability to automate the capture of depth composed images, eliminating depth of field issues, and allowing for perfect focus on all areas of the specimen, regardless of distance from objective lens, and can utilize objective lenses with magnification up to 5000 times. Capture of full color, high resolution two and three dimensional images with accurate scales allows for qualitative and quantitative comparison of specimens without the need to physically possess them. This enables greater communication of visual data, while still retaining accuracy. Digital microscopy could be used in textural and wear analysis, as well as morphometric analysis of individual elements. Museum institutions often will not loan some specimens, especially holotypes, so this method of image capture has great potential for increasing access to paleontological data.

E&O Poster Session

NATIVE EXPLORERS: INCREASING MINORITY PARTICIPATION AND OPPORTUNITES IN MEDICINE AND THE NATURAL SCIENCES

SMITH, Kent, OSU-Center for Health Sciences, Tulsa, OK, USA; WEIL, Anne, OSU-Center for Health Sciences, Tulsa, OK, USA; CZAPLEWSKI, Nicholas, SNOMNH, Norman, OK, USA; WHITTEN, Reggie, Whitten-Newman Foundation, Oklahoma City, OK, USA; HARGRAVE, Jeff, Native Explorers Foundation, Oklahoma City, OK, USA

Native Americans are the most under-represented minority in science and medicine in the United States (US). Oklahoma State University Center for Health Sciences (OSU-CHS) in Tulsa, Oklahoma is located in a tribal jurisdiction and has an unique opportunity for outreach in both science and medicine. The goal of the Native Explorers program is to expose Native Americans with an interest in higher education to a variety of scientific disciplines and to the field of medicine, and to educate them about potential careers. Native Explorers seeks Native people who have earned a high-school degree or equivalent and are interested in continuing their education. It offers a two-week intensive summer course, focusing on hands-on participation in activities the students would perform in school or professionally. The students are mentored by Native and non-Native faculty, graduate and medical students, and professionals. The program begins on the OSU-CHS campus, where participants learn about anatomy, osteopathic medicine, healthful lifestyles, and paleontology. Fortunately, paleontology integrates many disciplines and incorporates medical technologies. Subsequently the program moves off-campus, and the students learn to read topographic and geologic maps, prospect for and collect vertebrate fossils, and explore the natural history of the region. A key attribute of the Native Explorers program is partnerships with state and federal agencies, which includes colleges and universities, tribal colleges, and museums, and the US Forest Service, US Fish and Wildlife, and Bureau of Land Management. The program mentors from the Forest Service are geologists, archeologists, range management specialists, fisheries biologists, and botanists. These experts provide field experiences on the conservation and management of the natural resources and information about summer internships and careers. We hope to have a profound influence on our participants' professional trajectories, inspiring an appreciation of the natural sciences and tying the meaningfulness of scientific careers to stewardship and understanding of the natural world that is central to Native American traditions and culture.

Preparators' Session (Thursday, November 3, 11:30 am)

SEISMIC MITIGATION FOR PALEONTOLOGICAL DISPLAY SPECIMENS

SMITH, Matthew, National Park Service, Holbrook, AZ, USA; NUNAN, Elizabeth, American Museum of Natural History, New York, NY, USA

Potential damage caused by seismic activity and rough handling of exhibits by museum visitors is a threat faced by all museum displays. Traveling exhibits are particularly at risk as they may move from localities with low probability of seismic activity to areas that are more prone to earthquakes. An American Museum of Natural History traveling exhibition, "Dinosaurs: Ancient Fossils, New Discoveries" was scheduled to travel to venues in seismically active areas in southern California and central Italy. Seismic mitigation was not integrated into the exhibit design during the original fabrication in 2005.

After consultation with museum conservators, changes were made to twenty six specimen mounts or mounting techniques in an attempt to better secure specimens and minimize damages in the event of an earthquake. The modifications occurred during the 1-2 week periods between exhibition venues when specimens were accessible by museum staff. Due to time constraints, any modifications had to be simple, practical and inexpensive. The aim of these modifications was to decrease the potential for lateral and vertical movement due to seismic forces. Tie downs, anti-walkers, and removable clips were added to mounts that previously relied mainly upon gravity to secure paleontological specimens. Microcrystalline wax was used in some cases to secure casts, and it was avoided if possible with fossil material. Specimen mounts with removable clips have the added advantage of reducing damage caused by abrasion between the specimen and its mount while installing the object. Several of the earliest modifications were unintentionally tested by the April 4, 2010 Mexicali Earthquake which shook San Diego with a Modified Mercalli Intensity scale of V-VI, with the result that no damage occurred.

Technical Session XII (Friday, November 4, 2:15 pm)

BODY MASS AND FORAGING ECOLOGY PREDICT EVOLUTIONARY PATTERNS OF SKELETAL PNEUMATICTY IN THE DIVERSE "WATERBIRD" CLADE

SMITH, Nathan, The Field Museum of Natural History, Chicago, IL, USA

Extensive skeletal pneumaticity is a distinguishing feature of birds. Pneumaticity varies considerably among the >10,000 living species, with notable patterns including increases in large-bodied forms, and reductions in birds employing underwater pursuit diving as a foraging strategy. Selection for weight reduction related to locomotor demands, including aerial flight, is a prominent causal explanation for the former pattern, while the latter pattern is often explained as an energy-saving adaptation driven by selective pressure to reduce buoyancy in pursuit divers. I assessed the relationship between skeletal pneumaticity and body mass and foraging ecology, utilizing a dataset of the diverse 'waterbird' clade (including e.g., penguins, loons, herons, pelicans) that spans a broad range of trait variation. Inferred changes in pneumaticity and body mass are congruent across different estimates of phylogeny, whereas pursuit diving evolved independently between two and five times. Phylogenetic regressions detected positive relationships between body mass and pneumaticity, and negative relationships between pursuit diving and pneumaticity, whether independent variables are considered in isolation or jointly. Results are generally consistent across different estimates of topology and branch lengths. However, consideration of extinct taxa suggest that some transitions in pneumaticity likely occurred at different nodes, and the correlation of pneumaticity with body mass may be weaker than that inferred from extant taxa alone. Phylogenetically informed 'predictive' analyses reveal that several pursuit divers (loons, penguins, cormorants, darters) are significantly apneumatic compared to their relatives, and demonstrate that significance depends on the amount of phylogenetic information included. These results provide the strongest support yet for hypotheses regarding the evolution of avian skeletal pneumaticity as (at least partly) an energy-saving adaptive feature influenced by body mass and foraging ecology. These findings are also supported by qualitative patterns of increased pneumaticity in large-bodied taxa documented within pterosaurs, sauropods, and theropods.

Technical Session XV (Saturday, November 5, 9:15 am)

ANATOMY OF AN EXTINCTION: END-PERMIAN DROUGHT INDUCED DIE-OFF IN THE KAROO BASIN, SOUTH AFRICA

SMITH, Roger, Iziko South African Museum, Cape Town, South Africa; BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa

The southern Karoo Basin of South Africa contains an uninterrupted terrestrial record of the Permo-Triassic boundary (PTB). Isotope- and magneto-stratigraphy confirm that these fluvial strata are approximately the same age as zircon-dated marine PTB sections (252Ma). To date, our team has found 580 identifiable, *in situ* vertebrate fossils, mostly therapsids, in PTB exposures at four separate locations. Biostratigraphic range plots reveal a pronounced extinction event within the same stratigraphic interval in each of the PTB sections as well

as a regular order of taxon disappearances and taphonomic signatures that are interpreted as reflecting real changes in the original populations due to rapid climatic drying and drought. Within the uppermost 45 meters of the Balfour Formation, the sequence of sedimentological facies reflects progressive straightening of the channels and floodplain rubification. Although thicknesses vary, this sequence remains consistent across all sections and is interpreted as indicative of a rapid climatic warming and drying with the onset of a monsoon-type rainfall regime. In the lowlands of the Karoo basin ground level ferns, clubmosses and liverworts were the most susceptible to the lowering of groundwater. Consequently the formerly flourishing populations of small gregarious herbivorous dicynodonts such as *Diictodon* and *Pristerodon* decreased and eventually disappeared along with their medium-sized gorgonopsian predators (*Aelurognathus*, *Cyonosaurus*). As droughts became more frequent the *Glossopteris* riparian woodlands thinned out causing large-bodied dicynodonts (*Dicynodon*, *Aulacephalodon*, *Dinanomodon*) and their attendant carnivores to die off. A terminal drought phase is recognizable in all the sections as a roughly 5 meter-thick interval containing 1-3 beds of generally rubified finely laminated mudrocks with very little pedogenic modification. Rare skulls and fragmental caniniform processes of the larger Permian taxa *L. maccaigi*, *Moschorhinus* and a very rare skull of *Dicynodontoides* occur in this interval, the top of which is regarded as a reliable lithostratigraphic marker of end of the End-Permian mass extinction in the Karoo Basin.

Poster Session IV (Saturday, November 5)

PRESENCE OF ONYCHONYCTERID BATS IN THE EARLY EOCENE OF EUROPE

SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; HABERSETZER, Joerg, Senckenberg Forschungsinstitut, Frankfurt, Germany; SCHLOSSER-STURM, Evelyn, Senckenberg Forschungsinstitut, Frankfurt, Germany; SIMMONS, Nancy, American Museum of Natural History, New York, NY, USA; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA

Onychonycteris finneyi from the late Wasatchian (Wa7) of the Green River Formation in Wyoming, represents one the most primitive bats ever found. Together with *Icaronycteris index*, also from the Green River Formation, they constitute the best known early Eocene bats based on complete skeletons. Unfortunately, all other early Eocene bats are nearly exclusively known from dental remains only, making comparisons difficult. Micro-CT scanning of the teeth of *O. finneyi* has enabled study of occlusal tooth surfaces and allowed for a diagnosis based on the dental characters of Onychonycteridae to be formulated. Interestingly, the molars present a plesiomorphic pattern whereas the premolars appear more derived, similar to those found in *Eppsinycteris anglica* (middle Ypresian, MP8+9, Abbey Wood, London Basin, England); *Ageina tobieni* (Early Eocene, MP8+9, Mutigny, Marne, France); *Honrovits tsuwape* (late Wasatchian, Wa7, Wind River Formation, Wyoming); and "*Hassianycteris*" *joeli* (late Ypresian, Belgium; here transferred to the genus *Honrovits*). All of these taxa can be grouped in the family Onychonycteridae and differ from other bat families by: posteriorly tilted coronoid process of the dentary; P3/p3 and P4/p4 more reduced than in Icaronycteridae, Archaeonycteridae, Hassianycteridae and Palaeochiropterygidae; M1-2 of relatively square shape, especially M1 that is nearly as long as wide with centrocrista that does not reach the labial border; paraconule presents and metaconule minute or absent; ectoflexus relatively wide and shallow; p4 metaconid very small to absent; m1-3 with short cristid obliqua and hypoconulid well developed and nearly median on the talonid. This characterization of onychonycterid teeth has clarified the taxonomic position of several European and North American bats that previously could not be identified at the family level, and indicates that these continents shared several generic and family level taxa in the early Eocene. Identification of members of this primitive family in Europe opens the possibility that Onycthonycteridae – and perhaps the entire chiropteran order – might have originated in Europe.

Technical Session III (Wednesday, November 2, 3:15 pm)

CONSTRAINTS ON TOOTH SHAPE AND JAW MOTION IN CARNIVOROUS MAMMALS

SMITS, Peter, Monash University, Melbourne, Australia; EVANS, Alistair, Monash University, Melbourne, Australia

Dasyuromorphia is a group of Australian marsupial carnivores with ecological and morphological similarities to many of the placental carnivorans. While carnivorans have a single pair of carnassial teeth, in dasyurids each molar is adapted for shearing and slicing. Additionally, dasyurids have a greater overall number of teeth than most carnivorans. Both jaw motion and tooth shape have been studied in Carnivora, but similar work has not yet been done on dasyurids. The extinct creodonts are another interesting comparison to both dasyurids and carnivorans, having one or two carnassial pairs that are not homologous to that in Carnivora. 3-D morphometrics of carnivorous mammal skulls has also found that creodonts occupy a middle ground between carnivoran and dasyurid skull morphologies. Using 3-D scans of tooth and skull elements, orientation patch count (a measure of tooth row complexity or number of surfaces) and jaw motion information were calculated. Jaw motion is quantified as both the angle between initial tooth contact and centric occlusion and the lateral distances between the initial tooth contact and centric occlusion. A diverse selection of dasyurid were sampled and compared to a survey of carnivoran taxa. Our analysis has shown a strong correlation between tooth shape and movement of the jaw during occlusion in both dasyurids and carnivorans. This is consistent with previous work showing a change in carnivorans, but has now been expanded to a morphologically conservative group of carnivorous mammals. This shows that form and functional relationships are consistent between distantly related taxonomic groups.

Poster Session IV (Saturday, November 5)

INTERPRETATIONS OF A FOSSIL TRACKWAY FROM THE ST. LOUIS LIMESTONE

SNYDER, Daniel, Middle Georgia College, Dublin, GA, USA

In the 1980s, a large slab of Early Carboniferous (Viséan) limestone was quarried in the vicinity of northern St. Louis, Missouri USA. Several sets of impressions on the slab's surface were identified as tracks and the slab was donated to the St. Louis Science Center. The laminated sandy limestone and weathered surface, consistent with nearshore subaerial exposure, demonstrate the trackway is most likely from the nearshore marine Lower St. Louis Limestone.

A series of six impressions in negative epirelief are approximately 40 mm by 45 mm, and 155 mm apart. Four or five indistinct sub-impressions are preserved, each with the smaller sub-impressions approximately perpendicular to the largest sub-impression and the direction of travel. Small (1-2 mm) piles are present on at least two impressions. The series of six are likely real tracks, as they have a common structure, spacing and orientation. They do not bear close resemblance to known invertebrate tracks. Following the discovery of tetrapod remains from the St Louis Limestone, this slab was reexamined. However, the trackway is no more than broadly similar to known Carboniferous tetrapod tracks. The tracks may be impressions of digits, a manus/pes, or partial impressions of both. It also is not clear which of the associated impressions are part of the main trackway or are tracks from other organisms passing through. Three competing hypotheses are tested: the tracks are paired; the tracks are staggered; and the impressions are from multiple trackmakers, and therefore, posture and locomotory style cannot be determined from the trackway as preserved.

In light of these problems, no new ichnotaxon is defined. Future work will include additional collection in quarries in the St. Louis area.

Poster Session IV (Saturday, November 5)

NEW INFORMATION ON THE BRAINCASE AND INNER EAR OF THE ORNITHOPOD DINOSAUR *DYSALOTOSAURUS LETTOWVORBECKI* BASED ON X-RAY COMPUTED MICROTOMOGRAPHY

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While the inner ear of hadrosaurs is fairly well understood, the structure in basal ornithopod taxa and its subsequent evolution remains poorly known. Despite the good preservation of its braincase, little attention has been given to the Upper Jurassic dinosaur *Dysalotosaurus*, an ornithopod of uncertain phylogenetic relationships. For the first time, the material was scanned using high-resolution X-Ray computed tomography and the resulting images made possible further description and correction of several previously misidentified inner ear and braincase structures. Digital endocasts of the inner ear reveal that the anterior semicircular canal is slightly longer than the others, not extending beyond the common crus and being somewhat medially bent. Unlike in hadrosaurids, the posterior semicircular canal is the shortest. This is similar to theropods and may indicate the plesiomorphic condition for dinosaurs. The horizontal semicircular canal lies above the level of the vestibule. The lower end of the cochlear duct partially excavates the basioccipital/basisphenoid, but because both the medial wall and the floor of the otic capsule are not ossified, it is hard to determine its shape and orientation. As estimated from the distance between the lagenar crest and the lower margin of the prootic, the length of the cochlea can be considered relatively long, as more derived theropods. Because the crista interfenestralis is broken, a separation between the fenestra ovalis and the fenestra pseudorotunda is not discernible. The vagus nerve left the braincase via its own foramen, indicating a full bony subdivision of the metotic foramen and the presence of a fenestra pseudorotunda, a derived feature of unknown origin within crown-group Archosauria. From this preliminary analysis, the inner ear of *Dysalotosaurus* shows a mosaic of characters and regardless of its phylogenetic position, it seems that the changes in the hadrosaurid inner ear did not take place early in ornithopod history.

Poster Session III (Friday, November 4)

MAMMALS OF THE TARIJA VALLEY (SOUTHERN BOLIVIA): DIVERSITY, ENDEMISM AND THE PROBLEM WITH ITS ANTIQUITY

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The Tarija Valley is located in southern Bolivia, 140 km north of the border with Argentina. During the last 400 years, several paleontological expeditions worked there, but unfortunately most of the collected fossils lack precise stratigraphic and geographic provenance. However, the fossils were used to establish chronologies and correlations with the Pam-

pean Region ('PR', Argentina). The fossiliferous units were referred either to Early and/or Middle Pleistocene (Ensenadan and Bonaerian PR stages, respectively), and to the Late Pleistocene-Early Holocene (Lujanian PR stage). More than 90 taxa were reported, many of them considered as endemic. We present here the preliminary results of a taxonomic revision (including new fossil remains collected during our field work) and analyze the diversity and probable age of the Tarija mammals. We proposed that: (1) with respect to the endemic species published, at least four are not endemic (*Megatherium tarijense, Scelidodon tarijense, Arctotherium tarijense*, *A. wingei*), since they are registered in the PR, too; (2) in Tarija, there is a high frequency of pampatherids, gomphotherids, equids, hydrochoerids and tapirs, and a low taxonomic diversity of glyptodonts and tayassuids, compared with the PR; (3) two species that are distributed exclusively in the Ensenadan of the PR (*Glyptodon munizi* and *Arctotherium angustidens*) are also recorded at Tarija. According to recently published data, the fossiliferous levels are located at the upper part of the sequence, which was deposited during the Late Pleistocene, this implies a local survival of these species; (4) the lack of stratigraphic information for the previously collected fossils prevents us from assuming that every specimen comes from the upper levels of the Tarija sequence; and (5) some faunal elements (Hydrocheridae, Tapiridae) suggest a predominance of wet and warm environments, in contrast with that proposed for the PR. Finally, we took samples of volcanic ash and sediment (associated with well identified fossil remains) for dating.

Technical Session XVII (Saturday, November 5, 2:45 pm)

SYSTEMATICS OF EXTANT AND EXTINCT AFRICAN SUIDAE INFERRED FROM LANDMARK-BASED GEOMETRIC MORPHOMETRIC ANALYSIS OF CRANIO-MANDIBULAR SHAPE

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Fossil Suidae (wild pigs) are abundant in Plio-Pleistocene African sites and have been widely used as powerful biostratigraphical indicators due to their rapid changes in third molar morphology and size through time. However, their taxonomy is still debated and based mostly on dental evidence. In order to explore the potential of cranio-mandibular morphology as a taxonomic tool, it seems crucial to first quantify morphological variation in extant Suidae. To this purpose, 90 cranial and 45 mandibular landmarks were gathered using a Microscribe 3-D digitizer from a total of 200 specimens representing the five species of the three genera of extant African suids (*Potamochoerus*, *Phacochoerus* and *Hylochoerus*). Landmark data were treated using Generalized Procrustes analysis to remove all non-shape differences. They were then subjected to Principal Components Analysis in order to assess major axes of shape variation and discriminate the relative effects of different factors (age, sex, geographic origin and inter-individual variation) on shape of the skull among and within living African suid species. Variation in global skull size was also assessed using centroid size. Fossil specimens belonging to the genus *Kolpochoerus* and coming from Plio-Pleistocene sites from Ethiopia and Kenya were then included into this comparative dataset and subjected to a similar analysis with special focus on the most frequently preserved parts (maxilla and mandibular symphysis). Comparisons of intra- and inter-specific variation in extant African Suidae to the patterns observed in the fossil record seem to confirm the division of the genus *Kolpochoerus* into two long-lived and diverging anagenetic lineages (*K. limnetes* and *K. majus* lineages). It also highlights the strong phenetic affinities of the middle Pleistocene *K. majus* specimens with the extant species *Hylochoerus meinertzhageni*.

Technical Session XIV (Saturday, November 5, 8:30 am)

FUNCTIONAL 3D KINEMATICS AND SURFACE MORPHOMETRICS OF THEROPOD HIP-JOINT

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Quantitative methods of motion and shape analysis offer promising tools to reconstruct function in fossil species. We used a functional classification of joints to create a conceptual model of hip-joint function in extant theropods. In order to validate the model, we tested its predictions against the 3D kinematics of walking in two species of modern birds. Our results show that the complex 3D motion of the femur during walking can be accurately approximated by simple rotations around an axis well described by the *in vivo* anatomical axis of the femoral neck. This functional axis passively generates simultaneous parasagittal and mediolateral femoral motions. This conceptual model provides a better understanding of the role of the antitrochanter in generating long-axis rotation of the femur, acting as a major balancing mechanism in avian bipedal locomotion. We then used 3D surface geometrics morphometrics to investigate how the geometry and function of articular structures evolved in a phylogenetic context. Analyses were performed on selected extinct and extant theropods, using 810 points on 30 femora, and 936 points on 14 pelves, including true landmarks, curves and surface semi-landmarks. Our results illustrate differences in the nature and structure of the variation in pelvic and femoral morphology. Moreover, our results reveal the disparity in the terrestrial locomotor apparatus observed among modern birds and between early (*Allosaurus*, *Albertosaurus*) and derived (*Velociraptor*, *Bambiraptor*) non-avian theropods. As functional constraints act differently on the pelvis and femur, we show how they may have influenced the gradual evolutionary appearance of avian features in both structures. In particular, we discuss how the antitrochanter and hip joint evolved among non-avian theropods in the lineage giving rise to modern birds.

Poster Session III (Friday, November 4)

THE TAXONOMIC POSITION OF *PALAEOGALE* (MAMMALIA: CARNIVORAMORPHA)

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Palaeogale is uniformly agreed to be a member of the Carnivoramorpha, but this is the extent of the consensus to its taxonomic placement. Historically considered a mustelid, later cladistic studies reassigned it as *incertae sedis* within Feliformia. However, this affinity was suggested under the hypothesis of the early Cenozoic taxa that it resembled (Viverravidae) lying within Feliformia. As current studies have repeatedly rejected a close association of Viverravidae and Feliformia, the placement of *Palaeogale* relative to both groups therefore also is called into question.

Palaeogale is represented by cranial, dental, and postcranial material, ranging in age from the latest Eocene to early Miocene, and is known from localities in both North America and Europe throughout much of this temporal range. It is critically important to test the position of *Palaeogale*, as it has potential dramatic implications on reconstructing the biogeography and temporal extent of the various clades with which it has been allied previously. If found to be a member of the Viverravidae, *Palaeogale* will extend the range of that clade by over 20 million years, as no known viverravid has been found in strata younger than late Eocene. If a close relationship with Feliformia is supported, *Palaeogale* is by far the earliest known feliform in North America, as the oldest assured North American feliforms date to the early Miocene.

Recent studies have developed a more comprehensive view of the relationships and evolution of Carnivoramorpha; therefore, the placement of *Palaeogale* can be tested more rigorously than was previously possible. Here a detailed examination of the morphology of *Palaeogale* is conducted and the genus is incorporated into the largest matrix to date designed to test carnivoramorphan relationships, consisting of over 60 taxa with over 200 characters (including cranial, dental, and postcranial). Preliminary results support a placement near the base of Carnivoramorpha to the exclusion of any close relationship with the Feliformia.

Poster Session IV (Saturday, November 5)

DISTRIBUTIONAL PATTERNS IN ORNITHISCHIA: A COMPREHENSIVE SPECIES-LEVEL BIOGEOGRAPHICAL ANALYSIS

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As obligately terrestrial animals, ornithischian dinosaurs are ideal for analyzing global geographical vicariance and dispersal patterns. These patterns can potentially illuminate previously unknown geological features such as archipelagos and land bridges that have been otherwise unnoticed or uncorroborated in the geological record. The early ornithischian record is sparse and predominantly Gondwanan, but the group achieved a global distribution shortly after the Triassic-Jurassic mass extinction. The earliest known ornithischians are from the Late Triassic of present day southern South America and South Africa, the likely location of their evolutionary origin. Here, I present a global species-level biogeographical analysis of all Ornithischia throughout the Mesozoic. In total, 176 basal and derived species were included in a phylogenetic framework, built from the concatenation of multiple phylogenies of subclades (*e.g.*, Hadrosauroidea, Stegosauria), to illustrate the overall phylogeny of Ornithischia. A parsimony optimization of areas from which each species was recovered delineates the putative region of origin for each major clade. Basal groups, such as Heterodontosauridae with a known temporal range of approximately 100 million years, ranged from southern Gondwana to Laurasia, but their phylogeny as presently understood is inconsistent with a vicariance model to explain their distribution. For larger well-established clades such as Thyreophora and Marginocephalia, *ad hoc* hypotheses of dispersal across Laurasia are required, either via "island hopping" from North America to Europe or across ephemeral land bridges between North America and Asia throughout the Cretaceous. The basal radiation of Ornithopoda is problematic in that there are multiple independent dispersals into present-day Asia, Australia, North America, and Europe that are inconsistent with the sequence of landmass fragmentation. These results suggest the presence of short-lived connections within and among these landmasses.

Symposium 2 (Wednesday, November 2, 10:15 am)

GEOCHRONOLOGIC AND PALEOENVIRONMENTAL FRAMEWORK OF THE LATE PLEISTOCENE TULE SPRINGS LOCAL FAUNA

SPRINGER, Kathleen, San Bernardino County Museum, Redlands, CA, USA; MANKER, Craig, San Bernardino County Museum, Redlands, CA, USA; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, USA; PIGATI, Jeffrey, United States Geological Survey, Denver, CO, USA; MAHAN, Shannon, United States Geological Survey, Denver, CO, USA

The ground water discharge deposits of the upper Las Vegas Wash north of Las Vegas, Nevada, entomb the Tule Springs local fauna (TSLF), one of the most significant late Pleistocene vertebrate assemblages from the American southwest. Ground water discharge deposits are excellent paleoenvironmental indicators, closely tracking paleohydrologic responses to climate perturbations through geologic time. Despite this rich source of data, no previous attempts have been made to relate vertebrate faunal responses to late Pleistocene regional and global climatic perturbations in the southern Great Basin and Mojave Desert. We therefore initiated a large-scale paleontologic and geologic investigation in the upper Las Vegas Wash with the goal of integrating the TSLF into a regional paleoclimatic framework. Our results include discovery of several hundred new fossil localities and detailed geologic mapping of

the fine-grained paleowetlands deposits, informally named the Las Vegas Formation. This formation comprises stratigraphically ascending units A through G, with multiple intervening soils. We have redefined and established new geologic units within this formation and have reevaluated the geochronology throughout the sequence. This new geochronologic scaffolding, based on radiocarbon and luminescence dates, provides high-resolution stratigraphic control for the TSLF. The new data expand the duration of the Las Vegas Formation from ~225 ka to at least 600 ka, encompassing multiple glacial-interglacial climatic shifts including the end-Pleistocene transition. The new chronology also refines the regional chronologic framework, enabling correlations with global climate drivers. Additionally, regionally unique, braided fluvial tufas occur iteratively within these deposits, as do multiple black mats – both important paleoenvironmental signals. This high-resolution geochronology provides a framework for ongoing stable isotope analyses on ostracodes, vertebrates, and tufa, which collectively provide new insights into climate change during the late Pleistocene in the southern Great Basin.

Poster Session IV (Saturday, November 5)

ANATOMY AND RELATIONSHIPS OF A NEW TURONIAN HADROSAUROID FROM THE MATANUSKA FORMATION OF SOUTHERN ALASKA

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The fossil record of hadrosauroids (Ornithopoda, Hadrosauroidea) from the Albian to Santonian is very sparse, with few described North American and Asian taxa compared to the diverse record of Campanian to Maastrichtian hadrosaurids. In 1994, the partial postcranial remains of a hadrosauriform dinosaur were found in the Matanuska Formation of southern Alaska. The Matanuska Formation is a thick succession of Albian- to Maastrichtian-aged, dominantly marine, sediments deposited in a forearc basin along the actively accreting western North American margin. The Alaskan specimen is assigned a Turonian age based on molluscan biostratigraphy. The skeleton consists of postcranial elements including cervical, dorsal and caudal vertebrae, a partial pectoral girdle, proximal elements of the forelimbs, a partial pelvic girdle, and representative portions of the hindlimbs. This fossil represents the most complete, single skeleton of a dinosaur known from Alaska, and one of the few skeletal remains recovered outside of the North Slope. It is only the second North American Turonian hadrosauroid described, the other being *Jeyawati rugoculus* from New Mexico. This specimen also represents a new taxon of basal hadrosauroid that can be diagnosed by its unique combination of humeral, ilial, and femoral characters. A phylogenetic analysis recovers the new taxon nested within a paraphyletic assemblage of non-hadrosaurid hadrosauroids, being more derived than the North American Cenomanian taxa *Eolambia* and *Protohadros* but more basal than stratigraphically younger hadrosauroids from Asia, including *Tanius*, *Bactrosaurus*, and *Gilmoreosaurus*. The temporal and geographic occurrence of the Alaskan taxon provides an important new data point for hypotheses of hadrosauroid biogeography in the Late Cretaceous.

Poster Session IV (Saturday, November 5)

3D METHODS OF DIETARY RECONSTRUCTION IN THE EARLIEST ANTHROPOIDS

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Dental morphology of extant small-bodied primates and marsupials was compared between primarily insectivorous species (*Tarsius bancanus*, *Loris tarigradus*, *Arctocebus calabarensis*, *Galago senegalensis*, *Galagoides demidovii*, *Antechinus stuartii*, and *Sminthopsis crassicaudata*) with more frugivorous/gumnivorous forms (*Cheirogaleus medius*, *Microcebus murinus*, *Phaner furcifer*, *Euoticus elegantulus*, *Acrobates pygmeus*, and *Petaurus breviceps*). First and second lower molars were scanned with a Laser Design Surveyor RPS-120 probe laser scanner. Scans were made with a step size of 0.01mm and each specimen was scanned from six different angles for complete tooth coverage. Geomagic was then used to merge, clean, and decimate the scans into a single completed model. Using this 3D data, dental complexity, shearing ratios, and 2D/3D surface area ratios were calculated. Dental complexity was calculated in SurferManipulator. All teeth were scaled to the same length of 150 data rows and topographic contour maps were created. Orientation patch count (OPC) was calculated as any time two or more patches had the same slope orientation (within a range of eight possible predefined orientations). Results indicated that more traditional measures appear to be better indicators of diet within tight taxonomic units with quantifiable homologous dental features, whereas OPC counts are more robust across more distantly related taxa.

Nine species of small-bodied middle-late Eocene primates were compared to this extant sample. Results indicate that *Eosimias centennicus*, *E. sinensis*, and *Xanthorhysis tabrumi* were the most insectivorous whereas *Arsinoea kallimos*, *Catopithecus browni*, *Plesiopithecus teras*, *Proteopithecus sylviae*, *Qatrani wingi*, and *Serapia eocaenus* were more similar to living frugivorous primates. These results indicate that primitive African anthropoids were ecologically distinct from insectivorous eosimiids and that the initial radiation of Anthropoidea involved diversification of feeding strategies.

Symposium 2 (Wednesday, November 2, 8:30 am)

CHANGING LATE NEOGENE BIRD COMMUNITIES IN NORTHWESTERN MEXICO AND THE SOUTHWESTERN UNITED STATES

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This study is based on bird fossils from Pliocene and Pleistocene localities (Blancan through Rancholabrean NALMA) from Sonora, Arizona, and New Mexico (ca. 107-114°W, 29-33°N). The birds identified from most of these local faunas are dominated by aquatic species such as grebes, pelicans, cormorants, herons, ibis, stork, swans, geese, ducks, cranes, rails, sandpipers, flamingos, and terns, reflecting the lacustrine (marsh, lake) and riparian environments in which the fossils typically accumulated. The non-aquatic species of birds (various vultures, hawks, eagles, falcons, cracids, quail, turkeys, pigeons, cuckoos, and owls) suggest habitats ranging from grassland to open woodland to desertscrub to tropical thornscrub. The fossil passerine (songbird) communities were dominated by icterids (blackbirds, cowbirds, grackles, orioles), which corroborate the non-passerine evidence that marshes, lakes, riparian forests, savannas, and tropical thornscrub (grading into oak-pinyon-juniper woodlands at elevations ›1000 m) dominated this vast region through much of the Plio-Pleistocene; today, this region mainly sustains desertscrub vegetation of the Sonoran and Chihuahuan deserts. The more tropical biogeographic affinity of some of the birds agrees with that suggested for certain associated reptile and mammal fossils. Modern (Holocene) bird communities are not as rich as those of the Plio-Pleistocene, largely because of extinctions at the very end of the Pleistocene. These extinctions disproportionately affected storks, ducks, flamingos, vultures (including condors), eagles, and icterids.

Symposium 4 (Friday, November 4, 11:45 am)

USING PALEONTOLOGICAL DATABASES TO ASSESS SPATIAL AND TEMPORAL CONSERVATION OF MAMMALIAN COMMUNITY STRUCTURE AS AN AID TO CONSERVATION PLANNING

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Environmental and ecological changes are proceeding rapidly today, thus it is critical to conservation efforts that we understand natural ranges of variability experience by ecosystems in the past. Toward that end we used the NEOMAP database to examine how mammalian size and dietary guilds varied through time and space in the Great Plains and Great Basin. Temporal variation was assessed using species occurrence data for the Northern Great Plains biogeographic province in the Holocene, Rancholabrean, Hemphillian, Clarendonian, and Barstovian, encompassing marked climate changes. Spatial variation was examined for the Rancholabrean across four regions (Northern and Southern Great Plains, Northern and Southern Great Basin) that represent pairs of neighboring biogeographic provinces that have been ecologically, topographically, and climatologically distinct since the Oligocene.

Species were grouped by dietary guild and body size (15 distinct groups) to investigate whether the distribution of species in diet/body size classes: (1) has changed over the past 16 million years, and; (2) differs among biogeographic provinces during a single time interval. We used pairwise Fisher's exact tests to compare the distribution of species in diet/body size classes among provinces and time periods. The numbers of species in each dietary guild and body-size class showed no significant differences between the four Rancholabrean biogeographic provinces, nor did they show significant differences through time in the Great Plains. However, the Holocene fauna has a significantly different trophic and body size structure than that observed over the previous 16 million years: extra-large (>44 kg) and small (<500 g) herbivores and small insectivores dramatically decline in diversity relative to the four previous time intervals. The long-term stability of diversity within these size and diet groupings suggests that tracking this metric into the future may be useful for monitoring whether current human activities are significantly changing existing faunal patterns.

Poster Session I (Wednesday, November 2)

OSTEOCYTE LACUNA DENSITY IN SAURISCHIAN DINOSAURS AND THE CONVERGENCE OF FIBROLAMELLAR BONE IN MAMMALS AND DINOSAURS: DIFFERENT STRATEGIES TO GROW FAST

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Fibrolamellar bone (FLB) in mammals and dinosaurs looks identical on the histological and nanocristallite level. Parsimony, however, suggests FLB evolved convergently in both lineages. On the cellular level, significant differences between mammalian and dinosaur bone tissues can be observed in the osteocytes. Apart from a more organized canalicular distribution, mammals also have generally larger osteocyte lacunae than saurischian dinosaurs. Additionally, mammal osteocyte lacuna density (OLD) has been shown to correlate inversely with body mass, and speculation that OLD reflects the metabolic output of periosteal bone growth has received support as well. Until now, lacuna density in Saurischia, and dinosaurs in general, remains unstudied. We focused on saurischian dinosaurs, and measured OLD with a z-stack method in the woven bone component of cortical fibrolamellar bone of a broad range of sauropodomorph taxa, and in ontogenetic series of large theropods. Additionally, we measured OLD in cortical bone of extant poikilotherm ectotherms. We found that, similar to mammals, OLD correlates inversely with body mass in saurischians and poikilotherms. However, 95% confidence intervals suggest that saurischian dinosaurs have a much higher, and ectotherms a much lower OLD than similar-sized mammals. High OLD in sau-

rischians, compared to mammals, illustrates there are different ways to build fibrolamellar bone and hence grow fast. Both groups have high appositional growth rates, but saurischians have generally smaller osteocyte lacunae than mammals, and hence require higher osteoblast proliferation rates for similar bone apposition rates. Low OLD of poikilotherms is not compensated significantly by lacuna size, and rather reflects low bone apposition and growth rates. Moreover, high lacuna densities in saurischian dinosaurs compared with low lacuna densities in ectothermic poikilotherms provides additional strong evidence for sustained high metabolic activity in saurischian dinosaurs. These results demonstrate the potential of OLD quantification for life history and bone physiology studies of extinct and extant vertebrate clades.

Poster Session III (Friday, November 4)

ECOLOGICAL PROFILE FOR SOUTH AFRICA AND EAST AFRICAN EARLY HOMININ FOSSIL SITES USING STABLE CARBON ISOTOPES FROM FOSSIL BOVID DENTITION

STEININGER, Christine, Institute of Human Evolution, University of the Witwatersrand, Johannesburg, South Africa

The conventionally held view of a uniform global trend of open grasslands after ca. 2.0 Ma for South Africa and East Africa is questioned with new isotopic data. Isotopic analyses of bovid dentition from these two regions indicate more complex palaeoecological settings. The new isotopic data suggest differential timing of grass expansion between East African and South Africa, with a C4-dominated ecosystem occurring in East Africa prior to South Africa. Early hominin assemblages from South Africa encompass a mosaic ecosystem that was more C3-dominated than contemporaneous East African sites.

Poster Session IV (Saturday, November 5)

FAUNAL COMPOSITION OF THE LATE OLIGOCENE SONGWE MEMBER OF THE NSUNGWE FORMATION, TANZANIA

STEVENS, Nancy, Ohio University, Athens, OH, USA; EGBERTS, Sebastian, Ohio University, Athens, OH, USA; ROBERTS, Eric, James Cook University, Townsville, Australia; O'CONNOR, Patrick, Ohio University, Athens, OH, USA

The Songwe Member of the Nsungwe Formation, exposed in southwestern Tanzania, is a 200+ m thick succession characterized by a myriad of micro-depositional environments. It represents a shallow wetland system that developed in a semi-arid climate approximately 25-24 Ma, early in the development of the modern East African Rift System. The presence of aquatic and semi-aquatic taxa (e.g., fish, frogs, crustaceans and aquatic molluscs) in many of the localities suggests perennial availability of water with periodic or seasonal climatic fluctuation. Differential preservation of fossils at the ten localities presents rich potential for detailed taphonomic and paleoecological investigations. Sedimentological data suggest that fossil-bearing localities represent a range of depositional environments from fluvial to lacustrine to shoreline and deltaic deposits, each represented by different taphonomic modes of preservation. This study compares faunal composition and size sorting among the Nsungwe Formation localities. An analysis of 1409 identified specimens from ten localities indicates the following taxonomic breakdown: mammals comprise ~31% of the total fauna, with invertebrates and fish each just over 20%, anurans ~13%, crocodylians and turtles each < 5%, and squamates and aves together accounting for ~2%. The composition is highly variable across localities, with for example mammals ranging from 11% of the recovered specimens at one site to over 57% from a different but nearby locality. Maximum length was recorded for all prepared specimens (n=675; min < 1 mm, max 132mm), with the majority of specimens from well-sampled localities measuring between 2 and 5 mm in length. Recently discovered localities near the base of the Songwe Member represent wetland/lacustrine environments that preserve freshwater ostracods and a greater size diversity of vertebrates, from micromammals to megaherbivores, the latter likely transported by periodic discharge from local river systems. Notably absent from those localities, however, are some of the most common micromammal and invertebrate taxa of the Nsungwe fauna.

Poster Session I (Wednesday, November 2)

A NEW METOPOSAURID (TEMNOSPONDYL) BONEBED FROM THE LATE TRIASSIC OF PORTUGAL

STEYER, J. Sébastien, CNRS and MNHN, Paris, France; MATEUS, Octávio, Universidade Nova de Lisboa, Faculdades de Ciências e Tecnologia- CICEGe & Museu da Lourinhã, Lourinhã, Portugal; BUTLER, Richard, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; BRUSATTE, Stephen, American Museum of Natural History, New York, NY, USA; WHITESIDE, Jessica, Department of Geological Sciences, Brown University, Providence, RI, USA

The end-Triassic extinction event (ETE), considered one of the 'Big Five' mass extinctions, marks a dividing line between early Mesozoic vertebrate assemblages, typically including abundant temnospondyls, basal synapsids and basal archosaurs, and 'typical' Mesozoic faunas dominated by dinosaurs, pterosaurs, crocodylomorphs, turtles and mammaliaforms. Recent geochemical work has provided strong evidence that the ETE is synchronous with, and likely caused by, the emplacement of the Central Atlantic magmatic province (CAMP). However, stratigraphic sections containing both terrestrial vertebrates and CAMP basalts are scarce, complicating attempts to examine terrestrial faunal changes during this extinction event. The Triassic–Jurassic Algarve Basin, southern Portugal, is an extensional rift basin formed during Pangaean breakup. The infill of this basin consists of a series of terrestrial-to-marginal marine red beds (the 'Grés de Silves' Group) interbedded with CAMP basalts. New expeditions in this basin have identified a rich, paucispecific, temnospondyl-dominated bonebed from the interval 'AB1' of the Grés de Silves. Preliminary excavations yielded at least nine well-preserved temnospondyl individuals represented by partial to nearly complete skulls and disarticulated postcranial elements of juvenile to adult ages. Nearly all material appears to represent a single species of metoposaurid referable to the genus *Metoposaurus*, well known from the late Carnian–early Norian of Germany and Poland. A number of characters of the occiput and mandible suggest that the Algarve material may represent a new species. This new material provides new data on the diversity and paleogeographical distribution of the metoposaurids, a highly autapomorphic and peculiar group composed of large aquatic carnivores with a unique elongated but brevirostral skull. This taxon also provides the best current age constraints for the bonebed, suggesting that at least part of the "AB1" Horizon may be within or close to the late Carnian–early Norian. Additional bone-bearing horizons within the 'Grés de Silves' provide a rare opportunity to examine terrestrial faunal change in the lead-up to the ETE.

Poster Session I (Wednesday, November 2)

PHYLOGENETIC INFORMATION FROM THE QUADRATE OF *DIATRYMA* (NEORNITHES)

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The galloanserine quadrate exhibits a suite of characters unique among birds. That morphology is present in the Cretaceous and occurs in a wide range of bird body sizes from quail to the large-bodied *Diatryma*. Examination of the quadrate of *Diatryma* documents the presence of this typical set of derived galloanserine characters, anseriform characters, and potentially autapomorphic states. For example, *Diatryma* has two mandibular condyles and a subcapitular tubercle as in other galloanserines. In addition, *Diatryma*'s quadrate has a basiorbital foramen that is likely primitive for galloanserines (and absent in many anseriforms). The presence of that foramen appears to be correlated with the presence of a pneumatic foramen on the pterygoid, and *Diatryma* likely also has a pneumatic pterygoid. In combination with the similarly primitive morphology of the quadrate in *Presbyornis*, the homologous structures in *Diatryma* support its placement within crown galloanserines, but not within crown anseriforms (possibly along the anseriform stem). *Diatryma* shares the derived morphology of the mandibular condyles (two condyles meeting with interdigitated beveled tips) with *Presbyornis*, the Lance galloanserine, and extant anseriforms. Some of the characters that may diagnose a clade composed of *Diatryma* and other extinct close relatives include the extremely dorsoventrally tall orbital process (over 50% of quadrate height), massive subcapitular tubercle, shallow dorsolaterally facing quadratojugal cotyla, and extremely mediolaterally elongate squamosal condyle. However, *Diatryma*'s quadrate appears to retain the primitive proportions of the neornithine ancestor since it is more similar to paleognath and neoavian proportions than it is to that in galloanserines. The non-crown anseriform placement of *Diatryma* is suggestive that its evolutionary lineage and quadrate morphology diverged from other galloanserines in the Cretaceous.

Poster Session III (Friday, November 4)

DETECTING AND ACCOUNTING FOR DEPOSITIONAL BIAS IN THE LATE MIOCENE MCKAY RESERVOIR FAUNA

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Fossil assemblages have the potential to tell us about the ecology of a specific time and place in geologic history. What we can glean about ancient ecologies can tell us something about the consequences of past environmental changes and gives us clues as to how human and habitat change will affect modern faunas. However, taphonomic biases complicate paleoecological inference. A collection of fossils is rarely, if ever, preserved in the same proportions in which the animals lived. We are looking at ways to measure the taphonomic bias in terrestrial mammal assemblages to the original fauna. Our focus is the McKay Reservoir, a locality in north-central Oregon, where fossils were deposited by fluvial transport in the late Hemphillian. We are using two main approaches to determining the taphonomic history of McKay, the Voorhies method and Rank-Order Analysis. The Voorhies method classifies fossils by element in a sedimentary deposit. Voorhies diagrams use the element to determine the degree of sorting in an ancient river system. Surface Index is another different method to measure fluvial transport. Rank-Order analysis involves sorting by mass, size, shape and degree of weathering. Past analyses have simply looked at these data qualitatively; we reanalyze them in a more rigorous statistical framework to generate numerical descriptors of the degree of hydraulic sorting. Results from these two approaches are consistent with deposition by a flooding event. The bones rolled a medium distance at high velocity and were buried relatively quickly. The weathering and abrasion suggest the specimens came from nearby, perhaps as close as a mile from the site of deposition to the site of final burial. Therefore, this assemblage should be a good indicator of ancient local species abundances.

Technical Session IX (Friday, November 4, 9:45 am)

DISCERNING THE DIVERSITY AND BIOGEOGRAPHIC HISTORY OF AMPHISBAENIANS (SQUAMATA) IN THE LATE UINTAN (MIDDLE EOCENE) BASED ON THE FIRST SPECIMENS FROM WEST TEXAS

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Initial collecting efforts in the Middle Eocene Devil's Graveyard Formation (DGF) of West Texas focused on the recovery of mammalian fossils for Eocene mammalian biostratigraphy and biochronology. The DGF also was calibrated with radioisotopic dates and paleomagnetic data, resulting in exceptional temporal precision for investigating hypotheses addressing correlations between changes in climate and changes in faunal composition. Though numerous fossils representing the herpetofauna were recovered, little work was done to identify the squamate fossils, integrate them into a broad-based assessment of the local faunas, or utilize them to address broader questions concerning squamate evolution in one of the southernmost Eocene localities in North America. Previously, specimens of amphisbaenians from the Eocene of North America were known mainly from deposits in Wyoming. Here we report on the first amphisbaenians known from Texas and elucidate the cranial morphology, alpha taxonomy, and phylogenetic position of these new specimens. At least four amphisbaenian skulls and several isolated vertebrae were collected from a single locality within the DGF. These specimens are hypothesized to represent new taxa based on anatomical features clarified by High Resolution X-ray Computed Tomographic data. The presence of a jugal and an unforked posteromedial process of the premaxilla in one new specimen are shared characteristics with the Eocene *Spathorhynchus fossorium* and the Oligocene *Dyticonastis*; however, the anteriorly-projecting median process of the parietals is not as prominent as in *S. fossorium*, and the frontals are more broad and without a scalloped articulation with the nasals as in *Dyticonastis*. Therefore, our new taxon is hypothesized to be the sister taxon to the *Dyticonastis*-*Spathorhynchus* clade. These new fossils extend the Paleogene range of Rhineuridae south to Texas, bridging the gap between the previous Eocene records and the modern distribution in Florida. This Texas record provides an important new data point for understanding larger patterns of amphisbaenian diversity and biogeography in the Eocene of North America.

Poster Session IV (Saturday, November 5)

A NEW HIGH ALTITUDE LATE PLEISTOCENE INTERGLACIAL/GLACIAL SITE (MIS 5?) PRESERVING LARGE AND SMALL VERTEBRATE FOSSILS FROM WESTERN COLORADO: THE SNOWMASTODON SITE AT ZIEGLER RESERVOIR, PITKIN COUNTY

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In October 2010, construction workers discovered bones of Pleistocene mammals at high altitude (~2671 m) near Snowmass Village, Colorado. The bones were preserved in an isolated lake basin (~15 acres) formed behind a lateral Bull Lake moraine. The site is radiocarbon dead and may range in age from >45.000 to ~150,000 years BP. Paleoenvironmental proxies include plants (pollen, leaves, wood) and invertebrates (ostracods, gastropods, insects). Exceptionally preserved remains of *Mammut americanum* (8+ individuals), *Mammuthus columbi* (4 individuals), *Bison latifrons* (4 individuals), *Camelops hesternus* (1 individual), cf. *Odocoileus* sp. (2 individuals), and *Megalonyx jeffersonii* (1 individual) have been recovered. One deer skeleton has attached antlers, morphologically like modern mule deer (*O. hemionus*), but body size is larger and limb proportions differ. Limited screen washing has yielded microvertebrates including a microtine rodent (1 tooth triangle), cf. *Peromyscus* sp. (2 teeth), anuran spp. (2 taxa), fingerling trout *Onychorhynchus clarki (*3 vertebrae*)*, a natricine snake (4 vertebrae), and hundreds of bones of *Ambystoma tigrinum.* The salamander bones represent neotenic, adult and cannibalistic morphs. Gnaw marks on mammoth and mastodon ribs suggest two sizes of carnivores. Beavers (*Castor canadensis*) are indicated by gnawed wood. At least four fossil horizons are recognized: a lower redeposited diamicton; a debris flow/aeolian silt; a "yellow" clay; and overlying sedge-peat capped by a thick clay. Changes in sedimentation, fauna, and pollen, track complex climatic changes reflecting a transition from warmer and moister (MIS 5e) to cooler and drier (MIS 5a-d?) conditions. Fossils from different units document varying taphonomic pathways. The basal units have disarticulated, broken and sometimes tumble-worn remains of bison, deer and mastodon. The peat environment preserves articulated remains of a juvenile mammoth, a juvenile deer and a bison, all lying horizontally. The upper clay also has well preserved mammoth material. All horizons contain salamander remains, some of which occur partly articulated and in high abundance in the pulp cavity of a mastodon tusk.

Poster Session III (Friday, November 4)

DOES CARBONATE CONTENT OF BIOGENIC APATITE CORRELATE WITH BODY TEMPERATURE?

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Raman spectroscopy is a non-destructive spectroscopic method that uses laser light and Raman scattering to identify the molecular make-up of a material. Carbonate-apatite (dahllite or francolite) has known Raman scattering at 959cm-1, 1046cm-1 and 1073cm-1 for P-O bonds, at 1073cm-1 for Type B CO3 (substituted for phosphate) and at 1103cm-1 for type A CO3 (substituted for OH). Raman spectroscopic analysis (using a 785 nm laser) of experimentally precipitated Type B and Type AB apatite at temperatures between 10°C and 60°C reveals that carbonate contents increase significantly when formed above 30°C, primarily in Type B CO3. The intensity of the CO3 Raman band at 1073cm-1 increases until it is equal to or greater than the 1046cm-1 P-O band. We tested these chemical and spectroscopic systematics on modern bioapatites including ectothermic taxa such as freshwater and marine fish, temperature regulating ectotherms such as turtles, and endothermic mammals such as cat, deer, and opossum. The two cold-water fish show much lower intensity of the 1073cm-1 band than the mammals and turtle. Turtles precipitate their shells between 31-33°C and the mammals analyzed precipitate their bones and teeth between 34.4°C and 39.7°C. We therefore suggest that temperature is a major control on the amount of carbonate in bone and teeth, at least above 30 °C. The apatite experiments and analysis of modern taxa suggest that spectroscopy of fossil material can be used as a non-destructive means to estimate the body temperature of extinct taxa. Tests using Raman spectroscopy on fossil teeth, however, have been hampered by intense fluorescence, which masks CO3-PO4 peaks and ratios. Alternative laser wavelengths and spectroscopic methods are being investigated to resolve the problem of fluorescence in fossil bioapatite.

Technical Session XI (Friday, November 4, 3:45 pm)

TITANOSAURIA (SAUROPODA) FROM THE UPPER CRETACEOUS (TURONIAN) BISSEKTY FORMATION OF UZBEKISTAN

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Extensive exposures of the Bissekty Formation (Upper Cretaceous: Turonian) at Dzharakuduk in the central Kyzylkum Desert of Uzbekistan have yielded abundant, often superbly preserved dinosaurian remains. Among these remains are cranial and postcranial bones as well as teeth referable to titanosaurian sauropods. Titanosauria is by far the most diverse clade of Neosauropoda, now known from every continent except Antarctica and with a particularly rich fossil record from South America. The material from Dzharakuduk is of considerable interest in view of the relative scarcity of Late Cretaceous sauropod fossils from Middle and East Asia. An incomplete braincase was originally assigned to the basal ceratopsid *Turanoceratops* but actually belongs to a sauropod. It shares a number of features (e.g., transversely expanded basal tubera) with braincases of titanosaurs such as *Nemegtosaurus* from the Maastrichtian of Mongolia. CT scan data of the braincase allows study of the brain endocast and endosseous labyrinth of the inner ear. The endocast itself generally resembles that of other sauropods, although the pituitary fossa is very swollen and the infundibulum has a novel posterior expansion. The inner ear resembles that of some other titanosaurs in having anterior and posterior semicircular canals of subequal length, but the lateral canal is remarkably short. The systematic implications of these differences remain enigmatic in the absence of comparable endocast data for key taxa, as well as uncertainties about the affinities of isolated sauropod braincases from the Maastrichtian of India. Numerous isolated teeth from Dzharakuduk have slender, "pencil-shaped" crowns, often with high-angle apical wear facets, and represent a considerable size range. A proximal caudal vertebra closely resembles those of *Opisthocoelicaudia* from the Maastrichtian of Mongolia but differs especially in the presence of a pair of pneumatic depressions on the neural arch on either side of the neural canal. The sauropod remains from the Bissekty Formation establish the presence of lithostrotian titanosaurs in present-day Middle Asia during the early Late Cretaceous.

Poster Session IV (Saturday, November 5)

THE VERTEBRATE FAUNA OF THE JURASSIC DAOHUGOU BIOTA FROM NORTHEASTERN CHINA, AND ITS ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS

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Northeastern China has long been famous as a source of feathered avian and non-avian theropod fossils, exquisitely preserved in lacustrine shales alongside a wide range of other organisms. The vast majority of these specimens come from the Jehol Group of western Liaoning Province, which is Early Cretaceous in age. However, the Daohugou Locality of easternmost Inner Mongolia, close to the Liaoning border, is of exceptional paleontological interest because it contains a rich assemblage preserved under Jehol-like conditions but clearly dating from the Jurassic. The exact age of the Daohugou strata is controversial, but appears to lie close to the Mid-Late Jurassic boundary. The presence at Daohugou of the cryptobranchid salamander *Chunerpeton tianyiensis* is a key piece of evidence linking the site biostratigraphically to five other nearby localities. The assemblages from these sites may be assigned to a coherent 'Daohugou Biota', now emerging as an important regional predecessor to the Jehol Biota. The Daohugou Biota includes twenty-two published vertebrate taxa (four salamanders, one probable anuran, two lizards, eight pterosaurs, four dinosaurs and three mammals), with another dinosaur known but unpublished. A narrow majority of these taxa occur at the Daohugou Locality itself, and many are represented by articulated skeletons that also retain soft tissue. The vertebrate assemblage of the Daohugou Biota is strikingly different from that of the Jehol Biota, indicating strong faunal turnover in northeast Asia between Daohugou and Jehol times, and also sheds light on various aspects of

Mesozoic vertebrate evolution. All of the Daohugou dinosaurs are paravian theropods, and their Mid-Late Jurassic age refutes the 'temporal paradox' argument against the theropod origin of birds even on its own terms. The Daohugou mammals include a gliding form and two probable burrowers, one of which was probably also semi-aquatic. This range of adaptive types points to a previously unappreciated ecological diversity among Jurassic mammals. Finally, the pterosaurs include forms that bridge the wide morphological gap between pterodactyloids and previously known non-pterodactyloids.

Poster Session I (Wednesday, November 2)

VERTEBRAL REMAINS OF THE LATE MIOCENE APE *HISPANOPITHECUS LAIETANUS* (PRIMATES: HOMINIDAE): FUNCTIONAL MORPHOLOGY AND PALEOBIOLOGICAL INFERENCES

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A description and functional interpretation of the vertebral specimens of the late Miocene (9.6 Ma) great ape *Hispanopithecus laietanus* (Primates: Hominidae) from Can Llobateres 2 (Vallès-Penedès Basin, NE Iberian Peninsula) are provided. These specimens include a partial thoracic vertebra, 3 partial lumbar vertebral bodies and 3 partial neural arches of lumbar vertebrae, corresponding to the male partial skeleton IPS18800 (estimated body mass: 39 kg). Despite the retention of some plesiomorphic features shared with pronograde monkeys and stem, early to middle Miocene hominoids (e.g., relatively long vertebral body with some vertebral wedging), *Hispanopithecus* displays a set of shared-derived features with extant great apes, which are indicative of upright trunk postures (orthograde bodyplan). The latter include, for the lumbar vertebrae: caudal origin and apparently caudally oriented neural processes, lack of ventral keel, mediolaterally wide and dorsoventrally shallow vertebral body, and root of transverse process clearly originating from the pedicle with a coplanar orientation; and for the thoracic vertebra: very dorsally situated costal foveae on the vertebral body, and dorsal origin and orientation of transverse process, implying a ventral position of the spinal column relative to the thorax, which can be therefore inferred to have been broad and relatively shallow. The presence of 4 to 5 lumbar vertebrae, as it is common in extant great apes, can be tentatively inferred for *H. laietanus* on the basis of available material. Overall, the vertebral morphology of this taxon agrees well with other postcranial elements, indicating the possession of a modern hominoid-like, orthograde bodyplan. Orthograde features have been also documented in the middle Miocene ape *Pierolapithecus catalaunicus* from the same basin. Although phylogenetic uncertainties still remain regarding these Miocene European dryopithecins (generally considered to be stem Hominidae or Ponginae), the lack of undoubted orthograde adaptations in the Asian pongin *Sivapithecus* raises serious doubts on the homology of these features amongst crown hominoids and even between pongines and hominines.

Poster Session II (Thursday, November 3)

JAW MECHANICS OF CROCODILES REVEAL THEIR FAST MASTICATION

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Anatomical approaches to the jaw mechanics of modern crocodiles can further elucidate the feeding behavior of extinct archosaurians. Nevertheless, jaw structure and movement in modern crocodiles are poorly understood. The crocodilian cartilago transiliens (CT) in the musculus pterygoideus anterior (MPA) has fibrocartilage body contact on the lateral wing of the pterygoid, and is essential for jaw closure. The CT is indicative of jaw movement because it retains a rough surface on the pterygoid, and is therefore useful in studies involving fossil taxa. Here we investigate the mechanics of the CT in modern crocodilian species and evaluate its functional importance.

Seven specimens of four crocodilian species (four *Crocodylus porosus*, one *C. niloticus*, one *C. siamensis* and one *Caiman latirostris*) were analyzed using CAT scans of open-jaw and closed-jaw positions, and one specimen was studied in four positions: full open, 20° open, 10° open and closed positions. We observed the movement of the CT during jaw closure and calculated the moment arm of the MPA under two different models: CT present and absent. The results revealed that the CT moves anteriorly on the lateral wing of the pterygoid and decreases the MPA moment arm during jaw closure. In both open and closed positions, the moment arm was significantly smaller in the CT present model (28.22±7.99 mm in open and 16.91±3.41 mm in closed positions) than in the CT absent model (34.15±8.87 mm in open and 20.94±5.43 mm in closed positions). In addition, the moment arm in CT present decreased rapidly from full open (approximately 30°) to 20°. As a result, the difference in the moment arm was the largest in the 20° -10° open position from the CT absent model.

This study indicates that the MPA is involved in rapid jaw closure by moving the CT anteriorly, instead of strong power generation, especially at the 20°-10° open position. Although fossilization of the CT is unlikely, the rough surface of the fossilized cartilage remnant on the lateral wing of the pterygoid faces the CT. The remnant can be an indicator of the speed/power trade-off structure in jaw mechanics.

Poster Session III (Friday, November 4)

THE MORPHOLOGY AND PHYLOGENETIC POSITION OF *ADOCUS/ADOCOIDES AMTGAI*, AN ADOCID TURTLE FROM THE LATE CRETACEOUS OF MONGOLIA

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Adocus amtgai was described based on a single incomplete shell from from the Late Cretaceous of Mongolia (Amtgai, Eastern Gobi, upper part of the Bainshire Formation, late Turonian – Santonian). Later, this species was placed in a separate genus *Adocoides* based on preliminary study of the second specimen (almost complete skeleton). Additional preparation and examination of the second specimen allows us to emend the characteristics of *A. amtgai*: skull: anterior part of skull sharply constricted in preorbital region; temporal emargination long and wide (more than 50% of skull length), medial portion of processus trochlearis oticum visible in dorsal view; orbits directed anterolaterally under 30° to long axis of skull; snout profile oblique in lateral view, projected ventrally; maxilla long and low in lateral view; cheek emargination deepest in its medial part; shell: nuchal notch weak, formed by nuchal and peripheral 1; six neurals; neural 6 not shortened; two suprapygals; cervical narrow and trapezoid, expanded anteriorly; vertebral 5 narrow; pleurals 2–4 narrowed (width about 30% of length); marginals overlapping onto costals beginning with marginal 4; anterior border of plastron straight; length of bridge about 40% of plastron length; width of anterior border of epiplastron more than length of epiplastral symphysis; width of anterior border of gulars more than length of epiplastral symphysis; gulars overlapping onto entoplastron; extragulars shortened (medial borders about 50-70% of length of epiplastral symphysis); humero-pectoral sulcus intersects entoplastron; four inframarginals wide and slightly extend onto peripherals; shell sculptured with small and regular pits; non-shell postcrania: coracoid flat and wide with truncated distal edge; pubes slightly narrowed anteriorly with broad interpubic contact; metischial processes long. Inclusion of *A. amtgai* in the phylogenetic analysis of Adocusia resulted in its position within *Adocus* clade sister to *Adocus aksary*, a species from the Late Cretaceous of Uzbekistan.

Poster Session III (Friday, November 4)

BRIDGERIAN MAMMALS FROM THE TYPE LOCALITY OF THE SAGE CREEK FORMATION, SAGE CREEK BASIN, BEAVERHEAD COUNTY, MONTANA

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At its type locality in the Sage Creek Basin, the Sage Creek Formation consists of approximately 35 meters of well stratified greenish-gray volcaniclastic sandstones and mudstones, with smaller amounts of pebbly volcaniclastic sandstone and rare pebble and cobble conglomerates. Most of the beds appear to represent sheetflood deposits. Poorly preserved fossil wood is relatively common and includes roots, logs, and a few vertically oriented trunks. Many of the exposed surfaces on the Sage Creek Formation are littered with shards of calcareous and siliceous debris derived in large part from the weathering of this fossil wood. This, coupled with the rarity of vertebrate specimens and their tendency to weather into tiny fragments, makes the search for fossil vertebrates in these beds unusually difficult. Nonetheless, the type exposures of the Sage Creek Formation have produced a limited, but informative mammalian fauna. Seven identifiable specimens preserving partial dentitions have been recovered thus far: a brontothere jaw identified as cf. *Telmatherium validus*, fragments of a rodent jaw tentatively referred to *Reithroparamys* sp., and five specimens of the helaletid tapiroid *Helaletes nanus*. The rodent, brontothere, and at least two of the specimens of *H. nanus* were collected *in situ* from beds of the type Sage Creek Formation and firmly establish a Bridgerian age for this part of the stratigraphic section in the Sage Creek Basin.

The type Sage Creek Formation is overlain with profound angular unconformity by the late Uintan Dell beds (currently an informal unit, but a unit meriting formational rank). The highly irregular contact between the two units is marked by the "Sage Creek breccia" of authors. The "Sage Creek breccia" consists of talus eroded from the Sage Creek Formation at, or prior to, the time that the type Sage Creek Formation was buried by the Dell beds. The holotype of *Hyrachyus douglassi* Wood is supposed to have been collected from this breccia, which suggests that the ultimate source of this specimen was probably the Sage Creek Formation.

Poster Session IV (Saturday, November 5)

DEPRESSION OF JAW JOINT IN EARLY EVOLUTION OF CERATOPSIANS

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Ceratopsia was among the dominant herbivorous dinosaur clades in the Cretaceous terrestrial ecosystems of Asia and western North America. Understanding the effectiveness of the masticatory apparatus should help to explain how Ceratopsia achieved ecological success. Recent discoveries of numerous new basal taxa with superbly preserved skulls make it possible to document the early evolution of the ceratopsian masticatory system. In this study, jaw joints of basal ceratopsians were examined to understand the early evolution of the ceratopsian masticatory system in biomechanical aspect. Glenoids of basalmost ceratopsians *Yinlong* and *Chaoyangsaurus* are almost at the same level as the dentary tooth row in lateral or medial view. Although not as lowered as those of ceratopsids, the derived ceratopsians, glenoids of psittacosaurids and basal neoceratopsians lie ventral to the level of the tooth row. In a mandibular lever system, the depression of glenoid lengthens the input lever arm whose

length is the distance from the glenoid to the apex of the coronoid process. The depression of jaw joint was associated with the caudal displacement of the coronoid process and caudal extension of the tooth row, which allowed shortening of output lever arm length, the distance from the glenoid to the bite point in caudal region of the tooth row. Both elongated input lever arm and shortened output lever arm increase leverage in the mandibular lever system. Depressed jaw joint also makes possible the anteroposterior grinding motion during occlusion as in the typical masticatory apparatus of herbivorous mammals with jaw joint dorsal to the level of tooth row, even though the mandible is merely rotating around a fixed transverse axis. This study shows the biomechanical improvement of the masticatory system in the early evolution of Ceratopsia.

Poster Session III (Friday, November 4)

VARIATION IN THE DELTOPECTORAL CREST IN BIRDS

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The shape and orientation of the deltopectoral crest (DPC), the insertion site of the primary wing depressor in birds, are central to our understanding of key aspects of wing function. Optimization of DPC characteristics in phylogenetic analyses reveal that the deltopectoral crest changed orientation relative to the humeral head at least twice on the lineage leading to extant birds. The DPC dominantly deflects anteriorly (or anterodorsally) in most non-avialan theropods, then dorsally in basal Mesozoic birds after *Archaeopteryx*. Changes in the size and shape of the crest are seen associated with this first shift. Finally, anterior deflection is again seen in Aves. Why does DPC orientation switch in these early fliers? Assessments of this character have been limited to a binary character state – anterior or dorsal. However, deciphering its functional role requires more precise angular measures. In this study, we measure the range of variation in DPC angle in extant birds using Aves3D, a database containing 100+ laser-scanned digital models of avian humeri from a broad range of taxa. We calculated inertial properties of each humeral model to provide a consistent reference frame for measuring DPC angle. Angles range from 17 degrees (anterodorsally deflected; 0 degrees = dorsally deflected in line with humeral head long axis) to 79 degrees, indicating broad variation in this character. DPC angle appears to be similar within some clades (e.g. hornbills and penguins) but disparate in others (e.g. falconiformes). Although no extant birds reach the level of dorsal deflection of the DPC in, for example, *Confuciusornis*, the presence of this range of variation is promising. Future studies combining biomechanical modeling and analyses of the most dorsally deflected extant birds may help explain the evolution of crest angle and its relationship to wing mechanics.

Poster Session II (Thursday, November 3)

VARIATION IN HINDLIMB MUSCLE ATTACHMENT SITES IN THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS)* AND IMPLICATIONS FOR PALEOBIOLOGICAL RECONSTRUCTIONS

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The use of the Extant Phylogenetic Bracket (EPB) method has become commonplace for hypotheses of musculature and their attachment sites in extinct archosaurs, particularly dinosaurs. Approximately 30% of the appendicular muscles examined in the Brown kiwi (*Apteryx australis mantelli*) could be reliably associated with distinct osteological correlates. Despite this, of the numerous reconstructions of archosaurian myology, few studies have quantitatively evaluated variation in the muscle attachment sites in the bracketing extant taxa, or the implications that insertion variability may have upon myological reconstructions in extinct taxa.

The hindlimb musculature of nineteen specimens of *Alligator mississippiensis* of varying but known life and locomotor histories were dissected and analyzed. Individual muscles with large attachments to the femora and tibiae were measured. The four largest alligators were acquired from the wild at the age of two. The remaining fifteen were raised in the lab and were much smaller despite being of a similar age. Seven muscles with large fleshy attachments to the femur and tibia were measured on both the right and left hindlimbs for comparison. The insertion sites of the following muscles were examined: M. iliofemoralis; M. adductor 1, and 2; and M. caudofemoralis longus. The following origin sites were measured: M. femorotibialis externus, M. femorotibialis internus and M. tibialis anterior.

High variation was recorded in the majority of muscle attachments between individuals even when adjusting for size. The largest disparity was observed in the origin of M. tibialis anterior. Variation seen in certain muscle attachments suggests that osteological correlates in the appendicular skeleton must be regarded with caution with respect to myological reconstructions. The findings from this study will aide in understanding the interface between soft tissues and their corresponding skeletal structures in extant taxa, with the aim of generating more robust reconstructions of soft tissues in extinct organisms.

E&O Poster Session

APPLICATIONS OF COMPUTED TOMOGRAPHY TO MUSEUM CONSERVATION AND EXHIBITS

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Computed tomography (CT) is frequently discusses in the context of its benefits to paleontological research. However, its applications to conservation and museum exhibits is infrequently discussed. Sharing CT data can provide easier and faster access than shipping loaned specimens, reducing physical stress on specimens. Three dimensional models can consist of a surface model of the whole specimen or by creating individual structures which can fit together (such as individual elements to create an articulated pes). Printed three-dimensional models can be used in research, exhibits, and hand-on settings in lieu of actual specimens, also reducing handling stress on specimens. Virtual exhibits utilizing CT data, even at low resolution, can show visitors internal structures (such as bone anatomy or virtual endocasts) not always visible in physical specimens. These data can also be integrated into classrooms as an educational supplement. These virtual exhibits can help show visitors and students and internal view to explore beyond just a superficial understanding. The use of computed tomography is useful in areas beyond such as conservation and exhibits.

Poster Session I (Wednesday, November 2)

DENTAL MORPHOLOGY OF *ALLOSAURUS FRAGILIS* (DINOSAURIA: THEROPODA) FROM THE UPPER JURASSIC MORRISON FORMATION OF WESTERN NORTH AMERICA: IS DENTITION MORE INDICATIVE OF TAXONOMY OR FEEDING NICHE?

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Theropod dentition has been used to erect new taxa and define the paleobiogeographic range of known taxa. However, only a small number of studies quantitatively describe the dental morphology of well-supported taxa. A detailed morphological study of the dentition of *Allosaurus fragilis*, one of the best sampled theropods, can lead to a better understanding of the variation in theropod dental morphology as a whole. In-situ dentition was used to set morphometric standards for the dentition of *A. fragilis*. The procedure is applicable to other theropods. In premaxillary teeth the mesial and distal carinae are convex, whereas the mesial carinae are wider than the distal carinae, which lead to a general "D-shaped" description. Both the maxillary and dentary dentition can be tentatively labeled "J-shaped", being flatter on the labial surface than the lingual and coming to a point along the distal carinae. As dental morphology may be closely linked to specific feeding behaviors, is it possible that changes in dental morphology could be linked with a shift between feeding niches. Niche-induced morphology may prove to be a more important factor in determining tooth forms than taxonomically diagnostic characters. In addition to dentition of *A. fragilis* the study includes dental morphology of other large theropod taxa for comparison, including additional Carnosauria (*Acrocanthosaurus* and *Carcharodontosaurus*), Coelurosauria (*Tyrannosaurus* and *Gorgosaurus*), Megalosauroidea (Spinosauridae) and Abelisauridae. Variables include crown base length, crown base width, crown height, and apical length along with a series of morphologically relevant ratios and angles, including the crown base ratio, crown height ratio, crown compression ratio and various angles. This study will lead to a better understanding of theropod dentition and its relationship to feeding behaviors and taxanomic relationships.

Poster Session III (Friday, November 4)

PETROSAL MORPHOLOGY OF THE PROTOCERATID CETARTIODACTYL *PROTOCERAS CELER*

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The status of the subarcuate fossa among protoceratids is disputed, and is of importance because of its potential systematic value in determining character polarity within cetartiodactyls. Computed tomography (CT) studies of the highly derived synthetoceratine *Syndyoceras* (UNSM 1153) had suggested that protoceratids lacked the deep subarcuate fossa and mastoid fossa seen in *Poebrotherium* and llamine camelids, and showed a ruminant-like cranio-caudal crest subdividing the dorsomedial surface of the petrosal into cerebral and cerebellar faces. The basal protoceratid *Leptotragulus* (MCZ 5303 and 5304) similarly showed a ruminant-like morphology with a shallow subarcuate fossa and cranio-caudal crest.

The protoceratine *Protoceras celer* was recently suggested to have instead a deep subarcuate fossa and a relatively flat dorsomedial surface, comparable to *Poebrotherium* and the llamine camelids, based upon AMNH-VP 645, an isolated petrosal. A high-resolution computed tomography (CT) scan of the skull of a male *P. celer*, AMNH-VP 53523, from the Poleside Member of the Brule Fm., South Dakota, shows the petrosal morphology of this small protoceratid. This skull shows a shallow, poorly defined subarcuate fossa, and a large crest on the petrosal, subdividing the braincase into distinctive cerebral and cerebellar cavities, similar to *Syndyoceras* and *Leptotragulus*. The lack of agreement between these two specimens suggests that the identification of AMNH-VP 645 may be erroneous, and that the subarcuate morphology of protoceratids is consistent, but this will require data from additional protoceratid taxa.

Poster Session IV (Saturday, November 5)

SPECIES-LEVEL APOMORPHIES IN SOUTHERN AFRICAN MICROFAUNA: DATA FROM THE POSTCRANIA

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Species assemblages of small mammals are informative environmental indicators due to their ecological specificity, sensitivity to environmental change, and small habitat ranges. While species composition and relative abundance of these assemblages are useful tools for paleoenvironmental reconstruction, lower level taxonomic identification using mandibles, maxillae, and teeth can be ambiguous. The postcranial elements of these fossilized microfaunal assemblages are often overlooked as potential indicators of taxonomic affinity. In order to test the use of micromammalian postcrania in species-level identification, an examination of 14 modern species trapped at the Koanaka Hills locality of Ngamiland Province in northwestern Botswana was undertaken. Results from these analyses indicate that elements such as the femur display genus-specific morphological features. Although features tend to overlap among genera, combinations of characteristics provide distinction among the genera examined. Our analysis also proved useful in differentiating between two species of *Gerbilliscus* (*G. brantsii* and *G. leucogaster*) that are similar in diet and habitat. An examination of the fossil small mammal femora (early to middle Pleistocene in age) collected from the Bone Cave locality of Koanaka South yielded distinctions consistent with the morphology of the modern taxa, indicating that the postcranial elements provide useful data for micromammal identification.

Poster Session I (Wednesday, November 2)

CHEMICAL EVIDENCE DEMONSTRATES A THERMAL SPRING DEPOSITIONAL ENVIRONMENT FOR THE FLORISBAD HOMININE SKULL

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The thermal spring depositional setting for the Middle Pleistocene partial *Homo* cranium from Florisbad, South Africa, has been tested using non-destructive chemical analyses. The fragmented hominine skull was found in 1932 in association with other mammal bones (so-called Old Collection fossils), including ancestral black wildebeest (*Connochaetes gnou antiquus*) and hippopotamus (*Hippopotamus amphibius*), in deposits of the Florisbad thermal spring. The spring is structurally controlled by an igneous intrusion of dolerite, and standing surface water at Florisbad has likely existed since well before the Pleistocene. Water issuing from the current 'spring eye' deposits sediment sourced from depth. Energy dispersive x-ray fluorescence spectroscopic analyses of the sediment from the active spring eye revealed characteristic bands attributed to iron, titanium and zirconium, which were concentrated in the heavy mineral fraction. The spring sediment chemical signature is present in carbonate-cemented and cancellous surfaces of Old Collection bones, including the fractured edges of the hominine skull. Spring sediment has been affixed to or embedded within fossil bone during transport and secondary mineralization within an ancient spring system. Chemical measurements support a taphonomic analysis of the Old Collection vertebrate remains, which suggests that the Old Collection is the product of carnivore predation and natural deaths at the periphery of ancient spring pools. Repeated events of migration of the spring eye through time consequently shifted the actively erosive water column and resulted in the burial of the Florisbad skull and other fossils in iron, titanium and zirconium rich spring sediment.

Poster Session I (Wednesday, November 2)

COMPARATIVE ANALYSIS OF ABELISAURID SKULLS INDICATES DIETARY SPECIALIZATION

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Comparative studies of the cranial anatomy of a range of abelisaurid theropods, from basal forms such as *Rugops* and *Krytops* to more derived forms such as *Majungasaurus*, indicate increasing evidence of dietary specialization within this group.

Similarly to other members of the Abelisauridae, *Rugops* and *Kryptops* are characterized by small teeth and a short skull length relative to overall body size. However, analysis of measurements of dentition size and number of serrations per tooth distinguish *Rugops* and *Kryptops* as basal taxa of Abelisauridae. In *Rugops*, the largest fully erupted maxillary tooth is roughly 1 cm in length and 1 cm in diameter, and there are an average of 10 serrations per cm on each tooth, which is fewer than there are in derived forms. These teeth are curved only on the rostral end and straightened on the caudal end, which would have reduced the slicing mechanism prevalent in most other theropods. Similar observed dentition size and form among modern mammalian scavengers suggests the possibility that this basal abelisaurid was limited to scavenging.

Post-Cenomanian taxa, such as *Majungasaurus*, are characterized by broader snouts than that those of *Rugops* or *Kryptops*, with more robust cranial bones and thicker, longer teeth. The largest fully erupted maxillary teeth of *Majungasaurus* are approximately 4 cm in length and 2 cm in diameter, proportionately larger than the teeth of more basal abelisaurids. There are also approximately 17 serrations per cm on each tooth. The most robust teeth were positioned close to the rostral end of the maxilla which, coupled with low crown height and straightened causal edges, would have allowed for powerful puncturing bites.

Abelisaurids lived on the landmass that joined the southern continents, such as Africa and South America, and shared their environment with large carcharodontosaurids and spinosaurids. The existence of this predatory triumvirate may have been the catalyst for such dietary specialization within each group.

Poster Session I (Wednesday, November 2)

AQUATIC BEHAVIOR AND LOCOMOTION OF ARCHOSAURIFORM REPTILES INTERPRETED FROM EARLY-MIDDLE TRIASSIC SWIM TRACKS OF THE WESTERN UNITED STATES

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Subaqueous tetrapod footmarks and traceways attributed to archosauriform reptiles are present in coastal and fluvial Early-Middle Triassic red beds of the Red Peaks Formation of Wyoming, Moenkopi (Torrey Member) and Ankareh (Mahogany Mbr) formations of Utah, and Moenkopi Formation of Arizona (Wupatki Mbr) and New Mexico (Anton Chico Mbr). Footmarks are composed of one, two, or three elongated digit marks preserved in convex hyporelief. One locality in the Moenkopi Formation at Capitol Reef National Park, Utah, exposes two offset traceways containing sequences of 19 and 13 footmarks, respectively. Re-alignment of these offset traceways reveals alternating pace lengths (9-30 cm), fairly consistent strides (39 cm), a front interpace distance (59 cm) significantly wider than the rear (41 cm), consistent pace angulations for front (33°) and rear (43°) footmarks, and high pes divarication angles alternating between 62° and 83°. Footmark positions are consistent with a swimming locomotion characterized by synchronized thrusts of the right and left limbs, respectively, followed by a pause before repetition. Because resistance of the substrate to a full arc of the limb results in posteriorly oriented digits retracting anteriorly to produce posterior overhangs, these overhangs and kick-off scours provide conclusive determination of traceway direction. Swim track surfaces also preserve current crescents that align subequally with traceway directions, demonstrating that the tracemaker swam against the current. Preservation of both manus and pes footmarks shows that all four limbs were used in propulsion. Small interdigit spacing suggests the digits were held together while swimming as opposed to spread at acute angles, like extant crocodylians. Single digit reflectures ("z-traces") have been interpreted as the tracemaker's attempt to maintain grip on the substrate by double kicking at the limit of limb extension. My analysis suggests this z-trace morphology and its behavioral implications are unique to these Early-Middle Triassic footmarks, suggesting that these early archosauriforms swam differently from those recorded by later Mesozoic traces.

Poster Session IV (Saturday, November 5)

ENDOCRANIAL MORPHOLOGY OF *CENTROSAURUS* (ORNITHISCHIA: CERATOPSIDAE) AND BRAIN-BODY SIZE RELATIONSHIPS IN CERATOPSIAN DINOSAURS

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The evolution of the brain has been studied extensively in mammals, but is less well understood in reptiles, such as dinosaurs, where brain evolution is critical for understanding the patterns and mechanisms associated with brain enlargement in maniraptorans and Aves. Here we use computed tomographic (CT) scanning and 3D visualization to reconstruct the endocast of the horned dinosaur *Centrosaurus* for the first time, and assess patterns of relative brain size within a phylogenetic context. We describe the external morphology of the braincase and the anatomy of the virtual brain endocast, cranial nerves, vasculature and endosseous labyrinth of the inner ear.

The endocast reveals a poorly developed cerebrum, optic lobe and cerebellum in comparison to psittacosaurs and non-ceratopsid neoceratopsians. The olfactory bulb in *Centrosaurus* is small relative to its total brain size compared to psittacosaurs, but is comparable to other ceratopsids. The inner ear reconstruction reveals a short cochlea allowing for the first estimation of hearing frequencies for a ceratopsid, with a best hearing frequency of 214 Hz and a high frequency hearing limit of 1437 Hz. The shape and relative size of the semicircular canals is typical for a quadruped.

The reconstructed endocast volume is 101cm3, and based on a body mass estimate of 1.84 tonnes for *Centrosaurus*, generated from a regression equation of predicted body mass and occipital condyle circumference, results in an encephalization quotient (EQ) of 1.1. This suggests a typical brain size for a reptile of its body size, yet relatively much smaller than that of less derived ceratopsians (3.4 for *Psittacosaurus*, and 2.1 for *Protoceratops*). This is the first EQ calculated for a centrosaurine and provides the opportunity to reassess the patterns of brain and body size evolution in ceratopsid dinosaurs. Although, results suggest a decrease in relative brain size in ceratopsid dinosaurs, this clade is also characterized by an increase in body size and thus suggests that selection on body size may have played a major role in the evolution of relative brain size in centrosaurines.

Poster Session III (Friday, November 4)

QUANTITATIVE INFERENCES ON MICROVERTEBRATE DEATH ASSEMBLAGES BASED ON RIGHT-LEFT DISPARITY OF SKELETAL PRESERVATION

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When there is no preservational bias against right or left skeletal elements that are mirror images, disparate numbers of right and left elements in a fossil assemblage must result from stochastic and at least partially-independent loss of right and left sides through taphonomic processes. The cumulative loss of skeletal elements can be simulated based on a simple model of stochastic exponential loss with three parameters: the number of individual organisms in the death assemblage (N0), relative time since the formation of the death assemblage (t), and the decay constant (λ), or the rate at which skeletal elements are lost after the formation of the death assemblage. An important general pattern that emerges from this simulation is that, for a given sum of right and left elements, the probability of more disparate preservation of right and left elements (i.e., deviation from the expected 1:1 ratio) increases as N0 or lambda increases. Thus, assuming that t is constant for all paired elements of the same taxon derived from the same death assemblage, it should be possible to obtain the combinations of the values of N0 and λ that maximize the fit of the model to empirical data. With this approach, the right-left disparity of skeletal preservation was evaluated for Quaternary microvertebrate assemblages from the San Francisco Bay region. The observed ratios of right and left elements are more constrained (i.e., closer to the 1:1 ratio) than expected from a wide range of values of N0 and λ, suggesting some of the assumptions of the model are violated.

Poster Session IV (Saturday, November 5)

VERTEBRATE MICROFOSSIL ANALYSIS IN THE PALAEONTOLOGICAL SITE OF 'LO HUECO' (UPPER CRETACEOUS, CUENCA, SPAIN)

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The site of 'Lo Hueco' preserves an extraordinary fossil assemblage, mainly composed of vertebrates, but also includes plants and invertebrates. The fossils are preserved in a stratigraphic succession of versicolor marly mudstone levels, partially cut by a sandy channel structure and two sulphated intervals. Most of the fossils are concentrated in only four of these lithosomes: the sandy channel structure (C), the grey marly mudstone levels (G1 and G2), and the lower part of the second red marly mudstone level (R2). The palaeontological material (0.5mm-1cm fraction) obtained from screenwashing and sorting of sediments in the G2 level has been preliminarily studied here, because this lithosome can be considered as one of the most representative of vertebrate richness, abundance and diversity at this site. The G2 level contains fossils that are rarely articulated, randomly scattered, and scarcely or not affected by erosion. The most abundant vertebrate microfossils that appear in this level correspond to fishes, mostly different morphologies of ganoid scales and numerous teeth. The ganoid scales are derived from the medium and posterior positions of the body and can be attributed to Lepisosteidae indet., as can numerous teeth and postcranial elements including an atlas. Other teeth and elements can be assigned to different fish groups, such as Pycnodontoidea, Amiidae and possibly Albulidae. Several postcranial elements, mainly diaphyses of lissamphibians, have been collected. A mandibular fragment attributed to a scincomorph, probably a Lacertidae, and cranial bones of other squamates, preliminarily assigned to iguanids, have also been identified. Crocodiles are represented by numerous teeth assigned to cf. *Musturzabalsuchus* and Crocodylia indet. Theropod remains, mainly teeth and an ungueal phalanx, are fewer but representative of Coelurosauridae indet., cf. Dromaeosauridae indet., cf. Velociraptorinae indet., cf. *Richardostesia* and cf. *Paronychodon*. This vertebrate assemblage of the G2 level is typical of an upper Campanian-lower Maastrichtian coastal shallow flooded muddy plain.

Poster Session I (Wednesday, November 2)

FEATHERING AND ESTIMATING WING LOADING FOR LITHORNITHID BIRDS FROM THE EARLY EOCENE GREEN RIVER FORMATION

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All extant palaeognath birds with the exception of tinamous are flightless. As the sister taxon to the clade including all other Aves, optimization of character states for Palaeognathae are essential to estimating those ancestral to all extant birds (crown clade Aves). New feathered specimens of the extinct taxon Lithornithidae provide key data on the diversity of feather number, wing shape and estimated wing loading in the palaeognath total group. Three specimens, recovered from the Fossil Lake Member of the Green River Formation in Wyoming, preserve the remains of primary and secondary flight feathers. The specimens preserve evidence of feather morphology, and quill knob impressions are visible along the carpometacarpus and ulna. The present study documents the preserved plumage and attempts to estimate wing loading, a metric of airfoil surface area compared to body mass often used for assessing flight ability. To estimate wing area, a composite reconstruction of a fully-extended lithornithid wing was created. Body mass was estimated using the femur and was reconstructed with reference to individuals of Tinamidae as well as other lithornithids. Lithornithid wing loading appears to be well below that of tinamous, more closely approximating pigeons. Several previous estimates of wing loading from other fossil birds appear to be unrealistic due to key methodological problems, including references used for estimating body mass and techniques for reconstructing wing shape.

Poster Session IV (Saturday, November 5)

CAVIOMORPH MICROWEAR REVISITED USING HDR IMAGING

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High dynamic range (HDR) imaging methods have been shown to produce outstanding high-resolution images of enamel microwear. Based on these excellent results and the ease of application, we chose to use this method to expand our microwear dataset previously used for extant caviomorph dietary classification. Since this technique is relatively new, we performed a small consistency study to evaluate whether the microwear features analyzed in our previous study would be consistent using HDR techniques. We reexamined four caviomorph taxa in two dietary categories: *Hydrochoerus* and *Cavia* (Caviidae; grass-leaf diet) and *Dasyprocta* and *Cuniculus* (Dasyproctidae and Cuniculidae, respectively; fruit-leaf diet).

The image capture segment of the study produced exceptional images with clearly defined microwear features. Nevertheless, our new HDR generated results are not entirely consistent with our previous study. The consistency study showed an increase in features associated with "hard object" feeding in the four taxa, including large pits, large puncture pits, and small puncture pits. We suggest that the increased number of these features is due to the high quality of the HDR image. Many fewer small pits were evident in the HDR images, and this was true for all four taxa. Many fewer scratches were observed for the two grass-leaf taxa, which previously were characterized by high scratch counts (average scratch counts for *Cavia* in previous study = 29.14, this study = 9.70; *Hydrochoerus* previous study = 26.61, this study = 11.05). We believe that these discrepancies are not due to differences in microwear per se, but rather that the same features look different when using HDR imaging. Small pits, which have been characterized as "bright" and "shiny" at low magnification, are much less evident in HDR images, as are fine scratches. This highlights the need to use a consistent method when comparing counts of microwear features. As we continue to explore the utility of this new method and add to the extant caviomorph dataset, we expect that the discriminating power of small pits may decline, at least for this group of mammals.

Poster Session II (Thursday, November 3)

AN EXCEPTIONALLY LARGE JUVENILE *CAMARASAURUS* FROM THE MORRISON FORMATION (UPPER JURASSIC) OF ALBANY COUNTY, WY, USA

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During construction of the Rockies Express (REX) natural gas pipeline in 2006, Uinta Paleontological Associates, Inc. discovered a dinosaur bonebed in the Upper Jurassic Morrison Formation of Albany County, WY. Among the five dinosaurs collected from the McKinsey-REX Quarry is a juvenile *Camarasaurus* (UW-46212), represented by at least 35 caudal vertebrae, four dorsal vertebrae, and the entire sacrum. Of these vertebrae, all but the last 22 caudal vertebrae have completely open neurocentral sutures, and the sacrum is completely unfused.

As *Camarasaurus* is the most common sauropod dinosaur known from the Morrison Formation, general patterns of ontogenetic growth have been observed and can be used to group specimens of *Camarasaurus* into stages of ontogeny. For the axial skeleton, the main characteristic used to determine the ontogenetic stage is the degree of neurocentral suture fusion. Based on the lack of neurocentral suture fusion in all but the posterior caudal vertebrae, UW-46212 can be classified as a juvenile. The pattern of neurocentral suture fusion seen in this specimen supports the hypothesis that fusion in *Camarasaurus* began in the posterior part of the tail and worked its way cranially through the vertebral column.

The relatively large size of these juvenile camarasaur vertebrae prompted a preliminary comparison of these vertebrae with those of other camarasaurs. Based on published measurements of two adult camarasaurs, we determined that the preserved caudal vertebrae of UW-46212 are approximately 90% of the size of these adult *Camarasaurus* specimens. This very large size coupled with the decidedly juvenile characteristics of this specimen is very curious and prompts questions as to the identification of this dinosaur, but at present no identifying characters contradict the assignment to *Camarasaurus*. Also, a U/Pb radiometric age of 152 Ma on this site places UW-46212 as possibly one of the oldest known camarasaurs. Further work may show that UW-46212 represents a new, larger species of *Camarasaurus*.

Technical Session XVIII (Saturday, November 5, 4:00 pm)

PELVIC ANATOMY OF *ALLIGATOR MISSISSIPPIENSIS* AND ITS SIGNIFICANCE FOR INTERPRETING LIMB FUNCTION IN FOSSIL ARCHOSAURS

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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 crurotarsan and crocodyliform evolution, reflecting a spectrum of

postures. However, the lack of soft tissues, such as articular cartilage, ligaments, and tendons in fossil taxa makes accurate inferences of joint function challenging. We test the hypothesis that hard-tissue manipulation alone is insufficient to accurately predict in-vivo range of motion in the hip joint of the American alligator. In addition, we also seek to further elucidate the anatomy of archosaur appendicular joints by providing the first description of the acetabular anatomy of the American alligator. Hip joints of ten specimens ranging from hatchling to subadult individuals were variably subjected to dissection, 3D imaging, and histology. MicroCT specimens were stained with Lugol's Iodine to enhance visualization of soft tissue structures. Our results show that alligator hips possess three capsular ligaments, as well as a ligamentum teres capitus which connects the lateral-most point of the femoral head articular surface to the acetabular notch. The lunate surface of the acetabulum has two distinct cranial and caudal regions of articular cartilage, bounded caudally by a meniscus and dorsally by a supraacetabular pad formed of fat and fibrocartilage. During femoral abduction, the ligamentum teres capitis limits the center of rotation to the edge of the femoral head, allowing the head to slide dorsoventrally within the acetabulum. Three dimensional analysis of hip joint movement with and without joint soft tissues showed that the bone-only model enabled significantly more movement in the joint than the soft-tissue model. This study provides new insight into soft tissue structures and their osteological correlates in the archosaur hip joint. Continuing identification and testing of these osteological correlates in fossil archosaurs will greatly enhance our understanding on evolution of locomotor capabilities such as bipedality and limb adduction of fossil archosaurs and other reptiles.

Poster Session III (Friday, November 4)

THE ANTHRACOTHERES (MAMMALIA, ARTIODACTYLA) FROM THE NEOGENE OF CENTRAL MYANMAR

TSUBAMOTO, Takehisa, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; HTIKE, Thaung, Shwebo Degree College, Shwebo, Japan; MAUNG-THEIN, Zin-Maung, Mandalay University, Mandalay, Japan; EGI, Naoko, Kyoto University, Inuyama, Japan; TAKAI, Masanaru, Kyoto University, Inuyama, Japan

The Neogene anthracotheres (Mammalia, Artiodactyla) of Southeast Asia have been very poorly understood. Here, we report new gnatho-dental specimens of the anthracotheres discovered from four Neogene localities in central Myanmar. Based on these new specimens, we recognize four species of anthracotheres in the Neogene of central Myanmar: *Microbunodon silistrensis* and aff. *Sivameryx* sp. from the middle Miocene (Pegu Beds), and *Microbunodon milaensis* and *Merycopotamus dissimilis* from the latest Miocene to Plio-Pleistocene (Irrawaddy Sediments). This discovery extends the distribution of *Microbunodon* and *Sivameryx*-like bothriodontine from the Indian Subcontinent to Southeast Asia, indicating their broader distribution in the Neogene. Furthermore, the discovery demonstrates that *Microbunodon* survived until the Plio-Pleistocene. The new specimens also indicate that both a highly selenodont and hippo-like form (*Merycopotamus*), and a bunodont and relatively primitive form (*Microbunodon*) were the last surviving anthracotheres. These two anthracotheres co-existed until the late Pliocene/early Pleistocene in Myanmar. In the Neogene of Myanmar, the anthracotheriid fauna changed around the late Miocene. This change was probably caused by the invasion of anthracotheres from the Indian Subcontinent, likely related to the major faunal turnover events there. The later fauna persisted until the late Pliocene/early Pleistocene, when the last anthracotheres became extinct.

Poster Session II (Thursday, November 3)

A SAUROPOD (DINOSAURIA: SAURISCHIA) BRAINCASE FROM THE LOWER CRETACEOUS OF THE EASTERN GOBI DESERT IN MONGOLIA

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An isolated, well-preserved sauropod braincase consisting of the nasal and more posterior bones was found from the Lower Cretaceous (Albian) sediments cropping out at the Khamaryn Khural locality in the eastern Gobi region of Mongolia by a field party of the Japanese – Mongolian joint expedition. Only fragmentary remains of sauropods have been previously described from the Lower Cretaceous of Mongolia. Thus, the present finding contributes to extending our knowledge on sauropod diversity in this region.

The nasal is wider than long, and the preserved, posterior part of the internarial bar indicates that the external nares would have been retracted and separate. The prefrontal is anteroposteriorly short, with the posterior end at almost the same level as that of the nasal. The frontals are fused together although the interdigitating suture line is still visible. The parietal and frontal are completely fused together without a trace of suture line, representing a character potentially unique to this specimen among sauropods. The prefrontal, frontal, and postorbital bear roughened ornamentation along the orbital margin as in *Nemegtosaurus* and *Quaesitosaurus*. The paroccipital process has a prong extending ventrally from its ventrolateral corner, as observed in derived titanosaurians. A cladistic analysis placed the present specimen in Titanosauria and, more specifically, within Nemegtosauridae. However, the support for this placement is weak, with only one character, the parietal not contributing to the post-temporal fossa, found as an unambiguous synapomorphy uniting the present specimen with other nemegtosaurids.

Brain and inner ear endocasts were digitally reconstructed based on CT scan data. Many aspects of their morphology agree with those of other sauropod endocasts, including strongly-developed dural expansions dorsal to the cerebrum and cerebellum. The olfactory bulb, however, is relatively smaller than those in *Diplodocus* and *Camarasaurus*, suggesting that olfaction may have been less important in the present sauropod. The direction of the lateral semicircular canal suggests the muzzle is habitually down-turned as in many other sauropods.

Technical Session II (Wednesday, November 2, 1:45 pm)

WHAT, IF ANYTHING, IS A 'DWARF' PAREIASAUR? NEW INFORMATION ON *PUMILIOPAREIA PRICEI*

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Recent advances in the understanding of pareiasaur taxonomy, phylogeny, and diversity, have greatly reduced the number of valid taxa. A paucity of specimens and their oftentimes unfavorable state of preservation has hampered the recognition of evolutionary patterns within the clade. This is particularly true for the smallest, 'dwarf' pareiasaurs from the *Cistecephalus* Assemblage Zone of the Karoo Basin of South Africa. Two taxa in particular, *Nanoparia luckhoffi* and *Pumiliopareia pricei*, are the smallest and ostensibly among the most derived pareiasaurs, but are known from only one and two specimens, respectively. The dearth of specimens and knowledge about pareiasaur ontogeny make it difficult to determine if these are, in fact, distinct taxa or are instead juveniles of the more abundant, large-bodied, contemporaneous taxa.

In 2005, a new pareiasaur specimen was collected from the southern slopes of the Skipberg Mountain in the Beaufort West District, South Africa, a locality assigned to the lowermost *Cistecephalus* Assemblage Zone. SAM-PK-K10498 consists of an articulated cranium and anterior skeleton with a large number of articulated osteoderms, which are closely associated with flattened dorsal ribs. The specimen was prepared from both dorsal and ventral aspects, and is notable for its small size (skull length approximately 20 cm) and exceptional preservation. SAM-PK-K10498 is assigned to *Pumiliopareia pricei*, as the taxon is currently defined. Despite the fact that it is twice as large as the other known specimens of *Pumiliopareia*, the specimen shows signs of immaturity: the epiphyses of the humerus are incompletely ossified, the angular boss is modest, the cranial sculpturing is attenuated, and the neurocentral sutures are incompletely fused. The new material indicates that the smallest pareiasaur taxon may not be such a 'dwarf' after all, and emphasizes the need to develop an ontogenetic framework within which other small pareiasaur specimens can be understood.

Poster Session II (Thursday, November 3)

NEBRASKA'S HIGHWAY PALEONTOLOGY PROGRAM: 50 YEARS OF LIFE IN THE PAST LANE

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Whenever the surface is disrupted in Nebraska, whether it is digging the foundation for a home or building a highway, there is a distinct possibility that fossils will be uncovered. Large, heavy earth-moving equipment can irreparably damage fragile bones yet many of these prehistoric remains would remain buried for millennia without construction. Without coordinated mitigation efforts, vast amounts of information critical to the interpretation of climate and life history in North America would be lost.

Nebraska has been a leader in fossil mitigation efforts for more than 50 years. The Nebraska Department of Roads (NDOR) has long been cognizant of its impact on these non-renewable resources having included a section on paleontological discoveries in their 1937 specifications for highway construction. In 1960, Nebraska created the nation's first full-time program devoted to fossil recovery on road construction projects. This cooperative effort between the University of Nebraska State Museum (UNSM) and NDOR prevents the destruction of unique, irreplaceable scientific resources. Backed by state and federal legislation, the Highway Paleontology Program has collected approximately 200,000 fossil vertebrate specimens, including 20 holotypes, from more than 150 localities in the past five decades.

UNSM works closely with contractors and NDOR personnel in all phases of construction to preserve the state's rich prehistoric past without stopping or delaying construction. Early notification of pending projects allows for field surveys and test excavations prior to construction. Pre-construction meetings and on-site training inform the contractor and NDOR staff of potentially fossiliferous areas and what to look for during excavation. If fossil remains are discovered, contractors continue working but shift their operations to temporarily avoid paleontologically sensitive areas. After construction is completed, NDOR will provide equipment to re-open localities for additional study. This highly successful inter-agency partnership preserves specimens that would be destroyed thereby enhancing our scientific knowledge of the paleoflora and fauna in our state.

Poster Session II (Thursday, November 3)

LANGEBAANWEG QUARRY, WESTERN CAPE, SOUTH AFRICA: THE ELASMOBRANCH FAUNA AND COMPARISONS TO FAUNAS OF PCS (LEE CREEK) PHOSPHATE MINE AND SHARKTOOTH HILL

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The Langebaanweg (LBW) site is a treasure trove of fossils, both terrestrial and marine from a Mio-Pliocene ecosystem in Western Cape, South Africa. Here we report on the elasmobranch diversity of the locality. We provide a revision of the initial listing of the elasmobranch fossils made in the early 1980s by Hendey, and we compare the fauna from LBW to the faunas of the PCS Phosphate Mine (PCS) (formerly the Lee Creek Mine) of North Carolina and Sharktooth Hill (SH) of California.

The LBW fauna is a moderately diverse group ranging over 10-11 genera consisting of hexanchiforms, lamniforms, carcharhiniforms, rajiforms, and myliobatiforms. The fossil material consists largely of teeth, some dermal denticles, tail spines, and the occasional centra. Genera represented by the LBW fauna are: *Carcharhinus*, *Galeorhinus*, *Notorynchus*, *Carcharodon*, *Isurus*, *Carcharias*, *Squalus*, *Squatina*, *Dasyatis*, and *Myliobatis* and/or *Rhinoptera*. Previous lists of the fauna include genera that are: a. not found in the current collections or b. have been revised in taxonomic schemes. In comparison, the similarly aged fauna of the PCS consists of 41 genera and the older SH consists of 21 genera. The LBW fauna is overwhelmingly dominated by *Carcharias taurus* teeth and very little else. The additional taxa represented in the fauna consist of anywhere from 1 tooth to dozens of teeth while *C. taurus* is represented by teeth that number in the hundreds. Despite the faunal size/diversity disparity, the following genera from LBW are also found in PCS and SH: *Carcharhinus*, *Galeorhinus*, *Carcharodon*, *Isurus*, *Squalus*, *Squatina*, and *Myliobatis*. The commonality in fauna would imply some level of similarity in overall paleoenvironment, particularly as both LBW and PCS are phosphate mines of similar ages. The fauna of PCS contains warm to warm/cool taxa that is consistent with the location, a warm shallow marine environment of the Atlantic coastal plain. The similarity in faunas suggests that LBW was also a shallow marine environment.

Poster Session IV (Saturday, November 5)

A NEW ANGUIMORPH LIZARD (REPTILIA: SQUAMATA) FROM EARLY CRETACEOUS OF ÖÖSH, MONGOLIA

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Estimated interrelationships within the Anguimorpha differ greatly between analyses where molecular and morphological data are used. One reason for this is the lack of knowledge about early anguimorphs. Well-preserved fossil forms are vital for understanding the evolution and phylogenetic relationships of this group, and for studying the origins of Varanidae, Mosasauria, Monstersauria and Shinisauria within Anguimorpha. We present a new anguimorph lizard from Early Cretaceous of Mongolia. The Ööish (Övörkhangai) locality has previously yielded dinosaurs, a pterosaur and a gecko but no anguimorphs. The new taxon is represented by several well-preserved disarticulated cranial bones and a few vertebrae and limb bones. In addition to traditional paleontological methods, the jaw elements were studied from high resolution X-ray computed tomography scans. The new taxon displays a combination of basal anguid and advanced varanoid-like characters, including: trenchant marginal teeth are slightly curved with plicidentine and are closely spaced; dermal sculpturing is present on the prefrontal but is absent from the maxilla; angulated jugal; large rodlike toothless vomers; broad quadrate with a pronounced pterygoid lappet and a wide tympanic crest; dorsal vertebrae with short and board neural spines with slight obliqueness of condyles; caudal vertebrae with autotomy planes on transverse processes. In a phylogenetic analysis of 136 extinct and extant squamate taxa scored for 422 morphological characters, the new taxon is recovered within Platynota as the sister taxon of Varanoidea. The new species offers novel insight into varanoid evolution and origins, especially since many characters present in this species are unknown from closely related fossil platynotans. Recent combined evidence analysis has rendered the traditional usage of the names Platynota and Varanoidea invalid and unnecessary, respectively. Incorporating the new taxon into subsequent combined evidence analyses will further aid in resolving anguimorph interrelationships, and address the position of the volatile taxa *Parasaniwa* and *Parviderma*.

Poster Session II (Thursday, November 3)

FLESHING OUT THE NEOSUCHIAN TREE: A REEVALUATION OF THE CROCODYLIFORM SHAMOSUCHUS FROM THE CRETACEOUS OF ASIA

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Shamosuchus is a small to medium sized crocodyliform known from numerous Late Cretaceous localities in southern and eastern Mongolia and fragmentary remains from Uzbekistan. In total seven species of *Shamosuchus* have been named from six localities in Mongolia and three in Uzbekistan. Three species originally described as *Paralligator* (*P. ancestralis*, *P. gradilifrons*, *P. sungaricus*) were later referred to *Shamosuchus* extending its range to the Albian. Much remains unknown about this putative *Shamosuchus* clade. Only the type species, *S. djadochtaensis* has be examined in detail and phylogenetic analysis suggests it is an advanced neosuchian closely related to *Rugosuchus* from the Early Cretaceous of China. The derived placement of *S. djadochtaensis* highlights its importance in understanding the suite of character changes taking place at the origin of Eusuchia and "modern" crocodylians. However, the morphology of the remaining 9 species have largely been unexamined and their phylogenetic placement and impact on more derived eusuchian relationships remain unknown. Many of the named species of *Shamosuchus* show striking differences in size and cranial morphology. Furthermore, most are based on partial remains of skulls suggesting that the true species diversity is overestimated and the assumed monophyly of *Shamosuchus* is perhaps unwarranted. Our firsthand reexamination of the known *Shamosuchus* specimens reveal that only *S. djadochtaensis*, *S. gradilifrons* and *S. ancestralis* represent valid species. We included these additional *Shamosuchus* species in a maximum parsimony analysis utilizing an expanded phylogenetic dataset focused on elucidating neosuchian and early eusuchian relationships. *Shamosuchus* species share a number of derived characters including a distinct depression on the dorsal surface of the squamosal together with a corresponding flared posterior process of the squamosal, a prominent crest on the lateral surface of the jugal, and an open cranioquadrate canal. These results suggest the presence of a diverse *Shamosuchus* clade present in eastern Asia during the Cretaceous which exhibited a remarkable diversity in cranial shape and morphology.

Poster Session IV (Saturday, November 5)

A NEW SPECIES OF PACHYRHINOSAUR (CERATOPSIDAE: CENTROSAURINAE) FROM THE LOWER MAASTRICHTIAN OF THE NORTH SLOPE OF ALASKA

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The Maastrichtian portion of the Prince Creek Formation of Alaska's North Slope has yielded several remarkably rich dinosaur-bearing localities. One of these sites, the Kikak-Tegoseak Quarry (69-70Ma) has produced a variety of taxa but is a monodominant bonebed containing ceratopsid remains from at least nine individuals. Fragmentary cranial specimens first collected from the site bear enlarged nasal bosses that justified early assignment of the material to *Pachyrhinosaurus* sp. Collections from the site in 2006 and 2007 included more complete cranial material that has revealed additional data. A recently prepared partial skull shares similarities with both *Pachyrhinosaurus canadensis* and *Pachyrhinosaurus lakustai*, but also has features, such as a rostral comb and a nasal boss that nearly contacts the supraorbital bosses, that are present in one but not the other of these species. Pieces of parietals from two individuals each bear an ornamental horn in a position not expressed in the two known *Pachyrhinosaurus* species. Indeed, the location and morphology of this parietal horn is currently unique among ceratopsids. This unusual frill apomorphy and the combination of other features in the skull support recognition of the Arctic taxon as a new species. Further, there is a substantial temporal gap between the Kikak-Tegoseak Quarry specimens and other previously described pachyrhinosaurs. A phylogenetic analysis that includes recently recognized centrosaurine taxa and additional characters that test pachyrhinosaur relationships finds the new species is the sister-taxon of *P. canadensis* to the exclusion of *P. lakustai* and the other centrosaurines.

Technical Session XIX (Saturday, November 5, 1:45 pm)

A NEW PROTOCETID WHALE FROM THE MIDDLE EOCENE OF MISSISSIPPI

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A new protocetid whale was recently discovered in eastern Mississippi that represents a new species similar to *Natchitochia jonesi*. The specimen includes three thoracic, three lumbar, one sacral and eleven caudal vertebrae, the right innominate, the proximal right femur, and one pedal (?) phalanx. The specimen was discovered along the southwest bank of the Chickasawhay River, south of Quitman, Mississippi. It was found in a mix of mud and carbonate typical of the Archusa Marl Member of the Cook Mountain Formation, which is early Bartonian (late middle Eocene) in age. The comparable vertebrae in the specimen are very similar in overall morphology to those of *Natchitochia jonesi*, but are about 20% larger in linear dimensions. The size and morphology of the innominate and the proximal femur indicate that the hind limbs of this new animal were relatively as large or larger than those of animals such as *Rodhocetus* and *Maiacetus*. The innominate is similar in size and morphology to that of *Georgiacetus*, but unlike *Georgiacetus*, this specimen displays a large auricular surface on the illum for attachment to the single sacral vertebra. This specimen greatly enhances our knowledge of the hind limb morphology of North American protocetids given its significant difference from the detached innominate of *Georgiacetus*, and the much reduced innominate of *Eocetus wardii*.

Poster Session III (Friday, November 4)

LARGEST KNOWN SPECIMEN AND FIRST MANDIBLE OF THE CRETACEOUS SIDE-NECKED TURTLE *TAPHROSPHYS SULCATUS* (TESTUDINES: PLEURODIRA)

ULLMANN, Paul, Drexel University, Philadelphia, PA, USA; LACOVARA, Kenneth, Drexel University, Philadelphia, PA, USA

New Cretaceous pleurodiran turtle remains from the Inversand glauconite pit in Sewell, NJ, include fragments of *Bothremys sp.* and a taxonomically informative partial skeleton of *Taphrosphys sulcatus*. The specimen of *Taphrosphys* represents by far the largest individual yet discovered of the species and includes the first known mandible for this rare taxon. Remains of the disarticulated but associated *T. sulcatus* individual include a nearly com-

plete skull roof, braincase, cervical centrum, humerus, metacarpal or metatarsal, plastron, pygal, left costal 3, right costal 4, left peripherals 5 through 7, right peripherals 7 and 8, and indeterminate carapace fragments. Remains of *Bothremys* include the fused dentaries, nuchal scute, left peripheral one, and indeterminate carapace fragments. The new specimen of *Taphrosphys sulcatus* expands the size range of this pleurodire and documents the morphology of its lower jaw, thus far only the second mandible discovered for the entire genus. As for *Taphrosphys congolensis*, the lower jaw of *T. sulcatus* presents a broad, flat mandibular triturating surface without deep pits that is narrow posteriorly and has low lingular ridges, the processus coronoideus is low, and the fossa meckelii is widely open ventrally. New insights from this specimen into lower jaw morphology for the genus *Taphrosphys* include lack of a splenial, fused rather than sutured dentary symphysis, posterior process of the dentary widely exposed laterally, foramen nervi auriculotemporalis present, narrow coronoid exposure in lateral view, anterior portion of the fossa meckelii enclosed by a long angular-prearticular contact, and a long, posteriorly-placed processus retroarticularis. These fossils were discovered in the basal Danian-stage Main Fossiliferous Layer (MFL) of the Hornerstown Formation. The Cretaceous Navesink and Cretaceous-Paleocene Hornerstown glauconitic greensands demonstrate that at this time southern New Jersey comprised a low sedimentation rate and low energy shallow marine setting. Abundant bioturbation is likely responsible for disarticulation and low sedimentation rate is reflected in the partial nature of these and most MFL specimens.

Symposium 4 (Friday, November 4, 9:45 am)

GEOLOGICAL AND ANTHROPOGENIC CONTROLS ON THE SAMPLING OF THE TERRESTRIAL FOSSIL RECORD: A CASE STUDY FROM THE DINOSAURIA

UPCHURCH, Paul, University College London, London, United Kingdom; MANNION, Philip, University College London, London, United Kingdom; BENSON, Roger, University of Cambridge, Cambridge, United Kingdom; BUTLER, Richard, Bayerische Staatssammlung fur Paläontologie Geologie, Munich, Germany; CARRANO, Matthew, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA

Dinosaurs provide excellent opportunities to examine the impact of sampling biases on the paleodiversity of terrestrial organisms. The stratigraphic and geographic ranges of 847 dinosaurian species (including Mesozoic birds) are analyzed for paleodiversity patterns and compared to several sampling metrics, such as the numbers of dinosaur-bearing formations and collections and rock outcrop area for western Europe. The observed diversity of dinosaurs, Theropoda, Sauropodomorpha and Ornithischia, are positively correlated with sampling at global and regional scales. Separate sampling metrics for the same region correlate with each other, suggesting that different metrics often capture the same signal. Regional sampling metrics perform well as explanations for regional diversity patterns, but correlations with global diversity are weaker. Residual diversity estimates indicate that sauropodomorphs diversified during the Late Triassic, but major increases in the diversity of theropods and ornithischians did not occur until the Early Jurassic. Dinosaur diversity increased during the Jurassic, but many groups underwent extinction during the Late Jurassic or at the Jurassic/Cretaceous boundary. Although a recovery occurred during the Cretaceous, only sauropodomorphs display a long-term trend towards increased diversity. The Campanian–Maastrichtian 'peak' in observed dinosaur diversity is largely a sampling artifact. There is little evidence for a gradualistic decrease in diversity prior to the end-Cretaceous mass extinction (except for ornithischians), and when such decreases do occur they are small relative to those experienced earlier in dinosaur evolution. Thus, contrary to several previous studies, there is little support for a long-term trend of increasing dinosaurian diversity throughout the Mesozoic. Instead, current data support a peak in diversification rates during the Early and Middle Jurassic followed by fluctuating diversity levels with no long-term trends.

Romer Prize/Technical Session 5 (Thursday, November 3, 8:45 am)

THREE-DIMENSIONAL GEOMETRIC MORPHOMETRICAL ANALYSES OF THE FUNCTIONAL MORPHOLOGY OF THE *URSUS SPELAEUS* MANDIBLE

VAN HETEREN, Anneke, Centre for Research in Evolutionary Anthropology, Roehampton University, London, United Kingdom

The diet of the Pleistocene cave bear *Ursus spelaeus* has been debated extensively. Traditionally, *U. spelaeus* was thought to be herbivorous, but more recent studies have proposed that it may have been more omnivorous. To test this proposal, the mandibular morphology of *U. spelaeus* was analysed using three-dimensional (3D) geometric morphometrics and compared to that of its confamilials. The eight extant Ursidae species occupy various dietary niches, which are expected to be expressed in mandibular functional morphology. These species were used to generate a dietary morphospace, in which the position of *U. spelaeus* was determined.

Landmarks for 3D digitisation of the mandible were chosen to reflect functional morphology relating to the *musculus temporalis* and *m. masseter*. Extant and extinct Ursidae, including Pleistocene *U. arctos*, *U. deningeri* and *U. spelaeus*, were digitised with a Microscribe G2. Generalised Procrustes superimposition was performed on the raw coordinates and allometry removed by regressing the Procrustes coordinates onto the natural logarithm of centroid size pooled per species. Principal component analyses (PCA) were conducted on the regression residuals, and analyses of variance (ANOVA) and post-hoc Tukey honestly significant difference (HSD) tests performed on the PC scores.

For both *m. temporalis* and *m. masseter*, PCA 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. Post-hoc Tukey HSD tests indicate that *U. spelaeus* forms a homogeneous subset with folivorous bears on PC 1. Differences in the results between *m. temporalis* and *m. masseter* are seen primarily in the position of the extant spectacled bear *T. ornatus*, probably due to the influence of its premasseteric fossa on the morphology of its masseteric fossa.

These results suggest that *U.spelaeus* was herbivorous, rather than omnivorous. And, the usefulness of separately analysing the function of individual muscles is demonstrated.

Technical Session I (Wednesday, November 2, 10:30 am)

QUANTIFYING THE POSTURE OF QUADRUPEDAL DINOSAURS: A MORPHOMETRIC APPROACH

VANBUREN, Collin, Western Illinois University, Macomb, IL, USA; BONNAN, Matthew, Western Illinois University, Macomb, IL, USA

Although the hindlimb of dinosaurs was fully erect, the forelimb posture of quadrupedal dinosaurs has been a subject of heated debate in vertebrate paleontology. It has been suggested that dinosaurs, unlike their archosaur relatives, had an erect forelimb posture, similar to therian mammals. While previous studies explored trends in dinosaur posture, quantifying forelimb posture has remained relatively unexplored. We focused on quantifying the shape of the radius, a long bone that closely correlates with forelimb posture. We tested the hypothesis that radius shape in dinosaurs should not be significantly different from that of therian mammals if their forelimbs were held erect. Over 380 mammal, sauropsid, and dinosaur radii were examined, photographed, and measured to quantify radius morphology. Linear dimensions, radial head photographs, and long axis photographs were captured for each radius specimen and traditional and shape analysis software tested these variables for significant differences among the taxa. Our results indicate there is a significant difference in radius shape between dinosaur and mammal radii, but, surprisingly, no significant difference was reported for radius shape between dinosaurs and sauropsids with non-erect forelimb posture. We find it significant that ceratopsians, a clade often depicted as rhino-like gallopers, showed a significant difference with therian mammal radii and most resembled non-erect sauropsids. Sauropodomorphs, in contrast, had a radius shape significantly different from both therian mammals and non-erect sauropsids, suggesting that their forelimb posture, if fully erect, did not resemble that of therian mammals.

Overall, our data suggest that, unlike therian mammals, quadrupedal dinosaurs had less erect forelimbs. We find our results significant given that they suggest previous models of quadrupedal dinosaur locomotion based on therian forelimb posture must be re-evaluated. Ultimately, we suggest that mammal forelimb posture and function are not a good proxy for dinosaur locomotion.

Poster Session III (Friday, November 4)

3D MORPHOMETRIC ANALYSIS OF INTERSPECIFIC VARIATION IN ODONTOCETE PETROSALS

VARADIAN, Elizabeth, New York College of Osteopathic Medicine, Old Westbury, NY, USA; BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA; GEISLER, Jonathan, New York College of Osteopathic Medicine, Old Westbury, NY, USA

Odontocete ear regions are diverse in their morphology and because of their density and isolation from the rest of their skulls to minimize acoustic interference, often preferentially preserve and separated from craniodental remains. Their distinctive morphology has been useful in cetacean systematics, yet the lack of understanding of their variation along with the complexity of their shapes, has made it difficult to qualitatively assess the characters derived from them. To quantitatively explore this question, 14 landmarks were digitized in 3D using a G2X Microscribe for 22 petrosals of 9 modern species: *Monodon monoceras*, *Delphinus delphis*, *Tursiops truncatus*, *Pontoporia blainvillei*, *Inia geoffrensis*, *Globicephela melas*, *Kogia breviceps*, and *Orcinus orca*.

Though PCA 1 and 2 do not always differentiate species, they clearly identify families Delphinidae, Iniidae, Pontoporiidae, Monodontidae and Kogiidae. Discriminant Function Analysis indicated specific landmark variables can discriminate family groups ($p < 0.05$: Delphinidae ($p = .000$), Monodontidae ($p = .000$), Iniidae ($p = .015$), Pontoporiidae ($p = .002$), Kogiidae ($p = .000$), Delphininae ($p = .003$), Orcinus orca ($p = .001$). Landmark data could not distinguish Globicephalinae ($p=0.14$). The landmarks involved in the greatest amount of variation in standardized canonical discriminant function coefficients differed between groups. Landmark points 5 (apex of ventrolateral tuberosity), 6 (posterior process margin), 2 (fenestra ovalis), 4 (ventrolateral tuberosity), 3 (center of malleolar fossa), 1 (fenestra rotunda), and 7 (posterior process margin bulla facet opposite Ant. process VL angle between growth lines) demonstrated the greatest discriminating ability within groups in decreasing order. With greater sampling of modern taxa, we hope to enhance the ability to differentiate genera. Trials using this information to identify Pliocene odontocete periotics from South Carolina indicate that this may not only be useful in recognizing Neogene odontocetes more quantitatively, but also in identifying trends of periotic evolution that will help tease out characters of these groups that can help us better recognize relationships between problematic fossil odontocetes, particularly early Delphinoidea and Platanistoidea.

Poster Session I (Wednesday, November 2)

THE STATUS OF MORPHOLOGICAL AND DEVELOPMENTAL EVIDENCE ON DIGIT IDENTITY IN THE HAND OF ANURA

VARGAS, Alexander, Universidad de Chile, Santiago, Chile; SOTO-ACUÑA, Sergio, Universidad de Chile, Santiago, Chile; WEISS, Camila, Universidad de Chile, Santiago, Chile; OSSA-FUENTES, Luis, Universidad de Chile, Santiago, Chile

The digits of the tetradactyl hand of living Anura are often labeled I,II,III and IV. A digit-like structure anterior to the digits is named the "prepollex", assuming the most anterior digit is comparable to the thumb. However, the developmental pattern of cartilage formation shows the digits develop in positions that become II,III,IV and V in amniotes. Homeotic frameshifts of digit identity are documented in limb development and have been proposed for a similar mismatch in the bird wing. To assess this possibility, we examined morphological evidence on amphibian digit identity. Three main groups of crown tetrapods are generally recognized: The Reptiliomorpha (leading to amniotes), the Lepospondyli (of debated affinities), and the Temnospondyli, widely considered the ancestors of Anura. The earliest known hands of temnospondyls already exhibit a tetradactyl hand with a Phalangeal Formula (PF) of 2-2-3-3 as in modern Anura. Lepospondyls often had four or three digits with PF 2-3-4-3 or 2-3-3, but *Urocordylus* presents a pentadactyl hand with PF 2-3-?(>2)-3-2. The PF of lepospondyls closely resembles that of early Reptiliomorpha, who had a pentadactyl hand with PF 2-3-4-5-4. The closest known outgroup to crown tetrapods in which a hand is known is *Tulerpeton*, a hexadactyl stem tetrapod with PF 2-3-4-5-4-3. *Tulerpeton* supports the notion that a reptiliomorph-like PF 2-3-4-5-4 was present in the first pentadactyl crown tetrapods, such that the hand of temnospondyls is derived. The available morphological data does not document how the PF 2-2-3-3 of Temnospondyls evolved from PF 2-3-4-5-4. The two more anterior digits are biphalangeal, so this trait is not linked to digit I identity. We conclude that morphological evidence is currently equivocal in support of either a I,II,III,IV or II,III,IV,V identification. It is therefore premature to consider a possible homeotic frameshift. Unlike the case of the bird wing, expression of HoxD-11 is present in the most anterior interdigit of the anuran hand, supporting a II, III,IV, V identification. More fossil hands from early crown tetrapods are necessary to solve the issue.

Romer Prize/Technical Session 5 (Thursday, November 3, 9:00 am)

DENTAL MICROWEAR AND THE EVOLUTION OF CHEWING IN CERATOPSIAN DINOSAURS

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Ceratopsians (horned dinosaurs) are remarkable for their derived masticatory system. This clade diversified during the angiosperm radiation, but there is little evidence linking their chewing adaptations to the evolution of flowering plants. Although the morphology and lever-arm mechanics of the masticatory apparatus have been well-documented, an understanding of the mandibular motions involved in ceratopsian chewing has remained elusive.

In order to address this issue, dental microwear striations were examined in 16 ceratopsian and 2 pachycephalosaur (sister to Ceratopsia) genera. Lack of preservation in some specimens prevented use of microwear in reconstructing mastication; however, a correlation between microwear pattern and facet architecture allowed additional reconstruction of chewing styles in 3 genera for which microwear was not preserved.

Microwear reveals an evolutionary sequence of four chewing styles within Ceratopsia. Contra previous hypotheses, orthal mastication was not present in Neoceratopsia but limited to the basal ceratopsian *Yinlong*, and the sister clade Pachycephalosauria. Oblique wear facets with rectilinear striations inclined ~60° to the dental apicobasal axis support reconstruction of clinolineal chewing as a synapomorphy of the recent common ancestor of Chaoyangsauridae and all subsequent ceratopsians. Palinal mastication in neoceratopsians exclusive of Ceratopsoidea is indicated by curvilinear striations that begin at the distal and mesial edges of dentary and maxillary teeth respectively and curve through an arc of ~60° to end in a mesiodistal orientation. Furthermore, all taxa with a labial (horizontal) shelf are palinal chewers. Orthopalinal chewing, diagnostic of Ceratopsoidea, is inferred from vertical, apicobasally oriented facets with rectilinear scratches oriented at 15-45° to the apicobasal axis.

Among herbivorous dinosaurs, palinal chewing with a mandibular orbit is unique to ceratopsians. Ceratopsians with palinal chewing replaced those with clinolineal chewing ~110 Ma. Palinal chewing first appears ~125mya in *Liaoceratops* and may be a response to the coeval eudicot angiosperm radiation.

Technical Session I (Wednesday, November 2, 9:30 am)

DINOSAUR EGGS IN SPACE AND TIME

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To assess the quality of the dinosaur egg record and whether the spatiotemporal distribution of ootaxa primarily reflects a taphonomic or biologic signal, we undertook an extensive survey of the scientific literature using coarse temporal and spatial divisions. The survey defined an ootaxon "occurrence" as the presence of a distinct oogenus or oospecies in a time unit (e.g. Middle Jurassic) on one of six continents. The search produced a minimum of 64 oogenera and 148 oospecies occurrences from nine principal oofamilies. Major finds include: 1) The Late Cretaceous represents 80% of all ootaxa occurrences worldwide. This pattern holds true at the continent level as well. 2) More than 50% of the occurrences come from Asia, primarily China and Mongolia, and include several "endemic" oofamilies. 3) If one extrapolates taxonomic identifications from specific oospecies across the oofamily, then saurischians and theropods dominate the oological record. Saurischian eggs represent 80%, ornithischian eggs 9%, and taxonomically ambiguous ootaxa 10%. Theropod eggs constitute 52-78% of the taxonomically assignable occurrences.

Predominance of the Late Cretaceous record likely reflects greater exposure of younger, less diagenetically altered terrestrial formations, but may also represent independent and multiple evolution of hard-shelled eggs. Continental deposits of semi-arid to arid paleoclimates with excellent exposures and a long research history potentially contribute to the rich Asian egg record. The strong taxonomic and temporal bias may correspond to the radiation of both titanosaur sauropods and maniraptoran theropods. Rarity of ornithischian eggs may reflect a predominance of soft-shelled eggs, ovoviviparity or viviparity, or reproductive behaviors detrimental to egg preservation. The latter might include choice of nesting habitat, absence of egg burial, use of above ground vegetation mounds for incubation, and parental care of nest-bound young leading to trampling, consumption, or removal of egg debris from the nest. The possibility of convergent evolution of egg and egg attributes should temper these interpretations.

Symposium 4 (Friday, November 4, 10:30 am)

BASELINE LEVELS OF ALPHA AND BETA DIVERSITY IN VERTEBRATE MICROFOSSIL ASSEMBLAGES

VAVREK, Matthew, Royal Ontario Museum, Toronto, ON, Canada; BRINKMAN, Donald, Royal Tyrrell Museum of Paleontology, Drumheller, AB, Canada

Understanding how patterns of species diversity change over geologic time scales is one of the ultimate questions of palaeoecology. However, not all patterns or changes may be significant, and testing these without any context may give misleading results. Modern ecosystems can show a large mount of variation in species diversity and abundance simply due to random, normal events, and this variation would be expected to also be present in fossil assemblages. We measured rates of ecological change using a data set of fossil microsite assemblages. These sites are from a relatively small area (Dinosaur Provincial Park, Alberta, Canada) from a stratigraphically well resolved and temporally restricted portion of the Dinosaur Park Formation. Within this spatially restricted region, species should not have experienced any geographic barriers to dispersal, and so any ecological difference in species composition between contemporaneous sites should be due to normal ecologic variability. Overall, there was a reasonable amount of turnover between sites, even those that were very close stratigraphically and spatially. However, within site species diversity through the section did not vary greatly. There was a detectable and significant pattern of turnover between the lower and upper sites, as had previously been found, possibly due to a rise in water levels of the interior seaway during the interval. Although alpha diversity appears to be relatively stable for a single region, species composition can vary greatly between sites; however, significant ecological patterns in the sites can still be found. When looking at patterns of beta diversity between fossil sites, it is important to recognise that observed turnover is the interaction we observe between actual effects and random chance, and a high level of turnover may not actually be due to any ecological pattern.

Technical Session I (Wednesday, November 2, 9:45 am)

THE EVOLUTIONARY SOURCES OF MORPHOLOGICAL DIVERSITY IN DINOSAURS

VENDITTI, Chris, University of Hull, Hull, United Kingdom; BENTON, Michael, University of Bristol, Bristol, United Kingdom; ORGAN, Chris, Harvard University, Cambridge, MA, USA; MEADE, Andrew, University of Reading, Reading, United Kingdom; PAGEL, Mark, University of Reading, Reading, United Kingdom

New phylogenetic methods coupled with data from the fossil record have the potential to change the way researchers think about and study evolutionary rates. Here we present a novel methodology which can automatically detect significant shifts in the rate of morphological evolution along the branches of a phylogenetic tree. We apply this methodology to a comprehensive phylogenetic tree of dinosaurs and multiple morphological data sets (including a number of femoral measurements which act as a proxy for body size). We find that, taken as whole, dinosaurs underwent a rapid and short-lived burst of diversification early in their evolutionary history – with some branches showing a 30-fold increase in rate. Following this initial increase we find that the rate falls precipitously to a level comparable to that initially seen. The rate remains at this level until near the end of the group's history where there is another significant burst of diversification. The pattern observed across the whole group masks considerable variation in rates within subgroups of the dinosaur phylogeny. The subgroups also show variation in rate through time with some recapitulating the burst pattern observed across all dinosaurs. The long-held view that the morphological diversity (body size in particular) is the product of homogeneous macroevolutionary processes may not be correct; rather our findings suggest that dinosaur body size evolution is better characterized by varying rates.

Poster Session III (Friday, November 4)

EARLY FRAMBOIDAL PYRITE FROM A SIMULATED WHALE FALL: NEW INSIGHTS INTO MARINE TETRAPOD BONE DIAGENESIS

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Pyrite framboids are often found associated with marine vertebrate fossil material. Framboids are frequently interpreted as products of sulfide generated by sulfate-reducing bacteria present on the degrading bone. Alternative interpretations exist, however, that attribute framboidal pyrite to changes in post-burial pore water geochemistry late in a fossil's diagenetic history. Here, we provide further evidence that pyrite framboids are microbially derived based on their appearance on submerged bone surfaces during laboratory experiments. Three de-fleshed domestic goat rib sections were placed in marine water and sediments from the Pacific margin of Costa Rica (1000-1025m depth) and were incubated at 10º C for 6 months. Two weeks after emplacement, bone surfaces were densely colonized by putative mat-forming sulfate-reducers (dark in color) and sulfide-oxidizers (light in color). The sediment around the bone became concentrically stained with proximal dark and distal red colored zones. Oxygen and pH profiles of sediment near bone show steeper geochemical gradients at the bacterial mat when compared with surrounding conditions, indicating an anoxic and acidic microenvironment. These conditions are consistent with microbial activity observed at natural whale falls. SEM analyses of bones removed after 3 weeks and 6 months of microbial exposure show a notable change in bone surface texture and an increase in framboid density. Framboids on bones removed after 3 weeks range in size from 4 to 10 microns. Framboid density is higher on bone surfaces facing the sediment compared to the water-exposed sides (50/cm2 vs. 10/cm2, respectively). Framboids found on bones exposed for 6 months are similar in size and are notably denser.

Our results suggest that framboidal pyrite is microbially mediated and begins to form on bone surfaces very early (~3 weeks or less) in the diagenetic process. Because framboid densities increase with microbe exposure time, they have potential to act as a sea-floor exposure time proxy, aid in time-averaging interpretations, and act as indicators of a sulfophilic community.

Poster Session III (Friday, November 4)

USE OF LINEAR MORPHOMETRY TO DEFINE DIAGNOSTIC MORPHOLOGICAL VARIATION IN THE APPENDICULAR SKELETON OF ANHANGUERIDAE AND TAPEJARIDAE PTEROSAURS (PTEROSAURIA, PTERODACTYLOIDEA)

VILA NOVA, Bruno, Universidade de Sao Paulo, Ribeirao Preto, Brazil; SAYAO, Juliana, Universidade Federal de Pernambuco, Vitoria de Santo Antao, Brazil

The Pterosauria is the best known tetrapod group recorded in the Lower Cretaceous Araripe Basin (northeast of Brazil), and belong to two major groups: Anhangueridae and Tapejaridae. These can be promptly identified based on skull synapomorphies, but few specimens are composed of cranial and post cranial remains. Incomplete specimens, including only post cranial parts, are more common, with limb bones sometimes crushed during burial, but still useful for identification. In this context, linear morphometric data obtained from the literature and measurements of specimens were analyzed using a Principal Components Analysis (PCA) to identify exclusive features of both the Anhangueridae and Tapejaridae. Six Anhangueridae and seven Tapejaridae were measured: *Anhanguera piscator*, *Anhanguera santanae*, "*Anhanguera" spielbergi*, *Araripesaurus castilhoi*, two Anhangueridae sp. indet.; *Sinopterus dongi*, and six Tapejaridae sp. indet. A variation of at least 10% in each ratio was employed to separate both groups and the relationships between the humerus (hu), wing metacarpal (mcIV), first phalanx of the wing digit (ph1d4), femur (fem), and tibia (tib) were considered as sufficient to diagnose partial remains of Araripe pterosaurs. The PCA shows that each clade has different, non-overlapping scores for the studied ratios, which allow for precise inferences. The data show that anhanguerids have a mcIV/ph1d4 ratio of around 0.4, and a fem/hu ratio below 1.00, whereas in tapejarids, these values are close to 0.6, and above 1.00, respectively. Moreover, the wing of anhanguerids is divided within the elements, with a mcIV/hu ratio of 1.00, and ph4d4/hu ratio of 0.6. In tapejarids, the wing metacarpal is larger (mcIV/hu ratio = 1.5), and there is a reduction in the length of the phalanges towards the wing end (ph4d4/hu ratio < 0.6). Specific bone ratios for the identification of anhanguerids and tapejarids were identified, indicating a faster way to diagnose fragmentary bones.

Poster Session III (Friday, November 4)

GIANT FOSSIL SOFT-SHELLED TURTLES OF NORTH AMERICA

VITEK, Natasha, Yale University, New Haven, CT, USA

Axestemys byssina, a large, potentially paedomorphic soft-shelled turtle (Trionychidae), and a number of other giant trionychids have been described from the Campanian to Eocene of North America, but no rigorous analysis has been undertaken to investigate their relationships. Because these trionychids are so unusual and occupy such a broad temporal range (70-46 myr), their study provides new insights into patterns of trionychid evolution. This project set out to use all material previously assigned to "*Axestemys*" as well as previously undescribed material to develop a concept of *Axestemys* that is meaningful in both a systematic and taxonomic context. *Axestemys*, after reanalysis, contains 5 species, two of which remain unnamed. The taxon name '*Axestemys'* is best defined phylogenetically as a stem-based clade rather than a character-based clade, because many characters are not consistently present throughout the clade. All members of *Axestemys* reach a gigantic size that is today found only in a few tropical trionychid species that independently evolved gigantism. The presence of *Axestemys* in North America indicates both a warmer climate and a higher trionychid diversity and disparity comparable to those found in tropical climates today. For example, the most diverse region on earth today contains four species of trionychids with bony carapaces ranging from 22 to 74 cm long. The Eocene Bridger Formation, in comparison, contains at least four trionychid species 21 to 97 cm long, in addition to 19 other named species, which still require reanalysis. Based on this work, it is hypothesized that further study of North American trionychids, such as those in the Bridger Formation, will reveal a diversity and disparity higher than any place on Earth today.

Poster Session III (Friday, November 4)

VERTEBRAL ANOMALIES IN FOSSIL SEA COWS (MAMMALIA, SIRENIA): DID THEY CAUSE BACKACHES?

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Osteological alterations in the fossil sea cow *Halitherium schinzii* from the Oligocene are hitherto known by left-right asymmetries of the spinous process and the centrum in vertebrae. Those observations of vertebral asymmetries are supplemented here by four caudal vertebrae of two fossil sirenian individuals from the Rhine area in Germany and northern Belgium. The vertebrae are incompletely preserved lacking the neural arches and possess an underdeveloped transverse process causing a left-right asymmetry. The growth retardation of the affected transverse processes indicates that they are less developed than their counterparts and, consequently, deviate from the norm. The transverse processes are important as attachment areas for ligaments and muscles of the back and thus contribute to static and dynamic stability during the extension and flexion of the vertebral column. Abnormalities of the development of the transverse processes therefore have clinical relevance. The observation of asymmetrical transverse processes in the fossil sea cow specimens presented here is interpreted as hypoplasia, a congenital defect, which might be developmental and/or genetically induced and causes the underdevelopment of an organ or parts of it. The presence of an anomaly is supported by CT scans that reveal osteosclerotic patterns, a morphological feature which characterizes sea cows and supports the non-pathological state of the vertebrae. According to the hypothesis that it is the close interaction of genes and environment producing the normal spine during somitogenesis, it is assumed that the growth impulse of the transverse processes must have been disturbed during this process leading to a single axial defect. A potential environmental setting that could be associated with the development of hypoplastic transverse processes in the sea cow specimens is red tide toxin exposure due to naturally occurring harmful algal blooms affecting the delivery of the genetic instructions during ontogeny. Hypoplasia in the transverse processes of *H. schinzii* might have caused a functional deficiency. This represents the oldest and first documentation of such an anomaly in any sirenian.

Poster Session I (Wednesday, November 2)

HYOID STRUCTURE AND BREATHING IN ICHTHYOSAURS.

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Hyoid bones provide attachment for both the tongue and gullet musculature and are seldom mentioned in description but provide information on respiration and feeding in extinct taxa. An opthalmosaur, UW24816, was collected with the hyoids disarticulated within the posterior portion of the intact skull. The orientation and muscle attachment on the hyoids are visible on this specimen and another of the same species, UW24804.

Large hyoids are used in expanding a cavity in the throat during feeding in secondarily marine vertebrates, developing a negative pressure space to capture prey. Cephalopod hooklets found as gastric contents in ichthyosaurs suggest a pelagic food source and suction feeding has been observed in extant marine predators that feed on soft-bodied cephalopods. Suction feeding has been suggested for the toothless ichthyosaur, *Shonisaurus sikanniensis*, based in part on its large hyoids. UW24816, however, has a full complement of teeth and large hyoids.

Gular pumping may also benefit from large hyoids to expand the throat region. Lepidosaurs are the only tetrapods that use gular pumping, in which air is pumped into the lungs using a volumetric change in the gular cavity, with the mouth, nares and glottis closed. Comparative phylogenetic methods suggest a taxonomic distribution of gular pumping in lepidosaurs including the basal extant taxon, *Sphenodon*.

Gular pumping supplements costal inspiration during high-speed locomotion and may have evolved to circumvent the speed constraint in secondary aquatic lepidosaurs such as fast swimming ichthyosaurs. Gular pumping increases in extant lepidosaurs during external pressure and this maybe analogous to differential hydrostatic pressure against the body of ichthyosaurs. Opthalmosaurs, with a narrow, deep head and short neck may have benefited from an expansive hyoid apparatus that supplemented the rate and volume of aspiration.

Large hyoids may be widespread in ichthyosaurs and argue for a breathing function rather than suction feeding as they are present in both toothed and toothless forms. Further work will compare hyoid size in both thuniform and non-thuniform ichthyosaurs.

Poster Session II (Thursday, November 3)

A NEW MACHAIRODONT FROM THE PALMETTO FAUNA (LATE HEMPHILLIAN) OF FLORIDA, WITH COMMENTS ON THE ORIGIN OF THE SMILODONTINI

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Because the original sample of the smaller Palmetto Fauna machairodont (PFm) consisted only of partial mandibles and isolated teeth, its identification as the earliest record of *Megantereon hesperus* was questioned, and more recent work allied it with *Paramachairodus* sp. from Arizona. Fortunately, several new mandibles provide characters not previously preserved, affording a closer look. Consequently, 38 cranio-mandibular characters were scored on 12 taxa (*Proailurus lemanensis*, *Promegantereon ogygia*, *Paramachairodus orientalis*, *P. maximiliani*, PFm, *Smilodon gracilis*, *S. fatalis*, *S. populator*, *Megantereon cultridens*, *Machairodus aphanistus*, *M. coloradensis*, and *Homotherium serum*). The first 25 characters are modified from a recent revision of the genus *Paramachairodus;* taxa were selected to represent the more derived subfamilies Homotheriini and Smilodontini, and to include previous identifications. Results agree with the revision of *Paramachairodus*: *Promegantereon* as a distinct genus (from the former) and both falling basal to all other machairodonts. More importantly, PFm lies basal within Smilodontini (in accord with its older geologic age) and is distinct from both *Megantereon* and *Smilodon*. Notable characters grouping Homotheriini: exaggerated serrations on all teeth; straightening and verticalization of the mandibular symphysis; alignment of P3 with P4 and p4 with m1; elongate and trench-like m1; elongate paraconid (approximately equal to protoconid); slight posterior "lean" to p3/p4. For Smilodontini, including PFm: serrations restricted to canines and not as large as in Homotheriini; offset of P3 with P4 and p4 with m1; complete verticalization of mandibular symphysis; m1 shortened and robust with widest point anterior to notch; extreme posterior "lean" to p3/p4. Features typical of machairodonts, yet lacking in PFm: P4 exhibiting more anterior protocone, and a paracone that is small-to equal in size with the former; small anterior and posterior accessory cusps on p4. This unique combination of both conservative and derived characters warrants erection of both a new genus and species. Moreover, this record supports a North American origin for the tribe.

Poster Session I (Wednesday, November 2)

A NEW WATER BIRD FROM THE EOCENE OF GUANGDONG, CHINA

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A fossil of a new taxon of long-legged bird was discovered in the middle Eocene black oil shales of the Buxin Formation in Guangdong Province, south China. It consists of a distal tibiotarsus, tarsometatarsus, and a complete foot in articulation. Associated with the bird are abundant fishes, including osteoglossomorphs, and some undescribed frogs. The new taxon is characterized by the following morphologic features: a peculiar hypotarsus morphology which is block-like and exhibits five shallow cristae, three trochleas for metatarsals II-IV similar in width, trochleas for II and IV project almost to same dorsal and distal level. A preliminary phylogenetic analysis, combined with comparison with other water birds, indicates that the new Eocene bird is most closely related to the members of the Ciconiiformes and Threskiornithidae. Compared with Europe and North America, Paleogene avian fossils, especially of waterbirds, are rare in China. The new fossil thus provides significant new information about the composition of the avifauna of Central Asia by that time.

Technical Session VI (Thursday, November 3, 2:15 pm)

SCALING IN SIZE AND STIFFNESS OF AVIAN PRIMARY FEATHERS: IMPLICATIONS FOR THE STRENGTH OF MESOZOIC BIRD FEATHERS

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The wing in birds and some of their dinosaurian relatives comprises forelimb bones and primary feathers, which play an important role in flight by generating lift and thrust. Primary feathers are subject to forces in the air and their shafts react by bending, so a certain flexural stiffness is required to avoid breakage during flight . Though considerable attention has been directed at understanding the aerodynamic, muscular and skeletal requirements of avian flight, the mechanical design constraints imposed by flight forces on feather shafts remains largely unexplored. This has implications for understanding dinosaur flight evolution.

By quantifying scaling relationships between body mass and feather linear dimensions in a large dataset, I show that both feather length and feather diameter scale much closer to the predictions for geometric similarity than elastic similarity in birds. This implies that the flight feathers of small and large birds are not functionally equivalent at different ends of the mass spectrum (0.02 to 9kg). Scaling allometry also indicates that the primary feathers of larger birds are relatively shorter and the rachises are relatively thicker. Two-point bending tests corroborate the result that larger birds have more flexible feathers than smaller species. Discriminant Functional Analyses (DFA) show that all three variables can be used to discriminate between different magnitudes of feather bending stiffness within extant birds. Primary feather length explains 68% of variance, reflecting its critical role in flight.

The feather rachises of *Archaeopteryx* and *Confuciusornis* are much narrower than extant birds and primary feather length of *Archaeopteryx* is extremely short. Adding fossil measurement data to DFA shows that *Archaeopteryx*, *Confuciusornis* and non-avian theropods with feathered arms do not overlap with extant birds. This strongly suggests that the bending stiffness of their primary feathers was different to extant birds and provides further evidence for distinctive flight styles and likely limited flight ability in *Archaeopteryx* and *Confuciusornis*.

Romer Prize/Technical Session 5 (Thursday, November 3, 9:45 am)

DID THE MEGAFAUNA ORIGINATE FROM TIBET? COLD-ADAPTED PLIOCENE FAUNA FROM ZANDA BASIN SUGGESTS ORIGIN OF ICE AGE MEGAHERBIVORES IN HIGH PLATEAU

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The Ice Age megafauna has long been known to be closely associated with global cooling during the Pleistocene and their morphological adaptations to cold environments, such as large body size, long hair and snow-sweeping structures, are best exemplified by the woolly mammoths and woolly rhinos. These traits were assumed to have evolved *de novo* as a direct response to the expansion of the continental ice sheet. We report a new Pliocene mammal assemblage from the high altitude Zanda Basin in the western Himalaya, southern Tibet, including a primitive woolly rhino as well as other ancestral species of the megafauna, suggesting some species of megaherbivores first evolved in Tibet before the beginning of the Ice Age. Zanda Basin features 800+ m of fluviolacustrine sediments that are paleomagnetically dated from latest Miocene to early Pleistocene, ~6.4-0.5 Ma. In four seasons of explorations, we have recovered a composite mammal fauna that ranges in age from about 5.2 Ma to 3.0 Ma. Large mammals include *Nyctereutes* sp. *Vulpes* sp., *Panthera* (*Uncia*) sp., *Meles* sp., *Mustela* sp., *Chasmaporthetes* sp., *Hipparion zandaense*, *Coelodonta* sp., *Cervavitus* sp., ?*Pseudois* sp., *Antilospira/Spirocerus* sp., *Qurliqnoria* sp., Bovidae indet., Gomphotheriidae indet. A composite small mammal fauna includes Soricidae indet., *Aepyosciurus* sp., *Nannocricetus* sp., Cricetidae indet., *Prosiphneus* cf. *P. eriksoni*, *Mimomys* (*Aratomys*) *bilikeensis*, *Apodemus* sp., *Trischizolagus* cf. *T. mirificus*, *Trischizolagus* cf. *T. dumitrescuae*, and four species of *Ochotona*. Overall, Pliocene Tibetan mammals begin to resemble their modern counterparts, which consist of a large number of endemic, high altitude, cold-adapted species. Presence of several potential ancestors of the megafauna raises a novel "out of Tibet" hypothesis that the cold winters in Pliocene Tibet served as a habituation ground for the megaherbivores and these cold-adapted forms in turn became pre-adapted for the Ice Age, successfully expanding to the Eurasian mammoth steppe in the northern Palearctic.

Poster Session IV (Saturday, November 5)

A REVIEW OF THE PLEISTOCENE PROBOSCIDEAN EVOLUTION IN SOUTH CHINA

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The evolution of the proboscideans, the last terrestrial giants, provides important information for the subdivision of Pleistocene biostratigraphy of South China. Excavations during the past few years in Pleistocene karstic cave sediments in South China have yielded a plethora of proboscidean fossils. Recent studies reveal that there are three sequential proboscidean taxa (*Sinomastodon*, *Stegodon*, *Elephas*) during the Pleistocene in the region. Furthermore, three turnovers also occurred in these radiations. *Sinomastodon*, one Neogene relic taxon, was once prevalent in the early Pleistocene (2.58-0.78 Ma), and became one of the typical members of the *Gigantopithecus*-*Sinomastodon* fauna. There was also a temporal 'primitive' *Stegodon* (*S. preorientalias*) during this period. The early stage is represented by the Sanhe fauna, Guangxi, with a paleomagnetic age of approximately 1.2-1.6 Ma. *Sinomastodon* and *Stegodon preorientalias* became extinct in the early middle Pleistocene and were replaced by *Stegodon orientalias*, which was one of the most distinctive species of the middle Pleistocene *Ailuropoda*-*Stegodon* fauna (0.78-0.13 Ma). Interestingly, *S. orientalias* survived with *Homo* and the relictual *Gigantopithecus*. The middle stage is represented by the Hejiang fauna, Guangxi, with U-series dates suggesting an estimated age of 0.32 Ma. The appearance of the archaic *Elephas* (*E. kiangnanensis*) in the late middle Pleistocene was one of the causes of the decline of the *Ailuropoda*-*Stegodon* fauna. *Elephas* gradually dominated the fauna, although *S. orientalias* also survived into the late Pleistocene. Here we suggest naming the late Pleistocene fauna (ca. 130-10 ka) containing *Elephas* from South China as the *Elephas* fauna, to distinguish it from the typical middle Pleistocene *Ailuropoda*-*Stegodon* fauna and early Pleistocene *Gigantopithecus*-*Sinomastodon* fauna. This late stage is represented by the *Homo sapiens* Cave (ZRD) fauna, Guangxi, with U-series ages estimated to be 110 ka. In the ZRD fauna, *E. kiangnanensis* coexists with the earliest modern human in East Asia.

Technical Session VII (Thursday, November 3, 2:45 pm)

A NEW PANTOLAMBDID PANTODONT (MAMMALIA) FROM THE PALEOCENE OF SOUTH CHINA: AN IMMIGRANT TO THE 'EAST OF EDEN' FROM NORTH AMERICA

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Asian Paleocene mammal faunas have been considered to be endemic for a long time. Several waves of intercontinental dispersal between North America and Asia during this period mainly involved the migration of Asian forms into North America, especially in the early stage. However, a pantolambdid pantodont, represented by a pair of lower jaws from the Paleocene of southern China provides evidence for an example of migration in the opposite direction. The specimen came from the Zhuguikeng Mb. (correlative to Ti1) of the Nongshan Fm. in the Nanxiong Basin, Guangdong. It is clearly distinguishable from all of the known Asian pantodonts, but shares the following features with the North American pantolambdids: lower canine moderately enlarged, subcircular in cross section; talonids of p2–4 very small and not basined; molar trigonids distinctly higher than talonids; talonid of m3 elongate anteroposteriorly, with a distinct hypoconulid forming a sharp angle at the posterior margin. These characters suggest a close relationship of the Nanxiong specimen to North American pantolambdids, and also distinguish it from other North American pantodonts. Recent paleomagnetic studies, with support of the latest radiometric date, provide evidence to correlate the Asian Shanghuan/Nongshanian boundary with the North American Torrejonian/Tiffanian one, and the Asian Nongshanian/Gashatan boundary with that between Ti4 and Ti5. Given the updated Asian Paleocene mammalian biochronology, some possible mammalian dispersal events can be outlined as follows: (1) At the To2, Asian Pantodonta and Mesonychidae dispersed to North America and gave their first appearance there; (2) North American Carnivora migrated into Asia and first appeared at the late Shanghuan, roughly the To3; (3) At the Ti1, North American pantolambdids migrated to Asia as represented by the new finding; (4) At the Ti5, Arctostylopidae dispersed from Asia to North America, while neoplagiaulacids, nyctitheriids, cimolestids and carpolestids migrated in a reverse route; and (5) At the beginning of the Clarkforkian, Asian Rodentia, Tillodontia, and possibly Coryphodontidae entered North America.

Technical Session XI (Friday, November 4, 2:30 pm)

THE AGE OF GIANTS &NDASH; HISTOLOGICAL EVIDENCE FOR ONTOGENY IN POST CRANIAL ELEMENTS OF SAUROPODS AND ITS IMPLICATIONS FOR GROWTH HISTORY

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Understanding the life history and growth of sauropods, the largest terrestrial vertebrates ever, represents a challenge. Long bones typically do not provide a good growth record. Therefore, we explored the histological growth record in other simple-shaped skeletal elements like cervical and dorsal ribs, chevrons, and gastralia. Because local bone apposition rates are lower compared to long bones, these elements have the potential to provide a more complete growth record. We sampled ribs of six different sauropod taxa (*Brachiosaurus*, *Camarasaurus*, *Dicraeosaurus, Spinophorosaurus*, *Apatosaurus*, and *Diplodocus*), from three different localities, and chevrons, cervical ribs and gastralia from different diplodocine sauropods. Lines of arrested growth (LAGs) are developed in all of these skeletal elements. However, the best growth record is preserved in the dorsal ribs. In all sampled taxa, a minimum of 10 cycles were found at the proximal end of the rib shaft or in the capitulum. Ten LAGs were found in a *Brachiosaurus* rib from the Morrison Formation, while other *Brachiosaurus* ribs from Tendaguru show 14 LAGs. In both cases, this represents approximately 40% of the growth record with clear evidence of the adult ontogenetic stage of both individuals, indicated by an external fundamental system (EFS). An *Apatosaurus* specimen (Morrison Formation) showing 16 cycles, representing 70% of the growth record, lacked an EFS, which indicates a subadult ontogenetic stage. With 38 LAGs and a completeness of 87%, the best preserved growth record was found in the dorsal ribs of a small senescent *Camarasaurus* individual (Morrison Formation). The ribs of a diplodocid sauropod (Morrison Formation) and in rib fragments, most likely belonging to a *Spinophorosaurus* (Niger), show dense Sharpey´s fibers that seems to inhibit the clear development of LAGs. Nevertheless, these samples show about 12 well developed LAGs (~45% of the growth record) with further cyclicity in the inner cortex. These results suggest that, depending on taxon, sauropods reached their full size between 25 and 35 years of age. This time span is intermediate between widely diverging earlier estimates.

Poster Session I (Wednesday, November 2)

BONE HISTOLOGY OF AN ALASKAN ORNITHOMIMOSAUR: IMPLICATIONS FOR POLAR DINOSAURIAN PHYSIOLOGY

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Polar dinosaurs provide for unique natural testing of hypotheses regarding paleobiogeography, paleobiology, and paleoecology. Histological studies allow for characterizations of somatic growth that can be used to make inferences regarding physiology in a comparative context. Here, I provide the first description of a long bone histology for an arctic theropod. Histological comparisons were made with lower latitude and southern high latitude dinosaurs to investigate latitudinal effects on growth. The element was discovered in the Upper Cretaceous Prince Creek Formation of the Alaskan North Slope. Both morphological and histological comparisons were conducted with lower latitude taxa to determine its taxonomic affinity. Based on external morphology, the specimen was ascribed to metatarsal IV of either an ornithomimosaur or a tyrannosaurid and bears a flat extensor surface, posteriorly extended lateral condyle, triangular lateral collateral fossa, distinct medial angle near the metaphysis, and a larger lateral condyle relative to the medial condyle. Histological analysis showed that the bone is composed of fibro-lamellar matrix with laminar, plexiform and reticular vascularization patterns, as observed in various long bones of lower latitude ornithomimosaurs. In contrast, the long bones of tyrannosaurids generally exhibit the laminar pattern. Taken together, morphological and histological comparisons suggest that the Alaskan specimen is from an ornithomimosaur. Despite this taxonomic designation, the structure of growth lines was shown to be variable among taxa. The growth lines in the Alaskan specimen are primarily composed of annuli, which imply seasonal retardation of growth, while lines of arrested growth (LAGs) were observed, for instance, in metatarsals of *Gallimimus* and *Struthiomimus*. Interestingly, LAGs were reported previously in a southern high latitude ornithomimosaur and these were interpreted as adaptations for polar conditions. The results here suggest somatic growth in ornithomimosaurs varies greatly and that their relevance to environmental adaptation needs a more comprehensive examination.

Poster Session I (Wednesday, November 2)

ONTOGENETIC CHANGES OF MORPHOLOGY AND SURFACE TEXTURE OF LONG BONES IN THE EXTANT GRAY HERON, *ARDEA CINEREA* (AVES, ARDEIDAE)—A FUNDAMENTAL STUDY FOR ONTOGENETIC AGEING

WATANABE, Junya, Department of Geology and Mineralogy, Kyoto University, Kyoto, Japan

Assessing ontogenetic age of fossil specimens is an essential step in paleontological studies including taxonomy, faunal studies and evolution. Studies in bird fossils, such as evolution of flightlessness as heterochrony, would be improved by a reliable and practical ageing method. "Textural ageing" has been proposed as a practical method, in which surface texture of a long bone is examined to age the specimen. However, only several studies were taken to describe ontogenetic changes of surface texture of long bones in birds, so fundamental data are lacking for establishment of textural ageing as a reliable method. The fact that little is reported on ontogenetic change in the morphology of skeletal materials in birds also hampers establishment of ageing methods. So here ontogenetic changes of morphology and surface texture are described in an ontogenetic series comprised of about 20 individuals of the Gray Heron *Ardea cinerea*.

Ardea cinerea is a common heron in the Palearctic Area, whose ecology has been well documented. Skeletal materials are dissected out from collected carcasses, treated with dilute hydrogen peroxide, and dried. Three ontogenetic stages are recognized; chick, juvenile, and adult. Chicks are birds before leaving nests, collected at a breeding colony of *A. cinerea* in Kyoto, Japan, and arranged as increasing body mass. Juveniles are birds that are under 1-year old and after leaving nests, which can be separated from adults with its plumage, and arranged with the date of death. Adults are here defined as birds 1-year old and older and not arranged.

In general, chick bones are characterized by cartilaginous epiphysis, faint osteological landmarks, and longitudinal grooves and pits on surface; juvenile bones are characterized by ossified though porous epiphysis, osteological landmarks with obscure contours, and smaller and shallower pits on surface; and adult bones are characterized by ossified epiphysis with little pores, obvious osteological landmarks, and smooth surface. These diagnoses may be useful as a simple ageing method.

Further studies, including comparison among various taxa, are needed for establishment of a more reliable ageing method.

E&O Poster Session

DEVELOPMENT AND BENEFITS OF STUDENT ORGANIZATION LED OUTREACH PROGRAMS: TWO CASE STUDIES FROM THE UNIVERSITY OF NORTH DAKOTA AND SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

WEILER, Matthew, University of North Dakota, Grand Forks, ND, USA; SCHUMAKER, Karew, University of North Dakota, Grand Forks, ND, USA

The benefits of science based outreach activities for young audiences have long been known. In student organization led outreach activities, valuable experience is gained both by the students being taught and those conducting the outreach activity. Evidence for this comes from the authors' experiences at the University of North Dakota and South Dakota School of Mines & Technology. Public and private schools have limited budgets, restricting the number of field trips classes can take. Thus reducing the likelihood of a visit to a local museum or university. Classroom visits and teaching kits are excellent ways of bringing hands-on science experiences to the classroom. Teachers benefit through these programs, by having a chance to interact with "experts" on topics that they have little training in. Another way to introduce children to paleontology is through large scale community activities independent of the schools, such as children's activities fairs, events for National Earth Science Week, community open houses, and assisting Boy Scouts. Volunteers, both undergraduate and graduate students, gain beneficial experience in public speaking and communicating effectively to a wide range of audiences. Cooperation between undergraduate and graduate students

promotes mentoring and leadership. Development and critical evaluation of new activities is useful for volunteers with career goals related to teaching. Operation of an outreach program does not come without some cost, the most tangible of these is funding for supplies. Funding for supplies can be obtained through student organization funding committees and the host department. A less easily determined cost is the number of hours that are needed to keep the programs operational. Recognition for student volunteers by the department, university, or board of higher education is a way for students to display their talents. These merits can be included on resumes and job or graduate school applications. If programs are operated successfully they can have wide ranging benefits for students, teachers, and volunteers.

Symposium 1 (Wednesday, November 2, 12:00 pm)

UNDERSTANDING THE IMPLICATIONS OF LATE-STAGE LIMB AND GIRDLE DEVELOPMENT ON MAMMALIAN LIMB/GIRDLE EVOLUTION— ADDING A FEW MONOTREMES REALLY HELPS

WEISBECKER, Vera, University of Queensland, Brisbane, Australia

Late stages of limb development - e.g. the formation of cartilage (chondrification) or bone (ossification) – effectively summarize a complex cascade of preceding developmental events, and are also sufficiently close to the completion of skeletal development to provide insights into the interaction between developmental change and the evolution of adult limb diversity, which is notoriously difficult to trace in the fossil record. Here, I showcase the usefulness of investigating late-stage limb development by presenting ossification sequences of monotreme limbs. Ossification sequences were determined through X-rays and Computed Tomography of 9 echidnas and 4 platypus of different ages, representing the first data on monotreme limb development ever acquired. Monotremes display a striking reversal of the generally highly conserved proximo-distal direction of tetrapod limb development, as humerus and femur ossify after radius/ulna and tibia/fibula. This pattern resembles only the similarly adapted European moles among all tetrapods, providing intriguing clues on the relationship between adaptation and limb development in mammals. The fact that humeri and femora both ossify late in monotremes and moles suggests a strong influence of serial homology on the evolution of mammalian limb development. Although monotremes are the only mammals that retain coracoids in the shoulder girdle, coracoidal ossification onset is later than in other amniotes. This suggests that the developmental basis for to coracoid loss already existed in the ancestor of extant mammals. Monotreme limb development resembles that of placentals. It does not follow the marsupial pattern of strong forelimb *vs.* weak hind limb development, which has been suggested to relate to the low forelimb diversity of marsupials compared to placentals. This is contrary to the common notion that monotremes and marsupials represent the developmental mode of late synapsids. Rather, the marsupial developmental mode and coincident diversity constraints appear to represent a derived pattern tied to their unusual reproduction, which did not characterize the evolution of limb diversity in derived synapsids.

Poster Session III (Friday, November 4)

NEW APPROACHES IN UNDERSTANDING THE SYSTEMATICS OF LEPTAUCHENIINE OREODONTS (ARDIODACTYLA: MERYCOIDODONTIDAE) AND IMPLICATIONS OF A NEW STRATIGRAPHIC OCCURRENCE OF *SESPIA* IN THE HIGH PLAINS

WELSH, Ed, South Dakota School of Mines and Technology, Rapid City, SD, USA

Oreodonts (Family: Merycoidodontidae) have undergone several degrees of taxonomic turbulence through over 100 years of study. Leptaucheniine oreodonts originally included one genus and three species. Expansive taxonomic additions gave rise to seven genera and 34 species. In response, contemporary researchers have reconsolidated taxa into two genera and four species, similar to the taxonomic diversity expressed in the original description. Much confusion has stemmed from these analyses including the use of characters resulting from post-mortem deformation in descriptions for expansive taxonomy as well as vague descriptions for condensed taxonomy.

A new approach in understanding Leptaucheniine systematics incorporates the use of the Cephalic Index (CI). CI is useful in modern anthropological studies to observe skull morphology delineating ontogenetic age, sex, and race in a population. Specimens of *Leptauchenia* and *Sespia* from the University of Nebraska State Museum (UNSM), South Dakota School of Mines and Technology Museum of Geology (SDSM), and Badlands National Park (BADL) were subjected to CI analysis coupled with morphologic comparisons of skulls. One outlier in this study included *Limnenetes platyceps*, which has been referred to as the predecessor to the subfamily by numerous authors. CI displays trends of dolichocephaly (long face) to brachycephaly (short-face) in respective order of *Limnenetes*, *Sespia*, and *Leptauchenia*. Specimens of juvenile to adult *Leptauchenia decora* from the BADL collections also display a trend of brachycephaly through ontogeny. This approach, along with morphological characters, provides a useful method of identifying taxonomically confusing specimens.

These methods were applied in validating the identification of SDSM 3210, *Leptauchenia nitida* (=*Sespia nitida*), from the Whitney Member of the Brule Formation in South Dakota. This study, included with the new specimen of *Sespia* from the Brule Formation, has provided a new stratigraphic range extension for the genus *Sespia* and new insights on biostratigraphy, biogeography, and morphologic development within the subfamily Leptaucheniinae.

Technical Session I (Wednesday, November 2, 8:30 am)

ARCHOSAUROMORPH BONE HISTOLOGY REVEALS EARLY EVOLUTION OF ELEVATED GROWTH AND METABOLIC RATES

WERNING, Sarah, University of California, Berkeley, CA, USA; IRMIS, Randall, University of Utah and Utah Museum of Natural History, Salt Lake City, UT, USA; SMITH, Nathan, The Field Museum, Chicago, IL, USA; TURNER, Alan, Stony Brook University, Stony Brook, NY, USA; PADIAN, Kevin, University of California Museum of Paleontology and University of California, Berkeley, CA, USA

Bone histology has established that birds, dinosaurs, and pterosaurs grew at much higher rates and had much higher metabolic rates compared to extant crocodylians and other reptiles, but it remains uncertain when these features evolved, temporally and phylogenetically. The study of key fossil taxa allows us to track changes in growth rate and its underlying metabolism through deep time and in taxa whose character states are not represented among living animals. We expanded the histological database of archosaurs and their ancestors to include early archosauromorph, pseudosuchian, and dinosauromorph taxa. Our study differs from previous works in its approach, phylogenetic breadth, and level of taxonomic sampling, but also in that we used apomorphy-based identifications for all specimens and sampled the same location on homologous elements from individuals of comparable ontogenetic stage. This allowed more rigorous control over factors affecting interpretations of histology and growth dynamics (e.g., differences in ontogeny or biomechanics). We then mapped characters relevant to growth and metabolism (e.g., osteocyte density, collagen organization, osteonal development, and vascularity) on a recent phylogeny of archosauromorph reptiles to assess where particular adaptations of growth dynamics first evolved, focusing on the lineages leading to Archosauria, Crocodylomorpha, Dinosauria, and Theropoda. Many histological features associated with high growth and metabolic rates in living birds evolved much earlier than the common ancestor of birds and pterosaurs, and several aspects of the accelerated growth syndrome did not evolve simultaneously. Most of these character changes accumulated in a short segment of the archosauriform tree before the end of the Early Triassic. Therefore, many physiological features related to high growth and metabolic rates of living birds evolved not in dinosaurs or the common ancestor of Ornithodira, but before the most recent common ancestor of crocodiles and dinosaurs.

Poster Session IV (Saturday, November 5)

FIRST LATE TRIASSIC VERTEBRATE LOCALITIES IN THE OWL ROCK MEMBER, UPPER CHINLE FORMATION, PETRIFIED FOREST NATIONAL PARK, AZ

WHATLEY, Robin, Columbia College Chicago, Chicago, IL, USA; BEHRENSMEYER, Anna, Smithsonian Institute, Washington, DC, USA; AMARAL, William, Emeritus, Harvard University, Cambridge, MA, USA; PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA; DOMEISCHEL, Jenna, Columbia College Chicago, Chicago, IL, USA

Systematic surveys in the Upper Chinle Formation in 2009-10 resulted in the discovery of over 50 new vertebrate localities, including the first fossils from the Owl Rock Member in the Petrified Forest National Park (PEFO) and additional sites in the upper part of the Petrified Forest Member. Fossils were recovered in the PEFO Wilderness Area (with the aid of pack horses and Navajo wranglers) from three main levels: the upper Petrified Forest Member; a series of intersecting channel fills and paleosols in the lower Owl Rock Member informally named the Pastel Bed Complex; and a conglomeratic mudclast unit above a prominent caliche near the top of the Owl Rock Member. As in older deposits in the PEFO, *in situ* phytosaur skeletal material and osteoderms occur in the Upper Petrified Forest Member and in overlying channel deposits at the base of the Owl Rock Member. Fossiliferous channel fills and paleosols of the Pastel Bed Complex near the base of the Owl Rock contain juvenile phytosaur teeth and actinopterygian teeth and scales. We also recovered large metoposaurid cranial elements, associated small metoposaurid material, cf. *Apachesaurus*, aetosaur cervical armor and osteoderms, and a partial archosauriform skeleton with upper and lower heterodont jaw elements, limbs and vertebrae. The latter find resulted from controlled lateral surveys ("Bone Walks") to locate fossil-producing sites along specific stratigraphic levels. PEFO localities higher in the Owl Rock Member typically yield microvertebrates, or larger isolated fragmentary bones in float or *in situ.* Fossil wood and root casts are abundant at the base but rare in upper portions of the Owl Rock. Gastropods and the unionid *Antediplodo*n are most abundant low in the section. The hybodontid shark *Riticulodus synergus*, a common component of the Ward Terrace Owl Rock assemblage, is rare or absent. The fauna and taphonomy of the Owl Rock Member changed through time as the depositional setting of the lower strata shifted from large-scale fluvial channel and floodplain environments to a low gradient alluvial plain with seasonal ponds, small-scale channels, and carbonate-rich soils near the top of the member.

Symposium 4 (Friday, November 4, 9:15 am)

NON-BIOTIC CONTROLS OF PERMO-TRIASSIC TETRAPOD DIVERSITY: IMPLICATIONS FOR UNDERSTANDING THE END-PERMIAN EXTINCTION ON LAND

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The end-Permian mass extinction is arguably the largest extinction event in the Phanerozoic, yet its effects on land remain poorly understood. Though many studies of the first and last appearances of taxa demonstrate that non-marine vertebrates suffered an extinction, few

studies have investigated paleoecological metrics that would provide insight into diversity dynamics during and after this extinction. The interpretation of these diversity patterns is complex because a number of non-biotic factors bias these data.

To elucidate the effects of the extinction on non-marine vertebrates, we analyzed raw and sample-standardized richness, evenness, and relative abundance for a specimen-level dataset of Late Permian-Middle Triassic southern African tetrapods identified to genus. These data demonstrate a major drop in richness and evenness across Permo-Triassic boundary, in addition to permanent changes in relative abundance of several clades; full recovery does not occur until the Middle Triassic. Rarefaction of the data does not appreciably change richness patterns. We also investigated the effects of outcrop area sampled for each temporal bin; there is a moderate but significant correlation with raw and rarefied richness values, and outcrop area has an extremely strong correlation with the number of specimens per temporal bin. The temporal length of each bin only has a weak relationship to richness values. The effect of outdated or erroneous taxonomy for specimens is difficult to quantify. Although it does affect our diversity estimates, taxonomic issues are down-weighted by rarefaction, and this error appears to be spread relatively randomly across the dataset. Non-biotic controls like taxonomy and geologic bias (i.e., available outcrop) do influence Permo-Triassic tetrapod diversity estimates; however, the main conclusion that non-marine vertebrates were severely affected by the end-Permian mass extinction, and that these effects lasted for millions of years, is still supported.

Poster Session II (Thursday, November 3)

CHARACTER VISUALIZATION METHODS IN PHYLOGENETIC ANALYSIS
WHITLOCK, John, University of Michigan, Ann Arbor, MI, USA

Character data in a phylogenetic analysis are often seen as being trapped in a 'black box', hidden from outside observers. In addition to the obvious difficulties this poses for independent assessment of the results of an analysis, important patterns within the data may go unnoticed without further examination. Here, we outline a simple graphical method for displaying regional character information. These images provide a convenient visual shorthand that allows a reader to understand at a glance the proportional representation of various anatomical regions in a matrix. This information can be used to identify regions of the body that are phylogenetically important, to identify areas of data paucity, and as a companion to comparative cladistic methods as a way to compare data between different analyses. In addition, these methods can be adapted to display missing data by body region; in tandem, these images provide a simple way to examine the influence of missing data on phylogenetically problematic taxa. Applying these methods to phylogenetic analyses of Sauropoda and its subgroups reveals interesting trends. Large-scale analyses examining the evolution of Sauropoda as a whole are represented subequally by characters from each of the three main body regions (cranial, axial, and appendicular). This is not surprising, as the broad taxonomic scope of these analyses covers important multiple alterations to the skull, changes in the complexity of neural spines and internal pneumaticity of vertebral centra, and important locomotor transitions. Finer scale analyses, such as those of the subgroup Diplodocoidea, reduce the importance of certain body regions, such as the appendicular skeleton, and highlight others, such as the dermal skull (20% of all characters). The relative importance of cranial characters is suggested to be a function of innovations focused on the cranial region over the limbs and girdles. The cranial region is also the region with the most missing data (41% cells unscorable), which suggests that the the phylogenetic importance of this region is not a function of preservation.

Technical Session XVIII (Saturday, November 5, 3:00 pm)

COMPARATIVE MORPHOMETRICS AND PHYLOGENETIC PERSPECTIVES ON THE MORPHOSPACE OF THE CROCODYLIFORM SKULL
WILBERG, Eric, University of Iowa, Iowa City, IA, USA

Extant and fossil crocodyliforms have long been divided into taxonomic or ecomorphological groups based on skull morphology. Numerous studies have shown that the skull shape of crocodyliforms shows a high degree of convergence, with similar skull forms arising in distantly related lineages, and even multiple different shapes appearing within a single genus. Previously formulated shape categories are largely based on qualitative or quantitative assessments of length and width of the snout. While snout length and width make up much of the variation present in crocodyliform skulls, categories based only on these features ignore important features in the back of the skull, such as the position of the jaw joint. Here I present a quantitative approach for assessing the variation present in the skull across Crocodyliformes while comparing multiple methodologies. Two dimensional geometric morphometrics including both homologous landmarks and sliding semi-landmarks as well as Elliptical Fourier Analysis (EFA) of skull outlines are used to characterize the shape of the skulls of 131 extant and extinct crocodyliforms. Model-based cluster analysis, in conjunction with discriminant analysis of EFA data, suggests three distinct categories of cranial shape, while landmark data suggest either three or eight categories (depending on optimality criterion). These categories are largely consistent with previously suggested qualitative groups, but avoid the subjective assignment of seemingly intermediate shapes. Optimizing skull shapes on a phylogeny demonstrates a very weak correlation. This suggests that overall skull shape should not be used as a discrete phylogenetic character in broad scale analyses of Crocodyliformes. These analyses are a first step to evaluating ecological and functional trends related to skull shape within a phylogenetic framework of the clade.

Preparators' Session (Thursday, November 3, 9:15 am)

THE MAMMOTH SITE OF HOT SPRINGS, SD: CURATION AND PREPARATION OF AN ACTIVE IN-SITU DIG SITE
WILKINS, William, The Mammoth Site of Hot Springs, SD, Hot Springs, SD, USA

The Mammoth Site in Hot Springs, South Dakota represents a highly fossiliferous Late Quaternary deposit formed from the collapse of bedrock forming sinkhole approximately 26,000 years ago. The sinkhole was a thermal pond fed by artesian spring water which was slowly in-filled over the course of about 350-700 years. Over 80 different Pleistocene taxa are represented here. and behaviorally favored adolescent male mammoths, with minimum number of 59 individuals. Since 1976, the Mammoth Site has been maintained as an active in-situ dig site and functions as an immersive exhibit for visitors. Curation and preparation are necessary tasks for this collection in order to maintain its scientific and public value. Currently over 5,000 specimens have been discovered, with over 1,500 remaining in-situ. While the bonebed acts as a natural archival storage facility for unexposed specimens, protecting and repairing the exposed specimens is the responsibility of Mammoth Site curatorial staff. Specific threats to the collection include: fluctuating environmental conditions (such as air temperature, relative humidity and light), consolidant degradation, accidental anthropogenic modification and natural disasters. Bonebed procedures at the Mammoth Site have been constantly modified In light of new advances in fossil conservation strategies to address these threats. Temperature, relative humidity and light have been controlled through the use of mass air humidifiers, inhibiting agents of deterioration. Consolidants have been changed following industry standards, going from the initial consolidant, Glyptal, to the current standards, Butvar and Acryloid. Solvents for removing thick or peeling consolidants are addressed, specifically for the use of ethanol on the Glyptal consolidant. Additionally the tools used for excavation and repair have been expanded from simple hand tools to include plastic and pneumatic instruments. Cataloguing and cartography are addressed through the use of a robotic total station and ArcGIS.

Technical Session IX (Friday, November 4, 11:30 pm)

FOSSIL SNAKES AND CLIMATE CHANGE: CORRELATING THE NEOGENE COLUBRID SNAKE RADIATION TO GLOBAL CLIMATIC CHANGES
WILLIAMS, Michael, Natural History Museum of Los Angeles County, Los Angeles, CA, USA

The North American colubrid radiation represents one of the most dramatic examples of large-scale, long-duration faunal turnovers. It occurred over a period of approximately 17 million years and resulted in the almost complete obliteration of the North American boid fauna (two modern species) and the proliferation of modern colubrids (approximately 102 species). To determine the extent to which climate played a role in the radiation, colubrid and boid snake abundances were plotted for the past 30 million years, with numbers of colubrids expressed as a percentage of the total colubrid and boid fauna. In addition, a composite stratigraphic section for North American snakes was constructed using chronological data for individual lineages. These data revealed a number of similarities between the spread of colubrid snakes and global climatic alterations as evidenced by the δ13C record. Two significant increases in colubrid percentages correspond to major global climatic warming periods, while a significant decrease equates to a decline in global temperatures. The first increase in colubrid abundance occurred during the Late Oligocene warming 27 million years ago, and the second major increase took place during the warming period leading up to the Middle Miocene Climatic Optimum. During this time, there were more species of snakes in North America than any other time within the Miocene. Following the Middle Miocene Climatic Optimum, percentages of colubrid snakes decreased as climate began to deteriorate, and four boid and three colubrid taxa went extinct. In the late Hemphillian, four snake taxa went extinct and five taxa originated. This occurred at the point where global climate was on its final decrease from relatively warm conditions during the Late Miocene and Early Pliocene to the climatic regime with permanent polar ice caps seen presently.

Poster Session III (Friday, November 4)

A LONG-TERM TERRESTRIAL RECORD OF EARLY PALEOCENE CLIMATE AND ECOSYSTEM CHANGE IN THE SAN JUAN BASIN, NEW MEXICO
WILLIAMSON, Thomas, New Mexico Museum of Natural History & Science, Albuquerque, NM, USA; PEPPE, Daniel, Baylor University, Waco, TX, USA; SECORD, Ross, University of Nebraska, Lincoln, NE, USA; BRUSATTE, Stephen, American Museum of Natural History, New York, NY, USA; WEIL, Anne, Oklahoma State University, Tulsa, OK, USA

The Nacimiento Formation in the San Juan Basin contains one of the most complete, diverse, and longest record of early Paleocene mammal evolution known anywhere in the world, spanning nearly four million years from 65.5-62.0 Ma. It documents the early Paleocene radiation of eutherian mammals following the end-Cretaceous mass extinction, a period of critical importance in the evolution of mammals. We are developing a regional climate record for the early Paleocene using fossil leaves and stable isotopes from mammal teeth collected from the Nacimiento Formation that will be integrated with a detailed record of mammal succession.

We find that the Nacimiento Formation therian mammal record contains several episodes of elevated species appearance and/or disappearance rates, with the highest levels of turnover coinciding with the Puercan-Torrejonian boundary and the middle-late Torrejonian (To2-To3) boundary. Preliminary mean annual temperature estimates of several Puercan and Tor-

rejonian fossil floras made using leaf margin analysis suggest a cooling trend within C28n that may correspond to the Puercan-Torrejonian boundary turnover event. Stable isotopes from the tooth enamel of two closely related periptychids (archaic ungulate mammals), *Carsioptychus coarctatus* (Puercan) and *Periptychus carinidens* (Torrejonian), show an increase in δ18O values and a corresponding decrease in δ13C values prior to the To2-To3 boundary. These preliminary data suggest a transient interval of warming, with the cooling phase of the interval corresponding to a high rate of extinction at the To2-To3 boundary. These results suggest that early Paleocene fluctuations in climate may have had significant impacts on mammalian evolution in western North America during the early phase of the Paleogene mammal radiation. Future work to refine the early Paleocene climate record and mammalian succession in the San Juan Basin will include isotopic analysis of gar-fish scales, bulk organic carbon, and additional mammal teeth, and further development of the paleobotanical and micromammal records through additional collecting.

Technical Session VII (Thursday, November 3, 2:15 pm)

MAMMALIAN DENTAL COMPLEXITY ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY WITH IMPLICATIONS FOR ECOLOGICAL RECOVERY AND EXPANSION

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Following the Cretaceous-Paleogene (K-Pg) mass extinction and associated collapse of dinosaur-dominated terrestrial ecosystems, an early Paleocene biotic recovery ensued that transitioned into an unrivaled evolutionary radiation of mammals. Studies of this critical interval, particularly those with a quantitative ecomorphological perspective, are fundamental to understanding evolutionary and ecological dynamics of recoveries and radiations, but are currently lacking. Most studies of post K-Pg mammals have focused on their taxonomic diversity. We quantified mammalian dental complexity across the K-Pg boundary by measuring orientation patch count (OPC) of mammalian tooth rows (premolars and molars of multituberculates, molars of therians) from Lancian and early Puercan faunas of northeastern Montana. We used OPC as a proxy for diet based on its demonstrated relationship to diet in a variety of modern taxa (carnivorans, rodents, bats).

Lancian multituberculates show a wide range of OPC values, corresponding to values among modern insectivores, omnivores, and herbivores. Lancian metatherians and eutherians have a narrower range of OPC values, which are on average lower than those of multituberculates and correspond to modern insectivores and animal-dominated omnivores. Early Puercan multituberculates show a range of OPC values that is similar to their Lancian counterparts, whereas early Puercan eutherians, driven by an influx of archaic ungulates, have a wider range of OPC values than their Lancian counterparts; some have OPC values corresponding to plant-dominated omnivores. Our results suggest that despite major faunal turnover across the K-Pg boundary via extinction, speciation, and immigration, the range of feeding ecologies of multituberculates was relatively unchanged during this interval. In contrast, eutherians expanded their range of feeding ecologies to include a greater plant component immediately across the K-Pg boundary.

Technical Session XI (Friday, November 4, 4:00 pm)

THE VALIDITY AND PALEOBIOGEOGRAPHIC HISTORY OF THE TITANOSAUR SAUROPOD *ALAMOSAURUS SANJUANENSIS* FROM THE LATEST CRETACEOUS OF NORTH AMERICA

WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA; D'EMIC, Michael, University of Michigan, Ann Arbor, MI, USA

Alamosaurus sanjuanensis is the only named sauropod from the Late Cretaceous of North America. *Alamosaurus* appears in the fossil record after a 'sauropod hiatus' of about 30 million years, during which sauropod fossils from North America are unknown. The validity, constituency, and paleobiogeographic history of *Alamosaurus* are contentious because of its single-bone holotype (a scapula), lack of critical evaluation of its hypodigm, and sampling issues, respectively. *Alamosaurus* has been incorporated into several cladistic and paleobiogeographic studies, which have assumed its validity and constituency for heuristic purposes. Our first-hand observations of the holotype of *A. sanjuanensis* and a broad sampling of other titanosaurs allow us to diagnose it with a combination of features, including: two processes at the ventral edge of the base of the scapular blade, an asymmetrically concave medial margin of the scapular blade, and a scapular blade with distal expansion on the ventral side only. These features and the absence of substantial differences allow confident referral of several more anatomically complete specimens to *A. sanjuanensis*, which in turn expands its diagnosis. This augmented hypodigm includes dorsal ribs, a nearly complete caudal vertebral series with chevrons, a complete pectoral girdle and forelimb, and ischia. A cladistic analysis incorporating relevant taxa indicates that *Alamosaurus* is a derived titanosaur most closely related to latest Cretaceous Asian or Gondwanan taxa. These results provide strong support for the hypothesis that *Alamosaurus* was an immigrant rather than a late-surviving member of a lineage of Early Cretaceous North American sauropods.

Poster Session I (Wednesday, November 2)

THE FEEDING ECOLOGY OF CRETACEOUS AND MODERN PURSUIT DIVING BIRDS

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Hesperornithiform birds are inferred to have been foot-propelled pursuit divers based on functional morphology, with a short, laterally rotated, robust femur, long tibiotarsus, and compressed feet with long toes. The geographic range of North American hesperornithiforms during the Late Cretaceous from the Arctic to Arkansas shows a stark contrast to that of extant avian pursuit divers, whose ranges are limited to colder high latitude and upwelling waters. Based on modern pursuit divers, water temperature is thought to be a primary factor limiting geographic distribution, as it gives an advantage to endothermic predators over ectothermic prey. However, greenhouse conditions during the Late Cretaceous and the apparent success of hesperornithiforms in the temperate waters of the Western Interior Seaway refute this hypothesis. Osteohistological patterns from high and mid latitude hesperornithiform femora indicate these birds were physiologically similar to modern birds, with rapid, sustained growth. Consequently, it is unlikely that there were major physiological differences between hesperornithiforms and extant pursuit divers. In the absence of a physiological explanation for differences in geographic ranges, two possibilities may account for the proficiency of hesperornithiforms in warm waters: (1) these birds pursued prey for which dive success was not dependent on thermoregulatory response to low temperatures; (2) differences in Late Cretaceous marine ecosystem structure meant reduced competitive and predation pressure on hesperornithiforms, resulting in an expanded geographic range. The dominance of marine reptiles in Cretaceous systems versus marine mammals in modern systems may explain some of these ecological differences. Overall, the hesperornithiform presence in temperate waters implies marine ecosystem structuring, rather than temperature, influences the geographic ranges of pursuit divers. This hypothesis has important implications for understanding not only hesperornithiform ecology along the Western Interior Seaway in relation to currents and food webs, but also differences between Late Cretaceous and modern marine ecosystems.

Symposium 1 (Wednesday, November 2, 8:00 am)

COMPARATIVE MORPHOLOGY AND SUGGESTED HOMOLOGIES OF PAIRED FINS IN JAWLESS AND EARLY JAWED VERTEBRATES

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The origin of jawed vertebrates (Gnathostomata) is one of the greatest events in vertebrate evolution yet it remains among the least well understood. Among the many features of gnathostomes with possible precursors in jawless (agnathan) vertebrates are paired fins. At one time, morphologists assumed that paired fins evolved in concert with jaws, teeth, and a variety of other predatory adaptations including hypaxial vs epaxial musculature, heterocercal tail, stomach, large eyes, and third semicircular canal. We now know that many of these features pre-date the origin of jaws, while others perhaps followed later. Prior to the origin of jaws, paired fin-like structures occurred in many species of vertebrates including anaspids, thelodonts, and osteostracans. These early, often rudimentary paired fins were at one time assumed to be remnants of a paired ventrolateral fin fold that was to become divided into pectoral and pelvic portions. However, I argue that the early paired fins can be homologized either with pectoral or with pelvic fins. A few taxa likely had both. Various agnathan clades lost either pectoral fins (furcacaudiforms) or pelvic fins (osteostracans, perhaps some thelodonts) that were present in their ancestors. In early gnathostomes, paired fins take on a remarkable variety of forms, with and without leading-edge spines and/or series of spines. Certain early fossil gnathostomes demonstrate that pectoral and pelvic fins differed in morphology and position; others show that one or the other pair could be elaborated or reduced, sometimes even lost. Apparently they were not anterior and posterior expressions of the same developmental field. The evidence from morphology supports the idea that paired fins preceded the origin of jaws, that the two kinds of fins were under somewhat different selection pressures, and that they were in distinct developmental compartments under largely separate fields of genetic expression.

Technical Session I (Wednesday November 2, 8:00 am)

BEYOND *EUROPASAURUS*: THE LATE JURASSIC VERTEBRATE ASSEMBLAGE OF THE LANGENBERG QUARRY IN OKER/GERMANY

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The marine deposits of the Langenberg quarry near Oker (Lower Saxony, northern Germany) are among the most important Mesozoic vertebrate fossil localities in Europe. The biostratigraphically well dated sediments range from late Oxfordian to late Kimmeridgian in age. The beds were tilted to a near vertical, slightly overturned position during the Harz Mountains orogeny in the Paleogene. The dominant lithologies are carbonates that may be impure and grade into marls. Sediment composition and invertebrate faunal contents record changes in water depth and salinity, but there is no evidence of subaerial exposure. Paleogeographically, the Langenberg quarry is located in the Lower Saxon Basin that was surrounded by several large islands, the source of the clastic components in the sediment. Surprisingly, at least the beds 56, 73, and 83 have yielded terrestrial vertebrates that were washed into the sea from a nearby island, while most other beds contain a partially or purely marine fauna. The finds offer unique insights in the Late Jurassic terrestrial island fauna of northern Germany. The most spectacular finds include different ontogenetic stages of the sauropod dinosaur *Europasaurus holgeri*, which evolved into a dwarf form on the island. Exquisitely preserved material of non-dinosaurian vertebrates has also been found and

consists of three-dimensional pterosaur remains including the articulated skeleton of a small dsungaripterid, the first from the Kimmeridgian of Germany, as well as articulated skeletons of the small atoposaurid crocodyliform *Theriosuchus* which also lived on the island. Abundant and diverse turtle material (including several skulls) comprise cf. *Thalassemys, Plesiochelys*, and at least one new taxon. Microvertebrate remains from Oker yielded in addition to many reptilian teeth a diverse fish fauna represented mainly by isolated teeth of marine chondrichthyans and osteichthyans. Current research activity is concentrated on the sedimentology, microfacies, and taphonomy of the Langenberg Quarry as well as the taxonomy and paleoecology of the island fauna and the paleobiogeographic and ecological controls of island dwarfing in dinosaurs.

Poster Session III (Friday, November 4)

NO GRASS TODAY: DIETARY RECONSTRUCTION AND DENTAL EVOLUTION OF THE BALEARIC CAVE GOAT *MYOTRAGUS* (PLIO-HOLOCENE, SPAIN)

WINKLER, Daniela, Biocenter Grindel and Zoological Museum, Hamburg, Germany; KAISER, Thomas M., Biocenter Grindel and Zoological Museum, Hamburg, Germany; SCHULZ, Ellen, Biocenter Grindel and Zoological Museum, Hamburg, Germany

The immediate interface between mammals and the environment are teeth, thus these are an excellent study object when questions of foraging efficiency and functional optimization are considered. Dental adaptations directly reflect demands of forage and environment. The dwarf bovid genus *Myotragus* forms a Plio-Holocene chronospecies endemic to Majorca island (Mediterranean Sea). *Myotragus* is comprised of six successively dwarfing species (*M. palomboi, M. pepgonellae, M. antiquus, M. kopperi, M. batei* and *M. balearicus*) with unknown ancestor. We apply 3D occlusal topography and microtexture analysis (Scale-Sensitive Fractal Analysis (SSFA) and Dental Areal Surface Texture Analysis (DASTA)) on the upper second molar to reconstruct the diet and quantify small scale morphological adaptations. Furthermore, we test for geographical dietary segregation in separated populations of the *M. balearicus*. Occlusal surface models and high resolution surface texture models of dental facets are generated and analysed. The older *Myotragus* species, *M. pepgonellae*, *M. kopperi* and *M. batei* have significantly higher enamel/dentin ratios than the younger *M. balearicus*. This suggests a gradual evolutionary decrease of the dentin/enamel ratio. Length and surface of inner enamel ridges decreases within the *Myotragus* lineage. SSFA revealed decreasing surface complexity from *M. pepgonellae* over *M. kopperi* and *M. batei* to *M. balearicus*. This is interpreted as to reflect the dietary shift from graze-dominated to browse-dominated diets. The maximum height of surface textures and the material volume (DASTA) decrease within the succession. This signature is indicating a dominance of soft and tough food items like browse in *M. balearicus*, while brittle and hard forage maintains a more elevated profile in the three older species. Within the two local populations of *M. balearicus*, no difference in occlusal topography or microtexture was found. Our results reflect an adaptation to energetic restrictions of an insular environment and reveal that either a dietary shift took place in the lineage or *Myotragus* successively adapted to increased intraspecific competition and expanded its dietary range.

Poster Session II (Thursday, November 3)

SYSTEMATICS, BIOSTRATIGRAPHY, GEOCHRONOLOGY AND PALEODIET OF THE SIWALIK HIPPARIONS FROM THE POTWAR PLATEAU, NORTHERN PAKISTAN

WOLF, Dominik, Howard University, Washington, DC, USA; BERNOR, Raymond, Howard University, Washington, DC, USA; HUSSAIN, S., Howard University, Washington, DC, USA

The Miocene to Pliocene fossil record of the Siwalik Hills in Pakistan contains abundant material of hipparionine equids. This material has been studied by many paleontologists over the last 150 years, but previous investigators have not fully utilized precise locality and stratigraphic provenience information for their studies. In view of the importance of this equid assemblage to the early evolution of a major Old World hipparionine lineage (the "*Sivalhippus*" Complex), we are reevaluating the taxonomy of the Siwalik hipparions using the extensive and paleomagnetically well dated Yale (now Harvard) Geological Survey of Pakistan collections. Preliminary results of bivariate and Log10 ratio statistical analyses of dental and postcranial morphometric data suggest that after the initial presence of relatively moderately sized horses similar to North American *Cormohipparion*, the Siwalik record between ca. 10.7 and at least 9.3 Ma was dominated by a somewhat more derived taxon with more hypsodont teeth, *Sivalhippus* cf. *nagriensis*. There is evidence for another species with massive cheek teeth, *Sivalhippus theobaldi*, at ca. 9.3 Ma. Some robust postcranial elements of similar age may also belong to this taxon. The later record of Siwalik hipparions shows a more derived endemic species, *Sivalhippus perimense*, co-occurring with an apparent immigrant population of hipparions with small body size, ?*Cremohipparion antelopinum*. *Sivalhippus perimense* might later have given rise to a morphologically similar but bigger taxon as evident from the presence of massive postcranial material at ca. 8 Ma. A new taxon with very high-crowned cheek teeth and robust-elongated metapodials appears in the record at ca. 7.3 Ma. Small, *Cremohipparion*-like horses are also present in the younger beds of the Siwalik sediments, but are quite rare. Our systematic studies will be used to evaluate phylogenetic relationships and paleodiet of the Potwar Plateau equid sequence.

Technical Session XVII (Saturday, November 5, 3:15 pm)

REGIONAL DIFFERENCES IN TARSAL MORPHOTYPES AMONG LATE MIOCENE-PLIOCENE EQUIDS: A 3D GEOMETRIC MORPHOMETRIC STUDY

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The Gulf Coast and northern Great Plains of North America experienced different intensities of Neogene climate change, affecting differential responses in equid diversity. Here I present a three-dimensional (3D) geometric morphometric analysis of equid astragalar shape in order to 1) determine if astragalar disparity between the two regions is consistent with taxonomic diversity patterns and 2) elucidate possible postcranial evolutionary responses to Neogene climate change. Seventy-six equid astragali from the Hemingfordian and Hemphillian of Florida and Nebraska, mostly unassociated with identifiable dental material, were digitally modeled using a surface laser-scanner. A new 3D semi-landmark extraction/alignment algorithm was applied to locate 350 semi-landmarks in a xyz-grid system encompassing the full 3D surface of each astragalus. Each semi-landmark was aligned by estimating the local tangent plane on the reference shape and then projecting the semi-landmark to the line passing through the grid block center normal to the tangent plane. A Q-mode principal components (PC) analysis of shape residuals resulted in 40% of total variance distributed among the first three PC axes. The PC1 axis (27% of total variance) best separates groups of astragali and represents shape differences associated with ligament-mediated stability of the tarsus (i.e., depth of intertarsal ligament sites and projection of the medial collateral ligament site). All Hemingfordian equid astragali (shallow intertarsal sites and medially-projected collateral ligament sites) are clearly separated from the Nebraskan Hemphillian astragali (deep intertarsal sites and posteriorly-projected collateral ligament sites) along the PC1 axis. Floridian Hemphillian astragali, however, are evenly split between these two groups. These results are consistent with the hypothesis that the Gulf Coast served as a refugium during the Hemphillian for equid taxa and morphotypes once widely spread in North America during the Miocene. Furthermore, the loss of forested habitats in the Great Plains may have imposed selective pressures for greater body size and increased ligament-mediated tarsal stability.

Romer Prize/Technical Session 5 (Thursday, November 3, 9:15 am)

AN INTRA-SKELETAL BONE MICROANALYSIS OF *ALLIGATOR MISSISSIPPIENSIS* AND ITS APPLICATION TO NON-AVIAN DINOSAUR OSTEOHISTOLOGY

WOODWARD, Holly, Museum of the Rockies, Montana State University, Bozeman, MT, USA

Bone microanalyses of extant vertebrates allow for more informed hypotheses regarding the growth and aging of extinct taxa and for more meaningful comparisons of growth dynamics across related groups. Here, an osteohistologic analysis of eight paired pectoral and appendicular elements from three juvenile *Alligator mississippiensis* assesses growth mark consistency and tissue type variation within extant archosaur individuals. Results demonstrate that: 1) every bone from an individual forms the same number of growth marks in each element; 2) the femur, humerus, and tibiae have the highest absolute growth rates; 3) as is typical for alligators, the periodic growth of the two captive individuals was much higher than that of the wild individual, suggesting eco-phenotypic plasticity. These results were used to infer aspects of non-avian dinosaur growth in a sample of 18 femora and tibiae from basal ornithopods from polar Australia, and 46 tibiae from the hadrosaurid *Maiasaura peeblesorum*; the latter being the largest single element, monospecific dinosaur analysis to date. Despite likely having the highest appendicular absolute growth rates, rapid tibia and femur mineral deposition occurred for only 2-3 growth cycles in the basal ornithopods before slowing, whereas every *Maiasaura* tibia exhibited high growth rates throughout ontogeny. Interestingly, some similarly sized basal ornithopod tibiae and femora vary in the number of growth marks present. If every growth mark is recorded in every element, the discrepancy may indicate that several taxa are represented in the sample or that eco-phenotypic plasticity caused differing growth rates due to external stresses. In contrast, growth marks of similar circumference from different individuals of *Maiasaura* represent the same period of growth suspension, indicating the more derived hadrosaurid possibly lacked marked eco-phenotypic plasticity. These results emphasize the need for more osteohistologic studies on extant taxa, benefitting paleohistology by enabling stronger extinct taxon growth hypotheses.

Technical Session II (Wednesday, November 2, 3:00 pm)

A NEW ARCHOSAUR (DIAPSIDA: ARCHOSAURIFORMES) FROM THE MARINE TRIASSIC OF CHINA

WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada; LI, Chun, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; ZHAO, Li-jun, Zhejiang Museum of Natural History, Hangzhou, China; SATO, Tamaki, Tokyo Gakugei University, Tokyo, Japan; WANG, Li-ting, Geological Survey of Guizhou Province, Guiyang, China

A new Middle Triassic archosaur was recently collected from the Zhuganpo Member (Ladinian) of the Falang Formation, eastern Yunnan Province, China. It is represented by a nearly complete skeleton and mainly characterized by a snout more than twice longer than the rest of the skull, the posterodorsal process of the premaxilla extending posteriorly well beyond the external naris, the presence of three sacral vertebrae, the pronounced anterior process/hook of the coracoid terminated by a dorsal/lateral process, the ischium with a boot-like distal foot, metatarsal IV the longest, and the anteriorly notched cervical osteoderms. The new archosaur is a crurotarsan on the basis of the crocodile-normal tarsal joint and other features. This is the second crurotarsan taxon known from the Triassic marine deposits in

China. The postcranial skeleton of the new taxon demonstrates few anatomical modifications toward an aquatic way of life when compared with *Qianosuchus*, the first Chinese marine archosaur from the Middle Triassic (Anisian) of the same area. However, the large and relatively posteriorly positioned external naris, the ornamented roof bones of the skull, and the fish remains of the stomach content suggest that the new archosaur may have adapted for an aquatic lifestyle although to a less degree than *Qianosuchus*. Our primary analysis based on 53 archosaurs and 188 characters derived from an existing data matrix confirms the crurotarsan status of *Qianosuchus* and suggests a sister-group relationship between it and the new form within the Rauisuchoidea but with a low bootstrap support value. The discovery of the second archosaur further underscores the affinity of the semi-terrestrial vertebrate faunas between the eastern and western regions along the northern coastline of the Tethys during the Middle Triassic.

Poster Session IV (Saturday, November 5)

A NEW RECORD OF *STEGODON* IN TAIWAN AND ITS BIOGEOGRAPHICAL IMPLICATIONS

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As a continental island connecting East and Southeast Asia, Taiwan has been in a critical position to understand the biogeographic history of species in Western Pacific area. *Stegodon*, an extinct Proboscidean member which was widespread in East and Southeast Asia during Miocene to Pleistocene, represents the dispersal history of macromammal traveling between landmasses and islands. A Middle Pleistocene *Stegodon* specimen found in the Toukeshan Formation of Taiwan may shed a light on this aspect. This specimen anatomically resembles *S. miensis* in Japan and *S. elephantoides* in southern China and Myanmar, yet shows more primitive characteristics than both of the species. Nevertheless, the sediment carrying this specimen is much younger than the youngest record of *S. miensis* of 2.9 Ma and relatively young to the living period of *S. elephantoides*, which is late Pliocene to middle Pleistocene. While *S. miensis* and *S. elephantoides* are both derived from *S. zdnaskyi*, a primitive species thrived in northern China during Miocene to Pliocene; this specimen set a new record in Taiwan to imply another derivative of *S. zdanskyi* spreading to this island and preserving the primitive characteristics during the isolation caused by risen sea level in interglacial period.

Technical Session XIV (Saturday, November 5, 11:30 am)

A NEW EUMANIRAPTORAN PHYLOGENY AND ITS IMPLICATIONS FOR AVIALAN ORIGINS

XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ZHANG, Fucheng, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; O'CONNOR, Jingmai, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Recent discoveries of basal oviraptorosaurs, basal avialans, basal dromaeosaurids, and basal troodontids have provided significant new information on eumaniraptoran phylogeny, but the full impact of this information has yet to be fully appreciated. Morphological comparisons among basal members of these groups reveal surprising similarities between basal oviraptorosaurs and basal avialans other than *Archaeopteryx* on the one hand, and between *Archaeopteryx* and basal deinonychosaurs on the other. A numerical phylogenetic analysis incorporating data from these new discoveries removes the Archaeopterygidae (consisting of *Archaeopteryx* and two eumaniraptorans from the Jurassic of China) from the Avialae and places it at the base of the Deinonychosauria. Salient synapomorphies shared by *Archaeopteryx* and other deinonychosaurs include an enlarged promaxillary fenestra, a longitudinal groove that widens posteriorly on the lateral surface of the dentary, a shortened manual phalanx IV-2 that has a rigid articulation with IV-1, a pubis with a lateral expansion at the mid-shaft, a highly shortened ischium with a distally located obturator process and a posterodistal process, and a highly extensible pedal digit II. This challenges the long-held view that the iconic *Archaeopteryx* is a central taxon for understanding the transition to birds, and instead indicates that *Archaeopteryx* offers important information about the early evolution of deinonychosaurs. The new phylogeny reveals an interesting structural and functional divergence at the base of the Eumaniraptora: basal birds probably retained the akinetic skull and herbivorous diet of their ancestral maniraptoran relatives, whereas deinonychosaurs evolved a more kinetic skull and a carnivorous diet. This new phylogeny has significant implications for avialan origins, and for related issues such as the origin and early evolution of feathers and flight.

Poster Session I (Wednesday, November 2)

MESOWEAR ANALYSIS OF EXTANT JAPANESE SIKA DEER (*CERVUS NIPPON*) IN DIFFERENT HABITATS AND SEXES

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Dental mesowear of Sika deer (*Cervus nippon*, Cervidae) in Japan was analyzed to evaluate intraspecific differences in their diet. Four wild populations from different habitats were compared. Hierarchical cluster analysis (HCA) divided them into two dietary categories. The data set of one population was significantly different from the others. The deer in south and west Japan were classified as browsers, and the deer in north and east Japan were grouped as mixed feeders. The dietary classifications of the four populations were supported by ecological studies about them. Japanese Sika deer have been known to be able to switch their eating habits based on the surrounding vegetational environment. The deer show a browsing diet in evergreen broad-leaved forests. On the other hand, the deer mainly rely on a grazing diet in deciduous broad-leaved forests or grasslands. Furthermore, foraging separation of the sexes within the same population was investigated. The mesowear variables indicated that male deer had a more abrasive diet (i.e., fibrous food). HCA classified the males as grazers and the females as browsers. The body size differences between the sexes likely play an important role in the contrasting results. Metabolic demands for energy and nutrients have been pointed out as a cause of sexual segregation in foraging behavior. The gastrocentric hypothesis predicts that large males consume abundant fibrous forages because of high digestive capacity, while females demand high nutrient food, especially during gestation and lactation. The results of this study are consistent with this hypothesis.

Thus, we conclude that mesowear analysis indicated dietary differences in different populations of the same species of Japanese Sika deer. Further studies of other extant ungulates are necessary before analyzing fossil populations.

Poster Session IV (Saturday, November 5)

SANDSTONE DIAGENESIS AS A PROXY INDICATOR OF PORE FLUID GEOCHEMISTRY: IMPLICATIONS FOR FOSSILIZATION OF VERTEBRATE SKELETAL MATERIAL IN THE HELL CREEK FORMATION (UPPER CRETACEOUS), EASTERN MONTANA

YAMAMURA, Daigo, Montana State University, Bozeman, Bozeman, MT, USA; SCHMITT, James, Montana State University, Bozeman, Bozeman, MT, USA

Enclosing sandstone matrix is often invoked as an entombing medium, facilitating preservation of vertebrate skeletal material by isolation from contact with pore fluids. We employed optical petrography, x-ray diffractometry, and scanning electron microscopy analysis of a fossil-bearing sandstone in the Hell Creek Formation to document pore fluid geochemistry during diagenesis and examine the role of sandstone matrix as an entombing agent. Excavated skeletal material includes a large hadrosaur humerus and rib, femur fragments (unknown dinosaur), a champosaur femur, and various small bones and fragments (turtle, crocodile). Presence of fine-grained ripple cross-laminated (Sr) and massive muddy sandstone (Sm), abundant coal stringers, and overlying and underlying floodplain mudrocks indicate a low-energy crevasse-splay origin. This overbank sequence directly overlies a trough-cross stratified (St), upward-fining fluvial channel sandstone. Both sandstones are feldspathic litharenites.

The channel sandstone shows evidence of secondary porosity development through acidic pore fluid migration including feldspar grain skeletonization, oversized pores indicating complete grain dissolution, suspended exploded-grain fabrics in biotite indicating dissolution of early calcite cement, and porosity values >50 percent. The bone-bearing crevasse-splay sandstone contains skeletonized and altered (feldspar to clay) feldspar grains, also indicating migration of acidic pore fluids, and later chlorite cement precipitation. Enclosed bones show minimal evidence of alteration; they are surrounded by a concretionary zone of calcite and iron oxide cement characterized by isopachous calcite rims on detrital grains indicating meteoric phreatic or vadose calcite precipitation.

Presence of well-preserved bone in sandstone extensively altered by acidic fluids suggests that early precipitation of surrounding calcite (concretion growth) enhanced bone preservation, chemically buffering it from the later corrosive effects of acidic pore waters. This indicates that early calcite precipitation (concretionary entombment) is an important factor in vertebrate skeletal preservation in sandstones.

Poster Session III (Friday, November 4)

MAMMALIAN OXYGEN ISOTOPE VALUES AS AN INDICATOR OF REGIONAL CLIMATIC DIFFERENCES IN THE PLEISTOCENE NORTH AMERICA

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Geochemical tools such as stable isotope analyses have the potential to clarify paleoclimatic and dietary information. Specifically, oxygen isotopes can be used to assess relative aridity and/or temperature, with greater δ18O values occurring in hotter and/or drier regions. Here, we compiled a database of stable isotope values obtained from mammalian tooth enamel to quantify regional climatic differences between the southeastern and southwestern US during the Pleistocene. By selecting only fossil localities containing proboscideans (i.e., evaporation insensitive taxa), we subsequently calculated the difference between average δ18O values of a given taxon and the average proboscidean value to calculate an offset value that can further identify evaporation sensitivity. Taxa including antilocaprids, camelids, cervids, and equids were identified as evaporation sensitive, in contrast to bovids, tapirids, tayassuids, and proboscideans (elephantids, gomphotherids, mammutids). Comparisons of evaporation sensitive and insensitive taxa between regions demonstrates greater δ18O values in the southeastern US overall and between like sensitivity categories while offset values were greater in the southwestern US in evaporation sensitive taxa. These data suggest cooler and drier conditions during the Pleistocene in the southwestern US as compared to the likely warmer and

wetter southeastern US. Furthermore, δ13C values were greater in the southwestern US in all categories and overall; however, there is no correlation between δ13C values and δ18O values. Thus, while C4 recourses may have been more abundant in the southwest, environmental sensitivity does not appear to be related to dietary feeding strategies. Collectively, this meta-analysis helps clarify regional climatic differences and identifies taxa that may be useful for quantifying changes in aridity over time.

Technical Session X (Friday, November 4, 8:45 am)

THE FIRST DENTALLY ASSOCIATED SKELETON OF PLAGIOMENIDAE (MAMMALIA, ?DERMOPTERA) FROM THE LATE PALEOCENE OF WYOMING

YAPUNCICH, Gabriel, CUNY Graduate Center, New York, NY, USA; BOYER, Doug, Brooklyn College/CUNY, New York, NY, USA; SECORD, Ross, University of Nebraska, Lincoln, NE, USA; BLOCH, Jonathan, University of Florida, Gainesville, FL, USA

It has long been recognized that Paleocene-Eocene plagiomenids have derived dentitions similar to extant flying lemurs. These affinities have led to their classification within Dermoptera, although discoveries of a plagiomenid basicranium and teeth of Eocene dermopterans in Asia seem to contradict this relationship. Here we describe the first dentally associated plagiomenid postcrania recovered from the late Tiffanian of the Bighorn Basin, Wyoming, which allow for a reassessment of plagiomenid phylogenetic affinities and provide insight into their positional behavior. A reconstruction of the pes of cf. *Plagiomene zalmouti* is inconsistent with committed arboreality, contrary to expectations for primitive dermopterans, both in the morphology of the astragalus and calcaneus, as well as in the stout proportions of the intermediate phalanges. The astragalus has an asymmetrical grooved trochlea with a shallow medial border and a proximodistally restricted sustentacular facet. The calcaneus exhibits a prominent fibular facet, an ectal facet oblique to the long axis, a sustentacular facet with no extension onto the body, and no calcaneocuboid pit-and-peg arrangement. The specimen also exhibits a distally fused tibia-fibula, elongate metatarsals on rays II-IV with cylindrical distal condyles, and shallow, straight-shafted claws. This suite of features limits the rotational capacity of the foot, but allows for powerful plantarflexion and extension, suggesting a more terrestrial lifestyle. Principal component analysis of measurements on the astragalus and calcaneus indicate that the pes of *P. zalmouti* is most similar to the extinct *Cryptotopos* (Nyctitheriidae, Eulipotyphla), while intermediate phalanx elongation ratios reveal that *P. zalmouti* was most similar to extant terrestrial scansorialists such *Tupaia* and *Sciurus*. Cladistic analysis of 240 characters coded for 36 taxa aligns cf. *P. zalmouti* (and Nyctitheriidae) with eulipotyphlans such as *Solenodon*, *Suncus* and *Erinaceus*. On functional morphological and cladistic grounds we consider Plagiomenidae to be more likely allied with laurasiatheres than dermopterans or other euarchontans.

Technical Session II (Wednesday, November 2, 2:45 pm)

FUNCTIONAL MORPHOLOGY OF THE LOWER JAW IN THE CHORISTODERA (REPTILIA: DIAPSIDA) INDICATES DIET DIVERGENCE BETWEEN ECOMORPHS

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Choristoderes are top predators in the fresh water ecosystems of the Mesozoic and Cenozoic of Laurasia. They are the only diapsid group that became extinct well after surviving the K-T extinction. Choristoderes reached the highest diversity and disparity in the Cretaceous, with three distinct ecomorphs: a long-snout form that is comparable with living gavials in snout shape, a short-snout form that is similar to living crocodiles, and a long-neck form that is unique in freshwater diapsids. Their widely varying body plans indicate ecological partitioning for different ecomorphs, although direct evidence (e.g., gut contents) is lacking. This study provides the first quantitative comparison of choristoderan lower jaw mechanics, aimed at an evaluation of dietary divergence between ecomorphs. Five choristoderan genera are measured for mechanical advantage (MA, force property) and velocity advantage (VA, speed property), based on reconstruction of musculature attachment in the lower jaw. Four extant fish-eating reptiles are also measured for comparison. The result shows that the long-snout ecomorph, including *Champsosaurus* from the Late Cretaceous and Paleocene of North America, has a high VA for jaw closing. The long-neck ecomorph, including *Hyphalosaurus* from the Early Cretaceous of Asia, approaches the closing VA of *Champsosaurus*, but has a much smaller skull for small preys. The short-snout ecomorph includes the crocodile-like Simoedosauridae and small lizard-sized Monjurosuchidae, and is generally characterized by a strong jaw with high closing MA. Comparison of choristoderan lower jaw mechanics to that of extant reptiles shows that *Champsosaurus* and *Hyphalosaurus* have a VA similar to living piscivorous reptiles (gavials). The short-snout ecomorph has an MA similar to living alligators, indicating their ability to prey on middle to large sized vertebrates. Furthermore, the difference of maximum MA and VA values for jaw closing between the short-snout ecomorph and the other two ecomorphs is statistically significant. Quantitative assessment supports dietary divergence in choristoderes, and indicates the importance of ecological adaptation in species diversification for choristoderes.

Poster Session IV (Saturday, November 5)

BASAL HADROSAURIFORM DINOSAURS FROM THE EARLY CRETACEOUS MAZOGNSHAN AREA OF GANSU PROVINCE, NORTHWESTERN CHINA

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Xuwulong yueluni is the latest reported basal hadrosauriform dinosaur from the Early Cretaceous Mazongshan area of northwestern Gansu Province of northwestern China. The specimen is based on an articulated specimen including a complete cranium, almost complete axial skeleton, and complete left pelvic girdle. *Xuwulong* is among the most basal members of hadrosauriform dinosaurs, and distinguished by its unique lower jaw in having a V-shaped rostral end of the dentary in lateral view and a mandibular articular surface which levels with mid-height of the dentary ramus, as well as an enlarged and downturned prepubic process.

Jintasaurus is recovered from the same horizon as *Xuwulong* in the Yujingzi Basin of Mazongshan area. It is represented by an articulated posterior portion of the skull and is unique in having an extremely long, pendant and crescentic paroccipital process with its ventral tip projecting far beyond the ventral level of the occipital condyle. Phylogenetic analysis recovers *Jintasaurus* as the sister-taxon to Hadrosauroidea (Hadrosauroidea includes *Bactrosaurus johnsoni*, *Parasaurolophus walkeri*, their most recent common ancestor and all descendants), more derived than other Early Cretaceous hadrosauriforms and *Protohadros* from the early Late Cretaceous of North America. The co-occurrence of two basal hadrosauriforms, together with a third (*Equijubus*) from the Xinminpu Group in nearby Gongpoquan Basin, indicates a rich diversity and abundance of basal hadrosauriforms in the Mazongshan area of northwestern China, and further supports the hypothesis of an Asian origin of hadrosauroids.

Poster Session II (Thursday, November 3)

A SAURODONTID FISH FROM THE LATE CRETACEOUS OF DAKHLA OASIS, WESTERN DESERT, EGYPT

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Field exploration efforts in Upper Cretaceous deposits in southern Egypt have recovered representatives of most major vertebrate clades, including dinosaurs, pterosaurs, turtles, marine reptiles, crocodyliforms, and sarcopterygian and osteichthyean fishes. Among the latter is a remarkable saurodontid fish consisting of a nearly complete skull with an articulated and dissociated series of vertebrae, numerous articulated costal elements, and a pectoral fin. The specimen was recovered from marine calcareous shale of the late Campanian Duwi Formation exposed near Dakhla Oasis, Western Desert, Egypt.

Although severely flattened, the specimen is very well preserved. The edentulous unpaired predentary bone, a neomorphic ossification projecting from the lower jaw and extending beyond the anterior margin of the upper jaw, is not preserved. However, the anterior surface of the dentary bears an articulation for this midline bone. Computed tomography reveals that the teeth are cylindrical, short and thin, forming a single series on the lower and upper jaws, consistent with what is known in other saurodontid fishes. Moreover, there is a small foramen/fossa positioned near the base of each tooth along the lingual surface of the tooth-bearing elements. This feature, along with the presence of a predentary bone, represents saurodontid synapomorphies. The teeth also are deeply rooted with short crowns, characters not seen in saurdontid fishes.

The Egyptian specimen is an exceptionally large saurodontid. Its predicted body length is estimated as ca. 3.5 m, based on cranial: postcranial proportions of more completely known saurodontids. Saurodontidae, a family of the stem-teleost Ichthyodectiformes, is presently known only from Upper Cretaceous deposits of North America, Europe, and Asia. The clade is currently represented by three established genera, *Saurocephalus*, *Saurodon,* and *Prosaurodon*, all of which are best known from material collected in North America. Thus, the specimen reported herein represents the first record of Saurodontidae from Africa.

Poster Session III (Friday, November 4)

THE DECIDUOUS DENTITION OF *DIDYMICTIS* (VIVERRAVIDAE) AND THE FIRST APPEARANCE OF HYAENODONTIDAE

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Mammalian deciduous premolars differ from their permanent counterparts in small but predictable ways that can nevertheless obscure relationships. As a result, deciduous premolars of fossil mammals are frequently misidentified as permanent teeth of different, often unrelated taxa. This is particularly true of members of Carnivoramorpha, due to the fact that DP4 has an elongate metastylar shearing crest, while its permanent equivalent, M1, lacks a metastyle. To avoid such confusion, it is critical that deciduous dentitions be documented when possible, particularly those of carnivoramorphans.

Among extinct, basal members of Carnivoramorpha, deciduous dentitions of one family, Viverravidae, have not been described. Viverravid deciduous premolars are reported for the first time, based on material referable to *Didymictis protenus* from the early Eocene Willwood Formation of Wyoming. Several specimens preserve deciduous teeth of *D. protenus* in association with elements of the permanent dentition, permitting confident identification. Elements of the deciduous dentition of *Didymictis* are smaller, lower crowned, less trans-

verse, and with weaker development of the principal cusps than their permanent equivalents. As in members of the carnivoran crown group, DP4 has a well- developed metastyle, which is lacking on M1.

These new specimens permit a re-evaluation of two Paleocene taxa of controversial affinities. *Prolimnocyon macfaddeni* and *Deltatherium durini*, both from the middle Paleocene of western North America, have been considered possible representatives of the creodont family Hyaenodontidae. Comparisons of the principal specimens of these taxa to deciduous premolars of *Didymictis* indicate that both are based on viverravid deciduous premolars. *Prolimnocyon macfaddeni* is based on the deciduous dentition of *Protictis haydenianus*, while *D. durini* represents a late species of *Protictis* or an early species of *Didymictis*. The reidentification of these taxa eliminates the only potential records of Hyaenodontidae from the North American Paleocene and the only records of the family prior to the latest Paleocene.

Technical Session XIV (Saturday, November 5, 9:45 am)

BODY MASS EVOLUTION IN OMNIVOROUS/HERBIVOROUS COELUROSAURIAN DINOSAURS

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Increasing body mass has long been recognized as a way to maximize the digestibility of plant fodder and is generally considered to pose a selective advantage in the evolution of herbivorous tetrapods. At face value, herbivorous dinosaurs appear to epitomize this process by ranking as the largest terrestrial vertebrates known. However, many carnivorous dinosaurs also achieve gigantism and some herbivorous dinosaur clades exhibit a trend toward miniaturization, so the role of herbivory in the evolution dinosaur body mass remains unclear. Moreover, the initial dietary shift from carnivory to herbivory is poorly represented in the majority of dinosaur clades, rendering it difficult to test for corollary increases in mass when they are expected to be most evident. One exception lies in bird-like, theropod dinosaurs (Coelurosauria), which are known to exhibit high trophic diversity and whose fossil record spans the dietary shift from ancestral hypercarnivory. Among the nine major clades of coelurosaurians, four are known to be omnivorous or herbivorous, and three of these also achieve relative gigantism (>3000 kg).

Here we reconstruct the evolution of body mass in the major omnivorous/herbivorous coelurosaurian subclades (Therizinosauria, Ornithomimosauria, Oviraptorosauria, and Alvarezsauroidea) using linear and squared change parsimony. Our analyses fail to recover a significant phylogenetic trend of increasing mass in any of these clades using a generalized least squares approach, despite an apparent increase in mean mass over time in Therizinosauria, and weak evidence for larger magnitudes of mass increases verses decreases in Therizinosauria and Ornithomimosauria as determined by Wilcoxon signed rank tests on ancestral descendant pairs values. Such a pattern minimally substantiates that increasing mass is not a universal trend among noncarnivorous theropods. Furthermore, our results demonstrate that either ecological and/or taphonomic factors exerted a more pronounced influence over body-size evolution in theropods than has been previously presumed or omnivorous/herbivorous coelurosaurians engaged in alternative strategies for increasing dietary efficiency.

Poster Session II (Thursday, November 3)

THE RELATIONSHIPS AND TYPE LOCALITY *HEPTASUCHUS CLARKI*, CHUGWATER GROUP (MIDDLE TO UPPER TRIASSIC), SOUTHEASTERN BIG HORN MOUNTAINS, WYOMING, USA

ZAWISKIE, John, Cranbrook Institute of Science, Bloomfield Hills, MI, USA; DAWLEY, Robert, Ursinus College, Collegeville, PA, USA; NESBITT, Sterling, University of Washington, Seattle, WA, USA

Loricatan pseudosuchians (previously known as "rauisuchians") typically consist of poorly understood fragmentary remains known worldwide from the Middle Triassic to the end of the Triassic. Renewed interest and the discovery of more complete specimens recently revolutionized our understanding of the relationships of archosaurs, the origin of Crocodylomorpha, and the paleobiology of these animals. *Heptasuchus clarki* was the first formally recognized North American "rauisuchian" and was collected from a poorly sampled and disparately fossiliferous sequence of Triassic strata in North America. The *H. clarki* type locality occurs within a sequence of red beds above the Alcova Limestone and Crow Mountain formations within the upper Chugwater Group which is exposed along the trend of the Casper Arch flanking the S.E. Big Horn Mountains. The age of the type locality is poorly constrained but is likely similar to or just older than that of the Popo Agie Formation assemblage from the western portion of Wyoming. The holotype consists of associated cranial elements found *in situ*, and the paratypes consist of crania and postcrania that are referable to the same taxon. Thus, about 50% of the osteology of the taxon is preserved. All of the pseudosuchian elements collected at the locality appear to belong to *Heptasuchus* and the taxon is not a chimera as previously hypothesized. *Heptasuchus* is distinct from all other archosaurs by the presence of large, posteriorly directed flanges on the parabasisphenoid and a distinct, orbit-overhanging postfrontal. Our phylogenetic hypothesis posits a sister-taxon relationship between *Heptasuchus* and the Ladinian-aged *Batrachotomus* from Germany within Loricata. These two taxa share a minimum of six discrete character states and further support the hypothesis that crocodylomorphs are loricatans. A minimum of four individuals of *Heptasuchus* are present at the type locality suggesting that a group of individuals died together. Moreover, aggregations of loricatans (e.g., *Heptasuchus*, *Batrachotomus*, *Decuriasuchus*, *Postosuchus*) are common suggesting that these animals may have lived in groups.

Technical Session XIV (Saturday, November 5, 9:00 am)

IMPORTANCE OF OLFACTION DURING THEROPOD EVOLUTION

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The nature of sensory changes that occurred during theropod evolution has recently been a topic of investigation. Here, we investigate the evolution of olfaction in Theropoda using the relative size of the olfactory bulbs, a neuroanatomical proxy for olfactory capabilities, for 157 species of non-avian theropods, fossil birds, and living birds. The size of the olfactory bulbs relative to the size of the cerebral hemispheres was quantified from braincase elements and from physical and virtual (CT scan-derived) endocasts for fossil taxa, whereas those for living taxa were derived from soft-tissue measurements available in the literature. Our results reveal that relative olfactory bulb size remained constant during a major portion of non-avian theropod evolution until a significant decrease occurred in Maniraptoriformes. Relative olfactory bulb size subsequently increased in Eumaniraptora, remained constant across the theropod-bird transition, increased through basal bird evolution, and then jumped in ancestral Neornithes. Olfactory bulb size remained stable through much of neornithine evolution, until it decreased in derived neoavians. Although olfaction is generally considered to have declined through theropod evolution while vision and other senses were enhanced, our results show instead that olfaction improved from Maniraptoriformes through to modern birds. Overall, olfaction remained an important sense during theropod evolution, as indicated by significant increases in the size of the olfactory bulbs in several clades of non-avian theropods (e.g., tyrannosaurids, dromaeosaurids) and basal neornithines (e.g., palaeognaths, procellariiforms). Better olfactory capabilities in early neornithines may have provided them with a competitive advantage for foraging or navigation over other Cretaceous bird lineages.

Poster Session III (Friday, November 4)

A LARGE CLUTCH OF DINOSAUR EGGS SHOWING UNEXPECTED VARIABILITY FROM YUN COUNTY, HUBEI PROVINCE, CHINA

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About 15 years ago, huge numbers of dinosaur eggs were recovered from Qinglongshan Mountain, Yun County, Hubei Province, China. The finds included a very large nest of about 61 eggs. This nest contained a greater number of eggs than any other known from China, even from the world, but has never been described in the literature. Recently, we went to Yun County to measure and photograph this large nest, and took shell fragments from different eggs to be thin-sectioned in the laboratory. Both radial and tangential sections show features indicating that the eggs belong to the oofamily Dendroolithidae. Furthermore, to our surprise, at least two microstructurally distinct egg types are present within the nest, and show differences of such magnitude that they can be assigned to different oospecies. It is possible that this clutch was laid by more than one individual. Based on eggshell microstructure, clutch size, and the way that the eggs belonging to the different types were arranged, we speculate that several dinosaurs that may have either been conspecific or members of different but closely related species contributed to the nest. The extremely large number and high diversity of eggs in this clutch provide both new insights and new puzzles with regard to dinosaur nesting behavior.

Poster Session I (Wednesday, November 2)

MASTICATORY PATTERN RECONSTRUCTION OF *MESODMA* (NEOPLAGIAULACIDAE, MULTITUBERCULATA, MAMMALIA) BASED ON TOOTH WEAR STUDY

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Except for *Ptilodus*, masticatory patterns of multituberculates have been rarely studied. The wear pattern of *Mesodma*, a widespread and important representative of neoplagiaulacids, is studied through extensive observations on more than four hundred specimens including *M. hensleighi*, *M. formosa*, and *M. thompsoni*, using a light microscopy. The main aim of this study is to compare the masticatory pattern of *Mesodma* to that of *Ptilodus* as well as to discuss their functional implications. Although generally similar wear features characterize both genera, differences between *Mesodma* and *Ptilodus* in tooth wear emerged that suggest different ways of processing food.

The orientation of wear striations on p4 and the dentine exposure pattern of molar cusps suggest that during the power stroke, the lower jaw was simultaneously elevated and retracted toward the upper jaw. From the obliquely oriented wear striations on the posterolingual side of P4, and the dentine exposure pattern on the lingual side of the posterior lingual cusps on P4, it is inferred that p4-P4 attrition happened during postero-orthal shearing between the labial side of p4 and the lingual side of P4. On P4 the wear facet first appeared at the posterodorsal side and subsequently developed ventrally. Reciprocally, on p4 it first appeared at the posteroventral side and subsequently developed dorsally. The wear facet on both blades extends anteriorly on more heavily worn specimens compared to less worn specimens, suggesting more extensive contact with wear. Most p4's maintain relatively differentiated serra-

tions even with well developed posterolabial wear facet. The wear pattern on m1 shows that during retraction, the lower dentition only slid for a short distance against the upper dentition. The extensive wear facet on both P4 and p4, and the relatively high crown of P4 shows that shearing played an important role in the masticatory cycle of *Mesodma*.

Technical Session I (/Wednesday, November 2, 12:00 pm)

LONG BONE HISTOLOGY AND GROWTH PATTERNS OF *PSITTACOSAURUS LUJIATUNENSIS* (CERATOPSIA: PSITTACOSAURIDAE)

ZHAO, Qi, University of Bristol, Bristol, United Kingdom; BENTON, Michael, University of Bristol, Bristol, United Kingdom; HAYASHI, Shoji, 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; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Psittacosaurus, the most species-rich dinosaurian genus, contains more than 12 species, although some of them are potentially invalid. In this study, eight individuals of *Psittacosaurus lujiatunensis* from the Jehol Biota of China were histologically sampled, resulting in 16 thin-sections taken from the midshafts of tibiae, humeri, and femora. The sample, spanning a growth series from hatchling to adult developmental stages, was examined for life history and longevity estimates based on diaphyseal growth line counts and other features of histology. We recognized four histologic ontogenetic stages, i.e., hatchling, juvenile, sub-adult, and adult. None of the specimens were fully grown, however. Radial vascular canals were found in the humeri of the hatchling stage (less than one year old), compared with only longitudinal vascular canals in femora. This suggests that the humeri grew faster than the femora in this stage, possibly indicating that *Psittacosaurus* was quadrupedal as a hatching. Four individuals in our study were from a cluster of six small *Psittacosaurus* individuals, which was reported in 2007. The largest individual in the cluster was three years old while the others where two years old, indicating that this cluster contained offspring from two different egg clutches. The cluster thus represents the remains of a mixed-age herd as previously hypothesized. Compared with the growth stages of *Psittacosaurus mongoliensis*, different growth patterns were found in *P. lujiatunensis*, especially in the juvenile stage. Longitudinally vascularized canals formed half of the growth zones from ages three to four in the femora of *P. lujiatunensis*, but none were found in *P. mongoliensis* at this age, indicating inter-species differences in bone histology in *Psittacosaurus*. Thin sections of the tibia and humerus from *Hongshanosaurus houi* were also analyzed in this study and compared with *P. lujiatunensis*. The similar growth patterns suggest that *H. houi* may be a synonym of *Psittacosaurus lujiatunensis*.

Technical Session XVI (Saturday, November 5, 8:30 am)

NEW CHARACTER DIAGNOSIS YIELDS NOVEL PERSPECTIVES ON THE INTERRELATIONSHIPS OF MAJOR GNATHOSTOME GROUPS

ZHU, Min, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; YU, Xiaobo, Kean University, Union, NJ, USA; QU, Qingming, Uppsala University, Uppsala, Sweden

Phylogenetic analysis based on new character diagnosis (including revised character formulations and codings) provides novel perspectives for reconstructing the interrelationship of major gnathostome groups (Placodermi, Acanthodii, Chondrichthyes and Osteichthyes). Characters previously used to unite *Acanthodes* and the Osteichthyes (e.g. the tropibasic basicranial morphology, the ascending basipterygoid pilla pierced by internal carotid), and characters previously used to assign the *Psarolepis* - *Guiyu* clade to the Sarcopterygii (e.g. the intracranial joint, the unconstricted cranial notochord), have been re-evaluated. Comparison between the *Psarolepis* - *Guiyu* clade and stem osteichthyan *Ligulalepis*, especially in neurocranial features (e.g. the postorbital pilla, the spiracular groove lying in front of lateral commissure) leads to revised codings and suggests that the *Psarolepis* - *Guiyu* clade might have a more basal position than previously thought. In addition, new findings of Silurian placoderms further challenge the view that a fundamental difference of dermal bone pattern exists between placoderms and osteichthyans. The resulting new character-by-taxon matrix yields topologies suggesting that 1) *Acanthodes* may be a stem chondrichthyan rather than a stem osteichthyan; 2) the *Psarolepis* - *Guiyu* clade may be stem osteichthyans rather than stem sarcopterygians; and 3) placoderms remain paraphyletic at the base of jawed vertebrates. Accordingly, the phylogenetic gap between placoderms and osteichthyans now appears to be less substantial than implied by previous phylogenies. With acanthodians as stem chondrichthyans and the *Psarolepis* - *Guiyu* clade as basal osteichthyans, new scenarios of gnathostome character evolution can be proposed, and observed morphological resemblances between placoderms and osteichthyans (e.g. similarities in dermal and endoskeletal girdle components between placoderms and the *Psarolepis* - *Guiyu* clade) can be explained more parsimoniously in this new light.

Poster Session I (Wednesday, November 2)

ASPIDIN OR GALEASPEDIN: NEW EARLY VERTEBRATE HISTOLOGY FROM THE LOWER SILURIAN OF SOUTHERN SIBERIA

ZIGAITE, Zivile, Uppsala University, Uppsala, Sweden; KARATAJUTE-TALIMAA, Valentina, Vilnius University, Vilnius, Lithuania

Micromeric tesserae of a galeaspid-like vertebrate from Irkutsk region in southern Siberia (Balturino district) come from a single outcrop near Old Balturino village, on the right bank of the Tchuna River, the left tributary of the River Angara. Vertebrate microremains are common in the Balturino Formation, which is Upper Llandovery (Telychian) in age, corresponding to the Agidyan Regional Stage, and consists of brackish lagoonal and proximal deltaic sediments with intercalating bone beds. Tesserae of this peculiar early vertebrate are comparatively large, up to 3 – 3.5 mm in diameter, flattened and cone-shaped, sometimes polygonal, oval or even quadrate, with a single or several growth centers. The growth center might be located either symmetrically in the middle, or be asymmetric. Continuous horizontal lamination and Sharpey's attachment fiber spaces are clearly observed in the thin sections, so as is the capping spheritic layer, characteristic of the galeaspedin. However, any perpendicular calcified fiber bundles, if present, are not distinct. The observed histology suggests a new tissue type with both features of aspidin and galeaspedin.

INDEX

INDEX

INDEX

I

J

K

L

M

INDEX

INDEX

T

U

V

W

X

Y

Z

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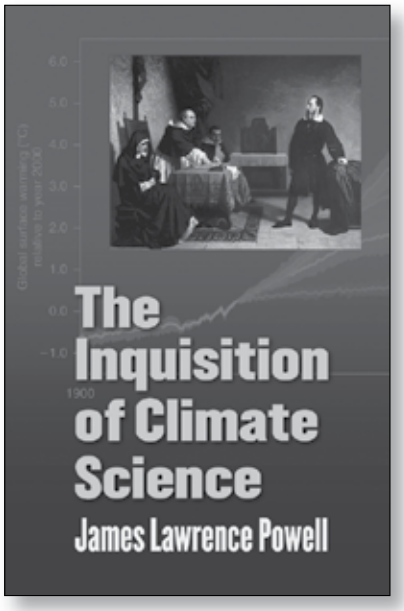

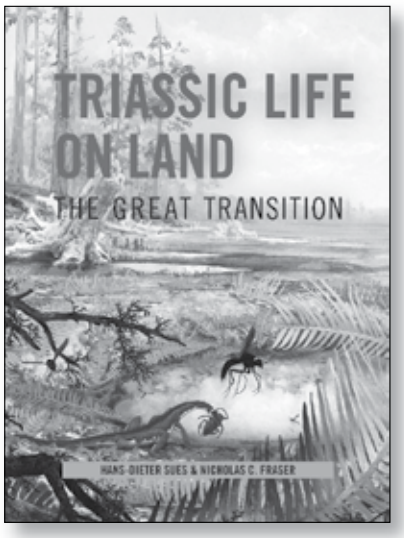

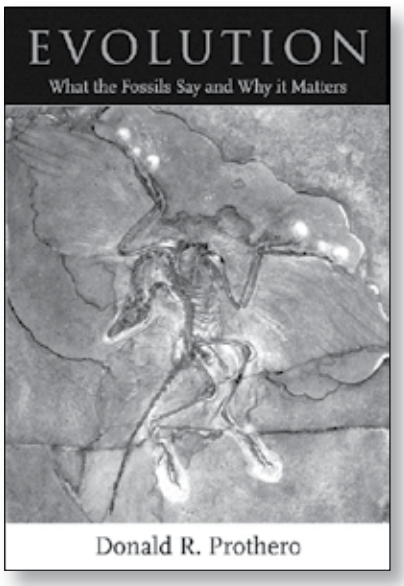

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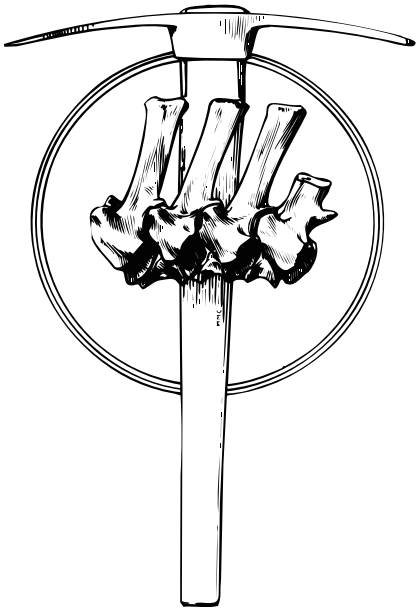

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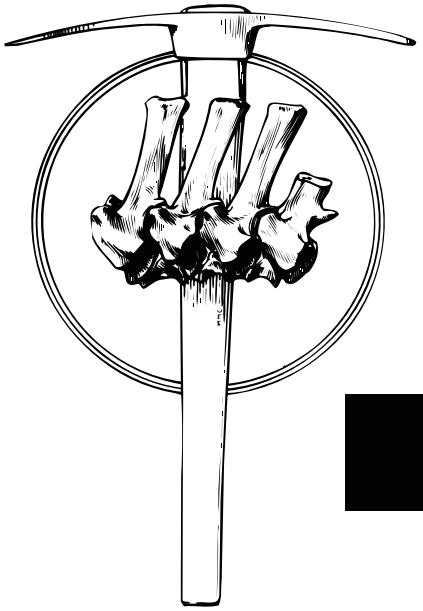

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